WECOUNT

WeCount: Citizens Observing UrbaN Transport

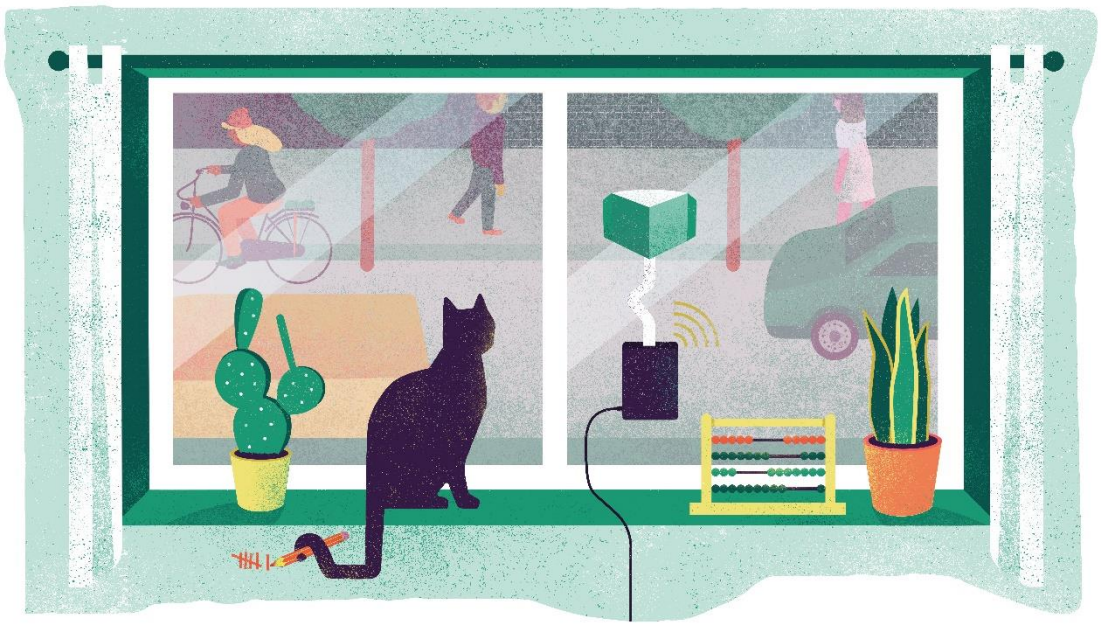
Deliverable 4.2: Summative Case Study Report – Cardiff, Dublin and Ljubljana

PART A: Introduction

Report for:
European Commission
Research Executive Agency (**REA)**

Date: June 2021

Authors: Lucija Ažman Momirski, Anja Bagon, Jon Šinkovec, Tomaž Berčič



The WeCount Project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 872743

Document Details

Authors	Lucija Ažman Momirski, Anja Bagon, Jon Šinkovec, Tomaž Berčič
Contact	Lucija.azman@fa.uni-lj.si
Creation Date	June 2021
Date of Last Revision	
Description	This document represents the second version of Deliverable 4.1. It summarizes the process of the realization of establishing the citizen science activity, the results of the citizen engagement in terms of participant involvement, data analysis on data generated in the citizen science activity and policy impact. The Summative Pilot Report builds on the experience of the three WeCount case studies, i.e. in England (Cardiff), in Ireland (Dublin) and Slovenia (Ljubljana).

Version History

Version	Updated By	Date	Changes / Comments
1.0	Lucija Ažman Momirski	March 2021	Document draft
1.1	Anja Bagon, Jon Šinkovec	April 2021	Content/Layout
1.2	Tomaž Berčič	May 2021	Review
1.3	Anja Bagon, Jon Šinkovec	May 2021	Full review
2.0	Lucija Ažman Momirski	June 2021	Final version

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Contents

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1 Introduction

WeCount, Citizens Observing Urban Transport, is a Horizon 2020 funded project that is part of a Science with and for Society (SwafS) call (H2020-SwafS-2018-2020). WeCount is a Citizen Science project working in five cities in Europe to empower citizens to take a leading role in producing data, evidence, and knowledge around mobility in their own neighborhoods and at the street level. The project applies participatory Citizen Science methods to collaboratively develop and deploy innovative, low-cost, automated traffic counting sensors (e.g., Telraam) and multi-stakeholder engagement mechanisms in five case studies in Leuven (BE), Madrid and Barcelona (ES), Cardiff (UK), Dublin (IE) and Ljubljana (SI). The five cases will follow a similar execution path, with Leuven & Madrid (and Barcelona) leading off and serving as a test case for the remaining three cases. Following this approach, WeCount aims to quantify local road traffic (cars, trucks, active modes, and speed), produce scientific knowledge in the field of mobility and pollution, and co-design informed solutions to address a variety of road transport challenges. In addition, the project provides cost-effective data for local authorities on a much larger temporal and spatial scale than would be possible with traditional traffic counts, opening up new opportunities for transportation policy and research.

This deliverable represents the second version of the document reporting activities conducted as part of WeCount's Work Package 4 (WP4): Use Cases: 5 Citizen Science Activities. This WP is the central component of the WeCount project. The main goal of the WP is to implement citizen science activities (WP2) and sensor arrays (WP3) across five case studies and explore how they can contribute to solving a variety of societal problems related to transportation that are important to citizens. This WP builds on previous Citizen Science activities (e.g., the Telraam pilot in Leuven) and scales to other cases in terms of scope (e.g., linking with other low-cost sensors from iSCAPE), size (more sensors per case), and geographic location (five cities in Europe).

Because the processes of finding local communities and individual citizens (local champions), scanning local communities, community building and citizen science activities, communication techniques used, co-design processes with participating citizens, workshops, communication activities, customizations of the platform and sensors, assembly, distribution and installation of sensors, data collection, processing of raw data, data analysis and interpretation were so extensive in detail, this document is therefore organized as follows:

- Part A: Introduction;
- Part B: Cardiff;
- Part C: Dublin;
- Part D: Ljubljana

The deliverable brings the summative case study report for three case studies, Cardiff, Dublin and Ljubljana.

Part A summarizes the actions related to scoping, community building, and co-design throughout the case studies, data collection and analysis, the case studies outcome, and planned actions for the future.

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2 Scoping, community building and co-designing the local citizen science activity

The most important step was to find local communities and individual citizens ("local champions") and their concerns about local transportation. This activity involved scanning the public realm, which led to direct meetings with community leaders and local champions able and willing to set up a citizen science activity. The activities were based on mapping existing citizen activities and groups (in collaboration with T 2.3) and identifying their needs, interests, and willingness to participate, as well as the type of support they need to effectively engage in citizen science.

The steps consisted of building the community around the citizen science activity using communication techniques common to any community (local Facebook groups, gatherings, community meetings, etc.). This led to a series of workshops with local citizens explaining the capabilities of WeCount. Once community leaders were identified, they were offered ongoing support to set up traffic count sensors.

The pilot reports present:

- Descriptions of the strategies used to build community management with the local champions;
- Description of how the community building evolved and what communication techniques were used.

2.1 Cardiff

This phase of the case study involved stakeholder and policy mapping, raising awareness of the project and co-designing local transport challenges faced by citizens. The key citizen engagement activity was a series of WeCount introductory and scoping workshops starting in August 2020 and ending in November 2020, with occasional updates as new members join. The primary task for Phase 1 was to undertake a rapid review of relevant transport-related policies and data in Cardiff. This review, while not exhaustive, provided the foundation upon which future conversations and interactions with Cardiff citizens could be based. In parallel to this policy review, a stakeholder mapping exercise was undertaken to understand the key networks, organisations, communities and individuals that could be engaged with WeCount Cardiff.

Stakeholder mapping was carried out to identify key stakeholders/actors in the city who might be interested in participating, willing to promote the project and/or interested in the project activities and outcomes. Engagement with these stakeholders, mainly through social media, opened doors to other communities that might not otherwise have been reached.

The process of scoping, identifying problems and co-creating solutions was done through participatory online workshops.

2.2 Dublin

The chapter provides a detailed description of the actions and interactions undertaken throughout the case study in relation to scoping and co-designing the intervention, as well as the ongoing efforts in exploring, building, establishing, sustaining and utilising diverse communities of different stakeholders in WeCount Dublin and spreading to Greater Dublin and the rest of Ireland.

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In Dublin actions began with mapping and engaging a range of strategic, high-level stakeholders to facilitate access to local communities in the Ringsend area (section 2.1). Engagement with high-level stakeholders and social media activity opened the way for expanded citizen science activities with local communities in Greater Dublin and the rest of Ireland (Section 2.1). The wide dissemination of activities nationally presented some challenges, exacerbated by the COVID pandemic, so the team had to quickly adapt their engagement strategy, integrating it with a range of online tools (Sections 2.2, 2.3, 2.4) to deliver the co-design workshops, provide support for sensor installation and other engagement activities. Ongoing dialogue with local communities highlighted a common traffic-related problem in the vicinity of local schools, so it was decided to implement a second set of Citizen Science activities focusing specifically on schools and integrating the traffic sensors with particulate matter sensors (section 2.5). The whole series of activities was supported by a multi-media communication strategy involving the promotion of citizen science activities through national television, local and national newspapers, NGOs and local group channels, local authorities, national authorities, social media and other channels (section 2.6).

2.3 Ljubljana

In the case of the study in Ljubljana, the focus was on cycling and the identification of cycling corridors. In the first phase associations and networks dealing with sustainability, green transport policy and cycling were identified and contacted. In the second phase, the search parameters were widened to find also other local stakeholders, mainly due to the poor response of the previous contacts. The team focused on educational institutions that would engage the younger population, PGD's (volunteer fire services) that play an important role in the local communities, and others who might be interested in the project. Because of the Slovenian social context, two new local networks in Novo mesto and the Primorska region expanded original network in Ljubljana. Several set up social networks increased local community participation in citizen science activities: Facebook (WeCount Slovenija) - spreading news, sharing events and tutorials; Twitter (WeCount Ljubljana) - spreading news, sharing events and tutorials, LinkedIn (WeCount Ljubljana) - expanding the network; YouTube (WeCount Ljubljana) - sharing tutorials (in preparation). The professional journals (non-scientific publications) published four articles about WeCount Slovenia. The actions and interactions undertaken in relation to scoping, co-designing the intervention, the ongoing efforts in exploring, building, establishing, sustaining and utilising communities of different stakeholders in WeCount in Slovenia were very diverse with the aim to reach as many participants as possible.

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3 Data Collection

This task is a series of workshops with all participants in the citizen science activity, explaining the approach to the activity in detail, developing the automatic sensor setup so that all participants can easily install the sensor, setting up a support/help desk structure led by people from the local community, with the project team's role focused on providing behind-the-scenes support to these local champions. This effort is gradually building toward data collection with automated sensors, which is the next task. The pilot reports present:

- Description of citizen engagement;
- Analysis of problematic and successful strategies.

3.1 Cardiff

This phase of the case study involved the recruitment of citizen scientists to build a WeCount Cardiff network using Telraam sensors. The key citizen engagement activity was the deployment of the Telraam sensors. This phase began in October 2020 and is ongoing as new members join.

Community building is an ongoing process throughout the WeCount Cardiff case study. Formal and active recruitment of citizens is coming to an end, but passive recruitment will continue as long as there is interest from citizens to participate. Registration rates were initially high from October to December 2020 and have since been received at a relatively low but steady rate. At the time of writing (June 2021), the Cardiff case study had 263 registered members, of which 17 members were only interested in participating as volunteers. Of the registered members, 103 completed the second web form.

The team in Cardiff bought unassembled Telraam sensors instead of pre-assembled sensors and initially ordered 100 of the Telraam sensors from the supplier (Gotron). As they were unable to run face-to-face sensor build workshops, they created a series of support tools to help participants in a socially distanced way (during the highest lockdown restrictions, sensor delivery was postponed).

3.2 Dublin

In the Dublin case study, the decision was made to purchase a combination of pre-assembled and unassembled Telraam sensors. Due to travel restrictions imposed by the pandemic, some of the funds were reallocated, i.e. the funds were used to purchase more sensors (150 pre-assembled sensors and 150 unassembled sensors instead of the 200 sensors originally planned from the supplier (Gotron)) instead of travelling to the meetings. The unassembled sensors were purchased to be used in face-to-face school and community workshops, and the pre-assembled sensors for direct collection by or delivery to participants. Each sensor that was shipped was accompanied by step-by-step instructions for installation. Despite these detailed instructions, many participants encountered difficulties installing the sensor.

There are a total of 186 registered users on the Dublin network, of which 57 users should be classified as inactive due to administrative accounts, accounts used for testing purposes (e.g. by students), duplicate registrations and people registering without having a Telraam sensor. The remaining users were participants who had been sent a sensor and some had received a sensor from a Community Champion. Of these users, five have not completed installation (as of 18/05/2021), 10 have completed installation but their sensor

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has not yet sent data, and 113 users are actively counting traffic or have counted traffic sometime after installation. In addition to the Dublin network, there are several sub-networks of traffic sensors across Ireland, in areas such as Kilkenny, Limerick, Ennis and Co. Laois. There are a total of 33 users registered on these networks. The membership registration website was closed in January 2021 after the pre-assembled sensors were dispatched.

3.3 Ljubljana

At the end of March 2020, the team in Ljubljana ordered 200 sets of unassembled Telraam devices from the supplier (Gotron). The original plan was for WeCount participants to assemble the devices themselves and to organise special workshops where the devices would be presented and assembled. Due to the limitations of COVID -19 and the possibility of device failures and delays in detecting problems in the operation of the devices, 150 devices were assembled, tested, loaded with programmes and updated by the team. The rest of the devices were left for participants to assemble, for which a video of the process of assembling the devices and other video instructions were recorded. We created a Youtube profile WeCount Ljubljana, which is accessible to everyone.

The first Telraam device was installed at the window of the Faculty of Architecture on 6 December 2019. The purpose of the installation was to understand the operation of the device in detail, to mount the device and to learn about the registration process. The aim was to anticipate problems that might arise during the registration of participants and the installation of the equipment. During assembly, it became clear that the sensor needed improvements, which were later included in the shipping package. Despite low participation in the online workshops, most participants successfully installed the Telraam device. Where problems arose, these were resolved through site visits, telephone, video and email communication. Companies and interested schools installed the devices. In Ljubljana, Novo mesto and the Littoral area, a total of 188 participants have registered for the WeCount project by April 2021. In Ljubljana, about 46 devices are working stably, out of the 73 sent. 14 devices have counted traffic in the past and 12 never counted at all.

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4 Data Analysis and Awareness

The result of this task is a continuous flow of monitoring data that generates a growing dataset of traffic counts and other sensor data. The focus is on extracting useful information from the data beyond the simple dashboard in the platform. Processed raw data from autonomous sensors is used to create a validated dataset with metadata that can be shared with participants and the public. The WeCount dataset offers a wide range of analytics, using a variety of tools to achieve this goal. A mix of participant engagement techniques (surveys, workshops, etc.) help to learn what aggregate and detailed output indicators can be extracted from the autonomous sensor dataset. Organizers and citizens explore what information from the data is likely to be relevant/prioritized/sensitive to policy makers.

The pilot reports present:

- Analysis of the data generated during the citizen science activity;
- Description of how the raw data were processed and the role of the participants;
- Commentary on which analysis are actually relevant to citizens;
- Interpretation of the data;
- Information about interactions with policymakers.

4.1 Cardiff

The aim of this phase was to work with citizens to understand how to analyse and interpret the data. The key citizen engagement activities were a series of workshops on data analysis and interpretation. This phase started in March 2021 and is still ongoing. It was decided to hold three types of workshops: Introductory workshops to identify area-specific issues related to transport and discuss the future direction of the project, data analysis and interpretation workshops to help participants explore their own data and data from their local community, and citizen advocacy and communication workshops. Participants were explained the value that Telraam sensor data can have at different geographical scales and for different audiences.

Analysing the data, an increase in cars and trucks across the Cardiff network has been observed, which may be related to a weekly increase in vehicle movements since Covid19 lockdown restrictions have been gradually lifted.

Many participants in Cardiff have also carried out data analysis for various purposes. For example, a data visualisation of a 9-year-old in Cardiff who used his parents' Telraam meter to inform his STEM activity.

4.2 Dublin

As all sensors in the Dublin network have been in operation for less than a year, only the available data for hour and day of the week was used. From a graph showing the relative counts (%) of bicycles and cars on the Dublin network from 6 May 2021 to 20 May 2021, it can be seen that bicycle counts tend to be higher than the typical count and car counts tend to be slightly lower than the typical count. Of course, this data should be interpreted with caution as most traffic sensors have only been counting for about two months and it is unlikely that a robust baseline has already been established. Nevertheless, the increase in cycling seems logical, as the warmer weather in May encourages more cyclists compared to March and April. From December onwards, the number of traffic sensors increased rapidly. In parallel, the mean counts of pedestrians, bicycles and heavy traffic increased from November to January, and the trend then levelled off, suggesting that the counters are now providing a more representative picture of the Greater Dublin

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area. In contrast, the average number of cars counted increased until March before levelling off. This is likely due to the greater variability of car traffic on different road types.

The general approach has foreseen three types of workshops: (1) Introductory workshops to identify area-specific issues related to transport and to discuss the future direction of the project. These workshops were held in April 2020. (2) Data analysis workshops to help participants explore the issues identified in the first workshop. These workshops are currently scheduled for July/August 2021. (3) Final workshops to discuss the overall results of the WeCount project. These workshops are planned for September/October 2021.

The main bridge to the policy level for the WeCount pilots in Greater Dublin and the rest of Ireland is linked to the activities in the school.

4.3 Ljubljana

The total number of all traffic categories in Ljubljana listed from November 2020 to March 2021 grows proportionally with the number of Telraam devices in operation. A large jump in all counts was observed in March, when the measures regarding COVID -19 were gradually relaxed, resulting in a higher number of road users. The team selected five road sections for detailed analysis: Zoisova Street, which is part of the inner ring road of Ljubljana and is heavily congested; Dunajska Street, which is one of the main access roads to Ljubljana, but the location of the sensor is outside the Ljubljana motorway bypass: Litijska Street, where the location of the sensor is also outside the Ljubljana motorway bypass; Pokopališka Street, a less congested street connected to another main access road to Ljubljana - Šmartinska Street - but the neighbourhood itself is exclusively residential; Street along the Ljubljanica, the least congested street along the Ljubljanica River, where cyclists and heavy traffic predominate. The analysis showed that fewer vehicles appeared when there were covid restrictions, but speeds were higher. Vehicles mostly adhered to the speed limit and only a small percentage exceeded it.

As part of the SNP course at the Faculty of Architecture, an exercise was conducted for urban planning students to test the usefulness of the data obtained from Telraam devices.

The main bridge to the policy level for the WeCount pilots in Ljubljana is connected to the Ljubljana City Council. In our search for suitable windows, we came across several buildings owned by the City of Ljubljana with a suitable view of the street where a Telraam device could be installed and traffic counted. The municipality showed great interest and recognised the many advantages of traffic counting with the Telraam device.

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5 Legacy and reflection – policy interaction

The ultimate goal of the use cases in this project is to achieve policy change as a direct result of the citizen science activity. This involves the continuous involvement of local authorities in the entire use case process, preparing city authorities to meet citizens' expectations, and likewise preparing citizens to engage in constructive dialogue with policymakers.

The pilot reports present:

- reflecting on the process, tools and methods;
- defining lasting impact.

5.1 Cardiff

In this phase, the team in Cardiff will help citizens to use the data for communication campaigns and to engage with and influence local transport policy. The third series of workshops will be introduced, focusing primarily on supporting citizens' groups to use the generated data in communication campaigns and to identify possible interaction pathways with local transport, environmental and public health policies.

The final series of workshops will be a selection of workshops on citizen advocacy. The workshops will provide practical resources, guides and tips to support local groups working for better urban mobility, clean air and a net zero carbon future. The workshops will provide advice to citizens on how to communicate their data (quantitative and qualitative) and ensure that they maximise the scale and reach of their activities.

Through the WeCount Cardiff network and a strategic alignment with the DETI initiative, the Cardiff team partnered with several Cardiff and Bristol based primary and secondary schools to support them in their active travel initiatives while also providing added value to STEM learning.

5.2 Dublin

Each case study was consistently conducted using the latest knowledge on citizen science and following the lessons learned from the case studies in Spain and Belgium. Participating citizens were actively involved during the different phases and it can be argued that the approach as a whole was fully citizen-centred.

As a legacy, a set of knowledge transfer resources and research and innovation tools have been created to enable other communities to replicate the Irish case study experience or other research and public sector institutions to undertake similar citizen science actions in the future: The WeCount Citizen Engagement Toolkit (WP2) which includes videos and printed instructions for assembling and installing the Telraam sensor; a printed step-by-step installation guide and a spoken video tutorial for this process; a guide to the installation and operation of the air quality sensors; a range of data analysis tools that can be used by non-technical people to gain valuable insights from the data.

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5.3 Ljubljana

Active citizens were involved in the project at different stages and with different strategies. With their help, we were able to identify traffic and other problems. Citizens participated in the co-design of the traffic counting network, the data analysis and the final reflection. Mitigation measures of COVID -19 changed the course of project implementation significantly. It was difficult to recruit new participants and build the network. Project implementation strategies had to be adapted and changed. Creating an initial plan to install 200 Telraam devices was very ambitious, but still feasible if a Covid -19 epidemic did not occur.

Several useful contents can be followed in different areas: Video content on the installation of the device and the registration process available to everyone on YouTube; Analysis of strategies and methods used to recruit people; Instructions on how to conduct online workshops, including presentations; Full instructions on how to extend the case study to other districts and cities in the country.

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6 Conclusion and next steps

The concrete next steps for the network in Cardiff are: the extension of the network to include Air Quality and Noise Sensors, the expansion of the case study to include schools engagement activities and links to the DETI Initiative, and legacy activities to ensure the maintenance of the network beyond the project lifetime and publication plans to disseminate the results.

The final phase of the WeCount pilots in Ireland will be to reflect on the overall process and outcomes and results of the intervention and to plan the legacy of a series of selected case studies. The selection of case studies will be based on the interest of the local community in receiving the sensors and using the data for policy proposals or other consultative processes.

For Slovenia, the realisation of the cooperation with the municipality of Nova Gorica, which wants to introduce Telraam sensors, is expected. Negotiations with the city of Ljubljana are in the final stages to install Telraam devices in the near future, which would give a clearer picture of traffic flows in the city. The results of the research will be presented to the public to draw attention to the problems where they have been noticed.

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WeCount: Citizens Observing UrbaN Transport

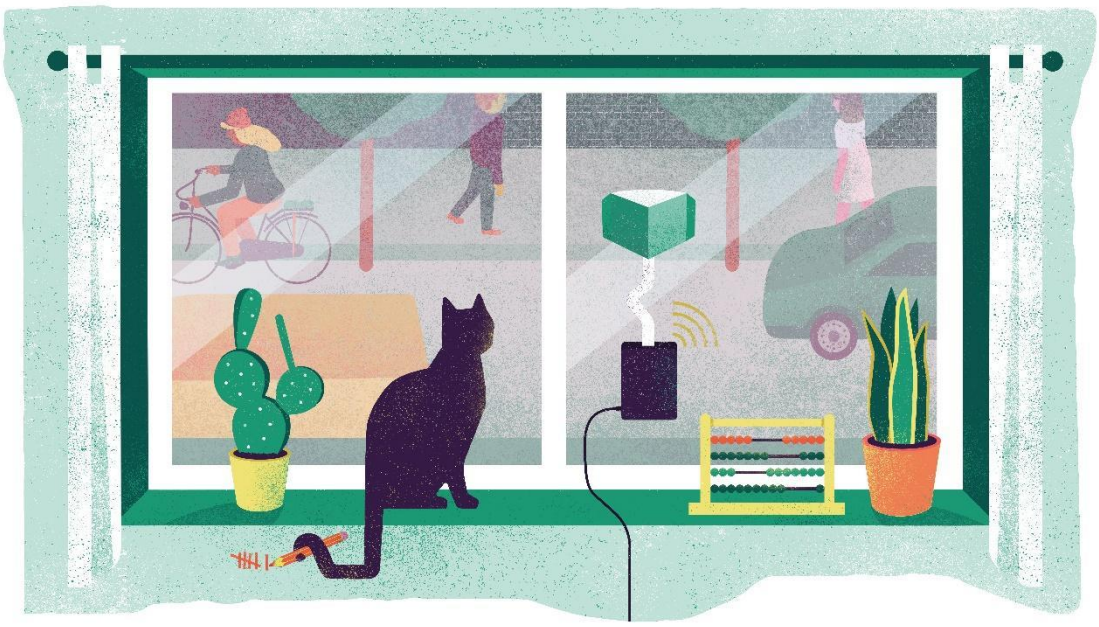
Deliverable 4.2: Summative Case Study Report – Cardiff

PART C: Cardiff, United Kingdom

Report for:
European Commission
Research Executive Agency (**REA)**

Date: June 2021

Authors: Enda Hayes and Ben Williams (UWE)



The WeCount Project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 872743

Document Details

Authors	Enda Hayes, Ben Williams
Contact	Enda Hayes (enda.hayes@uwe.ac.uk)
Creation Date	June 2021
Date of Last Revision	June 2021
Description	This report provides a detailed description and reflection on all activities and outcomes from the WeCount case study in Cardiff to date. The report follows the structure of the tasks within the work package, i.e. scoping and community building, data collection, data analysis and awareness, and reflection and legacy.

Version History

Version	Updated By	Date	Changes / Comments
1.0	Enda Hayes	21st June 2021	First draft with inputs from UWE team
2.0	Enda Hayes	25th June 2021	Second draft for review by WeCount team

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Contents

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The WeCount Project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 872743

1 Introduction to WeCount Cardiff

The Cardiff case study started in August 2020 and in keeping with the aims and ambitions of WeCount and the citizen science approach, participating citizens have assumed an engaged and proactive role across all phases of the case study, from its problem formulation and co-design, through data collection and analysis, and utilising the data generated for communication campaigns and policy engagement.

This report provides an overview of the activities carried out in the Cardiff case study to date (June 2021) and its next steps including planned expansion into Bristol and the West of England through schools activities. This report is structured across six sections, summarised as follows:

1. An introduction to the Cardiff case study and WeCount Cardiff network (Section 1).
2. An overview of the community building, co-design and initial engagement activities (Section 2).
3. A description of the steps taken to establishing the WeCount Cardiff data network and describes the data collection process (Section 3).
4. An initial overview of the transport data being collected to date (Section 4).
5. An overview of next steps in supporting citizen advocacy and policy interactions (Section 5).
6. A summary of proposed plans for the evolution of the WeCount Cardiff network and legacy plans (Section 6).

1.1 Overview of the WeCount Cardiff case study phases

Covid19 had a substantial impact on the Cardiff case study. As a project team, UWE, the Cardiff case study lead, made an early decision, primarily influenced by Welsh and UK Government guidance, to move all face-to-face interactions planned with participants online. Secondly, Covid19 changed traffic patterns in Cardiff due to businesses and schools being closed and most people being encouraged to work from home. Across the lifetime of the WeCount Cardiff network, the city has been in full or partial lockdown. Much of the Cardiff case study is still ongoing, and we are expecting to continue to collect and utilise valuable data through to the end of the project and beyond. To account for extensive Covid19 lockdown restrictions, the WeCount Cardiff process was adapted from the original workplan to incorporate the following phases:

1. **Phase 1: Community building**: This phase of the case study involved stakeholder and policy mapping, raising awareness of the project and co-designing local transport challenges encountered by citizens. The key citizen engagement activity of this phase was a series of WeCount Introduction & Scoping Workshops. This phase started in August 2020 and ended in November 2020 with occasional updates as new members join. See Section 2 for more details.
2. **Phase 2: Data Collection**: This phase of the case study involved the recruitment of citizen scientist to establish a WeCount Cardiff Network using Telraam sensors. The key citizen engagement activity of this phase was the Telraam sensor deployment. This phase started in October 2020 and is ongoing as new members join. See Section 3 for more details.
3. **Phase 3: Data Analysis and Interpretation**: The aim of this phase was to work with citizens to understand how the data can be analysed and interpreted. The key citizen engagement activities were a series of Data Analysis & Interpretation Workshops. This phase started in March 2021 and is ongoing. See Section 4 for more details.
4. **Phase 4: Communication & Policy Engagement**: In this phase, we will help citizens to utilise this data for communication campaigns and connecting into, and influencing, local transport policy. This phase will be delivered in Summer/Autumn 2021. See Section 5 for more details.

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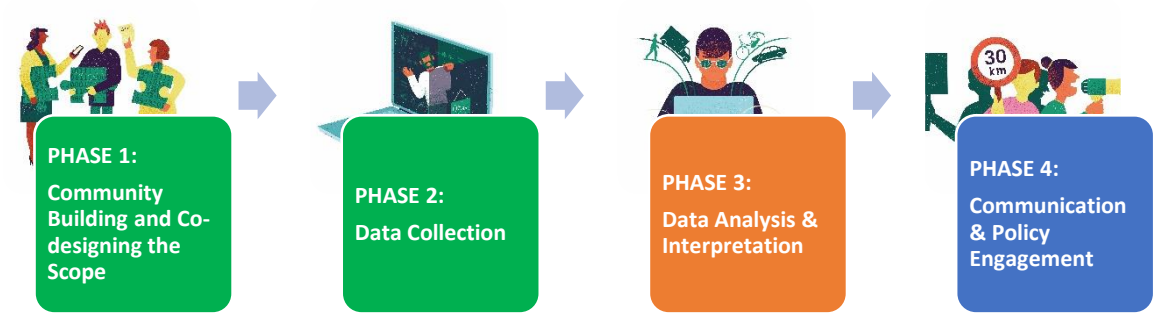
The following graphic illustrates the phase of the WeCount Cardiff case study highlighting the key phases that have been completed (green shading), phases ongoing at the time of writing this deliverable (orange shading) and phases that are planned for the coming months (blue shading).

Figure 1: Phases of the WeCount Cardiff Case Study



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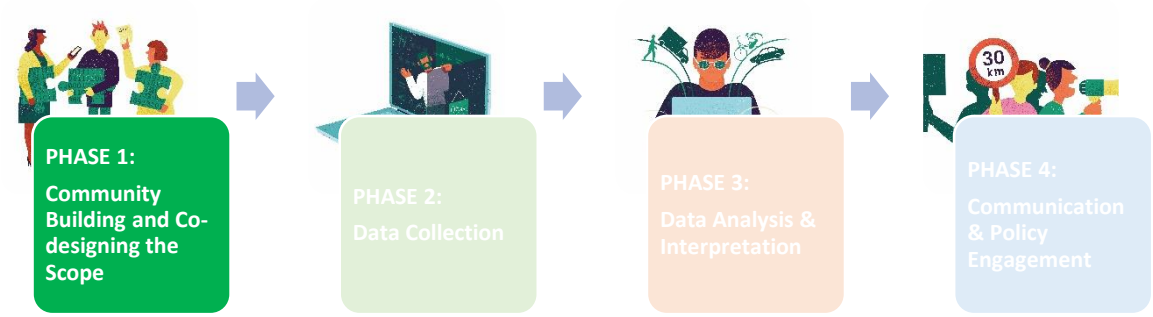
2 WeCount Cardiff Phase 1: Community building and co-design of case study

This section provides a detailed description of the actions, interactions and findings of the Phase 1 activities with respect to community stakeholder and policy mapping, community building and co-designing the scope of the WeCount Cardiff network of citizen scientists. It reflects on the ongoing efforts in engaging diverse communities of stakeholders in Cardiff. In summary, this section covers three key activities and provides a reflection on Phase 1:

- Awareness raising of the project in Cardiff (and UK) (Section 2.1)
- Stakeholder and Policy Mapping in Cardiff (Section 2.2)
- WeCount Introduction and Scoping Workshops (Section 2.3)
- A reflection on this Phase of the case study (Section 2.4)



2.1 Awareness raising

A considerable effort in this case study was placed on communication and dissemination activities both locally and nationally especially at the beginning of the project to raise awareness and establish connections with existing networks. A Local Communication Strategy was development which included:

- Definition of the main communication actions, target areas and groups of interest;
- Definition of the key messages for local activities tailored for different audiences; and
- Definition of the channels to be used for the dissemination of the project.

With respect to the channels for dissemination and day-to-day engagement, WeCount Cardiff established:

- A dedicated Twitter account – WeCount-Cardiff (@WecountC) for interactions with the local community through social media. This was the primary means of engagement.
- A dedicated email address (wecount.cardiff@uwe.ac.uk) was created and used to interact with participants praimrily for management and adminstration purposes.
- We used the NextDoor App to connect into various comunity groups to raise awareness of the project a recruit particpants.
- Web page: we decided to rely on the existing WeCount project webpage as the main language is English.
- A Facebook page was created primarily to raise awareness of the project with local community groups but this as discontinued as Twitter was having a much wider reach.

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The awareness raising campaign is still ongoing but primarily had three core strands: National and Local Media, Networking Presentations and Local Champions.

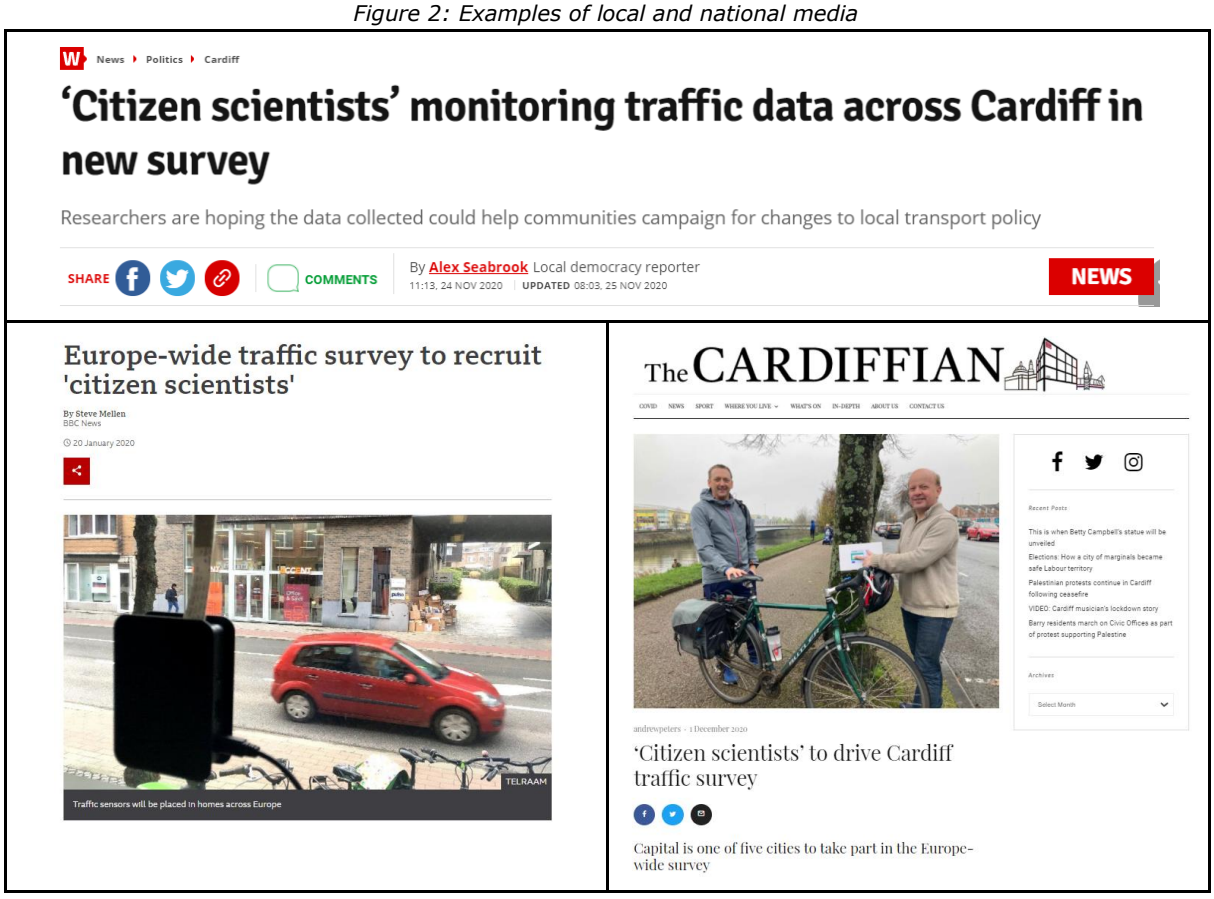
National and Local Media

At the early stages of the project and at the early participant recruitment stages we had national and local media articles published to generate interest in the project and start early awareness raising in local communities. Some key examples at the awareness raising stage include:

- BBC World News: Europe-wide traffic survey to recruit 'citizen scientists' (January 2020)
- Wales Online: 'Citizen scientists' monitoring traffic data across Cardiff in new survey (Nov 2020)
- The Cardiffian: 'Citizen Scientists' to drive Cardiff traffic survey (Dec 2020)

Additionally, as we are moving towards the data analysis and advocacy stage of the case study the local media will again run stories on the project and the utilisation of the data generated.

Figure 2: Examples of local and national media



Networking presentations

Throughout WeCount, the local project team at UWE have delivered numerous presentations and panel discussions. Several presentations and lectures were given to spread the word about the project and reach a wider audience from the academic, scientific, industry, and civic society fields. Due to the Covid19 restrictions, these were all delivered online. Some examples include:

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- A presentation for the Environment Platform Wales on Blue Sky Thinking: How can Wales achieve cleaner air (Sept 2020)

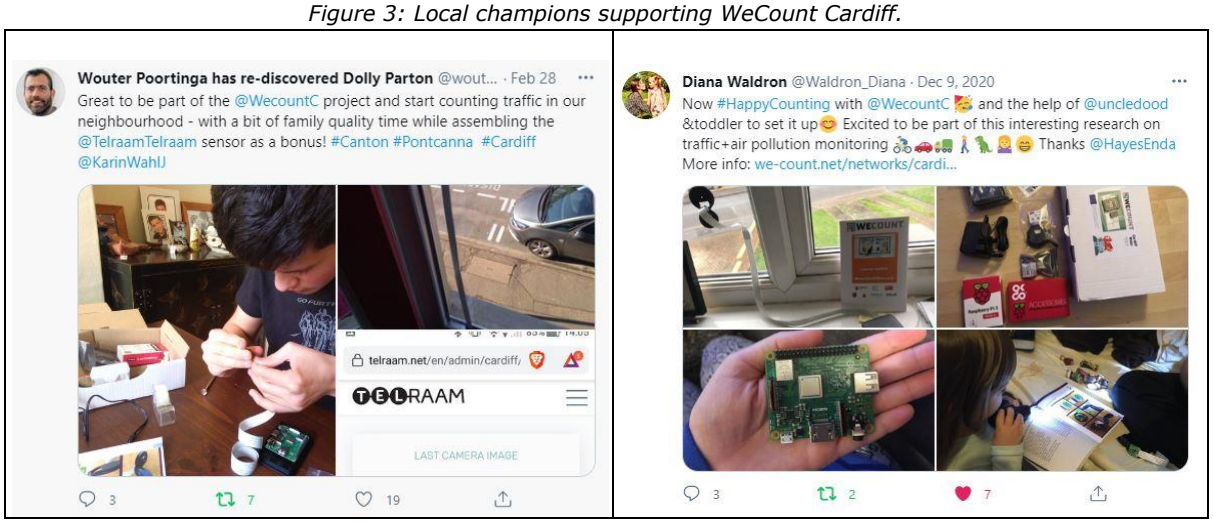
- A presentation to the Wales Cross Party Group: Clean Air Plan on Air Quality, Clean Air Legislation and Behaviour Change needs in Wales (Oct 2020)

- An overview presentation about WeCount for the EU Green Week (Oct 2020)

Local champions

Very early in the project, WeCount Cardiff recognised the value in local champions not only in raising awareness but also in recruiting participants and driving forward the use of the data. It was also recognised that they would enable and enact a snowballing effect that would help in recruiting participants. Additionally, we have used these local champions in project level communications and in WeCount Cardiff workshops as we identified the value in the citizen voice across the project. Some examples of working with local champions are illustrated in Figure 3.

Figure 3: Local champions supporting WeCount Cardiff.



2.2 Stakeholder and Policy Mapping

A core task for Phase 1 was to undertake a rapid review of relevant transport related policies and data in Cardiff. This review, although not exhaustive, provided the evidence basis upon which future conversations and interactions with Cardiff citizens could be based. Parallel to this policy review, a stakeholder mapping exercise was implemented to understand the key networks, organisations, communities and individuals that could be engaged with WeCount Cardiff. The following sections provides a summary of these initial tasks.

Policy context for Cardiff

Cardiff, the capital of Wales, UK, has a young, diverse and growing population (>400,000), but despite its economic role regionally and nationally, many of Cardiff's communities are amongst the poorest in Wales. Pre-Covid19, Cardiff attracted around 100,000 people travelling into the authority area every day (~80,000 by car). This is in addition to ~190,000 commuter trips made daily by Cardiff residents. Transport, especially road transport, is an emotive and contentious issue in the city. There are many individuals and advocacy groups supporting and encouraging more ambitious and faster interventions especially related to better active travel infrastructure, road safety and restrictions in vehicle movements. Conversely, there are also vocal pro-car individuals and networks, especially on social media, which challenge and cite the impact

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of transport interventions on increased congestion, displaced traffic and pollution and a reduction in accessibility.

The annual Ask Cardiff Survey, which provides an interesting insight into public attitudes to various issues in the city, found that almost three-quarters (73.8%) of respondents deemed travel and transport problems in Cardiff to be either serious (49.1%) or very serious (24.7%)[1]. The 2019 Ask Cardiff Survey found that the level of public satisfaction with public transport fell from 57.9% in 2018 to 51.7% in 2019 with issues like accessibility, frequency, access to information cited as some concerns. Citizens also cited safety concerns when walking or cycling with respondents feeling least safe when cycling in Cardiff after dark (24.8%), walking in the city centre after dark (36.2%) and cycling in Cardiff in the day (58.4%). Dangerous drivers (49.3%), lack of dedicated infrastructure (38.1%) and poor lighting (13.3%) were cited as reasons why people feel unsafe when cycling. The Bike Life Survey (2019) found that 27% of residents do not currently cycle but would like to and only 29% of residents think cycling safety in Cardiff is good[2].

Transport Policy and Plans in Cardiff

Key transport challenges for Cardiff include:

1. **Congestion**: Since 2018 drivers in the city are losing 19 full working days a year at a cost of around £1,056 per driver[3].
2. **Responding to the climate emergency**: In Cardiff, 81.2% of people who took part in the Ask Cardiff Survey 2018 said they were either "very" or "fairly concerned" about climate change[4].
3. **Clean air and public health**: Cardiff has some of the highest levels of Nitrogen Dioxide (NO_2) pollution in Wales. In fact levels exceed the EU and National limits for NO_2 in some areas.
4. **Creating Safe and Healthy Communities**: Cardiff want to create a transport network that focuses on people, as well as vehicles, we can make sure our streets, neighbourhoods and public spaces are safer, cleaner, and quieter
5. **A city for everyone**: Travelling around Cardiff is not always as easy as it should be, especially for people who are often the least mobile in our society

Cardiff has several ambitious strategies in place which focus on decreased car use and active travel to work towards carbon neutrality by 2030. The city is focusing on SMART corridors, investment in cycleways and parking provision, bike hire, park and ride, 20mph limits, Low Traffic Neighbourhoods, School Streets and traffic flow restrictions in the next five years. Key policies and strategies include:

- Transport White Paper - Lower car use and ambitious targets for active travel in the city. Cardiff as a well-connected city where everyone can easily, reliably and safely get to where they need to go in the greenest, healthiest and most affordable way. Linked to this as a Clean Air Plan which aims to address NO_2 levels in the short term, but also has a greater ambition to get the air we breathe in the city as clean as it can be.
- One Planet Cardiff: A response to the climate emergency which sets out the basis for a delivery plan to achieve carbon neutrality
- Local Wellbeing Plan 2018 – 2023: Produced by Cardiff Public Services Board, sets out the priorities for action across the public sector in Cardiff. Includes key transport indicators such as

[1] Ask Cardiff Transport Survey, 2017 - https://www.cardiff.gov.uk/ENG/Your-Council/Have-your-say/Ask%20Cardiff%20Library/Transport%20Survey%202017%20Report.pdf
[2] Bike Life 2019 - https://www.sustrans.org.uk/media/5946/bikelife19_cardiff-v73_eng_web.pdf
[3] Cardiff Transport White Paper: Transport Vision to 2030 - https://cardiff.moderngov.co.uk/documents/s44138/Appendix%202.pdf?LLL=0
[4] Ask Cardiff 2018 - https://www.cardiff.gov.uk/ENG/Your-Council/Have-your-say/Ask%20Cardiff%20Library/Ask%20Cardiff%202018.pdf

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sustainable transport modal split and percentage of children cycling/walking to school under Well-Being Objective 4 – 'Cardiff is a great place to grow up'.

- Local Development Plan 2006 – 2026: Used by the Council to guide and manage development, providing a basis by which planning applications will be determined. It includes the requirement for 40,000 new jobs and 41,415 new homes
- Child Friendly City Strategy: Sets out five key goals to lasting difference in the areas that are a priority for children and young people, with a particular focus upon the most vulnerable children and young people. This includes "Providing affordable and accessible integrated sustainable transport options to enable safe walking and cycling, with greater priority given to non-motorised road users, focusing first in more deprived areas", as part of the approach to the goal of ensuring children and young people have good physical, mental and emotional health.

Air pollution in Cardiff

One of the primary reasons for bringing WeCount to Cardiff was to generate traffic data that can support the understanding of air pollution in the city. Cardiff exceeds the National Air Quality Objectives and EU limit values for NO_2 (annual mean) and has an estimated 3.6T CO_2/capita emissions. Cardiff currently has four Air Quality Management Areas, declared for exceedences of the National Air Quality Objectives for NO_2 annual mean. Two AQMAs are primarily focused in Cardiff City Centre: Cardiff City Centre AQMA (est. April 2013) and Stephenson Court AQMA (est. December 2010). North of the City Centre lies the Llandaff AQMA (est. April 2013) and to the west of Cardiff is the Ely Bridge AQMA (est. February 2007). The Council's Annual Air Quality Progress Report (2019) summaries the air pollution monitoring currently happening in the city (two continuous analysers and eighty-five diffusion tubes) and it provides a summary of actions currently being implemented across the city to improve air quality and support wider Welsh Government principles as part of the Well-being of Future Generations Act 2015.

Nitrogen dioxide (NO_2) is the primary pollutant of concerns in Cardiff followed by PM_{10} and $PM_{2.5}$ with road traffic being a major contributor. However, the burden of these pollutants is not evenly distributed across the city population. Table 1 below illustrates the social inequalities related to air pollution in Cardiff[5]. Cardiff has a higher population weighted mean concentration than the means for Wales for both NO_2 and PM_{10}. This is to be expected as the Wales data incorporates all data from rural and urban areas while the Cardiff data is representative of the largest urban area in Wales. Across Wales, ethnic minorities and more deprived households have a higher population weighted mean concentrations for both NO_2 and PM_{10} indicating that these populations carry more of the pollution and health burden. A similar trend is evident for the Cardiff population although the differences in concentrations are not as large. This data is generated using census population data and background air pollution levels. The inequalities observed are conservative primarily because it is background air pollution data being used but they are indicative of the additional burden that ethnic and deprived communities face from air pollution which is predominantly transport related.

[5] This data was generated following a similar methodology as undertaken by Brunt et al., 2017 and the ClairCity Project Deliverable 3.6 Environmental Justice & Air Pollution

Table 1: Population Weighted Mean Concentrations for different demographics in Cardiff and Wales

Description	NO_2 Pop-Weight Conc (µg/m³)				PM_{10} Pop-Weight Conc (µg/m3)			
	Wales		Cardiff		Wales		Cardiff	
	Mean	Diff*	Mean	Diff*	Mean	Diff*	Mean	Diff*
Total Population	8.62	-	15.60	-	11.66	-	14.15	-
White / British	8.41	-0.21	15.35	-0.25	11.60	-0.06	14.14	-0.01
Asian / Indian	12.64	4.02	16.60	1.00	12.84	1.18	14.19	0.04
Asian / Pakistani	14.87	6.25	16.86	1.26	13.31	1.65	14.17	0.02
Asian / Bangladeshi	14.16	5.54	16.99	1.39	13.12	1.46	14.14	-0.01
Asian / Chinese	11.46	2.84	16.85	1.25	12.45	0.79	14.36	0.21
Black British / African	13.41	4.79	17.07	1.47	13.06	1.40	14.28	0.13
Black British / Caribbean	12.46	3.84	16.12	0.52	12.72	1.06	14.20	0.05
Household not deprived	8.58	-0.04	15.52	-0.08	11.61	-0.05	14.06	-0.09
Household deprived 1 category	8.50	-0.12	15.64	0.04	11.60	-0.06	14.12	-0.03
Household deprived 2 category	8.55	-0.07	15.53	-0.07	11.67	0.01	14.17	0.02
Household deprived 3 category	8.90	0.28	15.66	0.06	11.83	0.17	14.19	0.04
Household deprived 4 category	9.49	0.87	16.19	0.59	11.94	0.28	14.20	0.05
* Difference compared to the population weighted mean for the total population for that pollutant and geographical area								

Stakeholder Mapping

Parallel to the high-level review of transport, climate, air pollution and health policies and data in Cardiff, a stakeholder mapping exercise was implemented to identified key actors across the city that may be interested in participating, would be willing to promote the project and/or would be interested in the project activities and outputs. The engagement with these stakeholders, primarily via social media, opened gateways to other communities that may not have been reached otherwise.

The stakeholders mapping activities allowed the identification of local community organisations in Cardiff which are actively voicing their concerns about various transport related issues such as public transport, active travel, congestion and air pollution, road safety and the general liveability of their local area. In most cases these concerns were largely anecdotal, as they did not have quantitative data to support their arguments and activities. WeCount Cardiff provided the mechanisms to close these data and knowledge gaps. In total, we identified and contacted >100 organizations, networks, individuals and public sector bodies across the Cardiff area. Several other organisations contacted us after learning about the project through social media, national news or personal contacts, allowing us to reach local communities in various areas around the city and wider region. The WeCount Cardiff stakeholder can be broadly grouped into two categories: Community Groups & Civic Society and Public Sector Organisations.

Community Groups & Civic Society

This stakeholder category was central to the case study in Cardiff. We actively engaged with community champions and local community organisations, many of which were connected to local and national NGOs, to make them aware of WeCount, to show them the potential of using sensors to collect evidence, and to involve them in the case study. While doing so, an important component was about transferring knowledge about the project so they can act advocates creating a snowball effect in recruitment in their communities and networks. These stakeholders ranged in nature from very localised communities interested in change in favour of a more sustainable environment (e.g. Grangetown Community Group, Fairwater Community Group, Child Friendly Streets Cardiff etc), other communities involved in environmental and IoT activities (e.g. Cardiff Friends of the Earth, Extinction Rebellion Cardiff, Fablab Cardiff, The Things Network etc), civic associations (e.g. Cardiff Cycling City, Cardiff Civic Society, Cycling Cardiff, Community Gateway

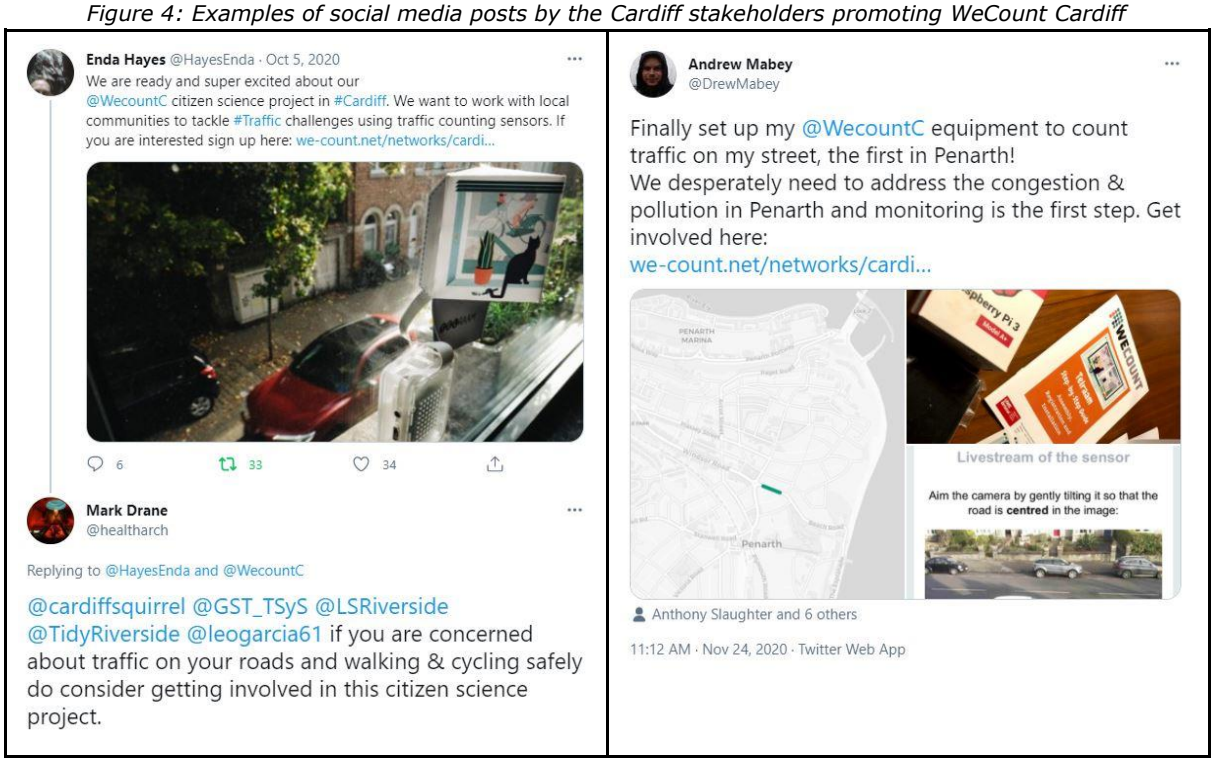
etc), and broader initiatives and associations already involved in this area (e.g. Living Streets Cymru, Sustrans Cymru, British Lung Foundation Wales, Healthy Air Cymru etc). Additionally, we used Facebook, Twitter and NextDoor to reach out to local neighbourhood networks representing different geographical areas of the city (e.g. Residents of Canton and Riverside, Victoria Park Matters etc).

Public Sector Organisations

While community networks and civic organisations were essential for successful recruitment of participants, the support of local actors and public sector organisations has been critical to the success of WeCount Cardiff. Cardiff City Council and local Cardiff Councillors, Welsh Government, Public Health Wales and STEM Wales have been engaged to define the high-level challenges, identify key networks and facilitate linkages with city initiatives. Two examples include:

- Cardiff City Council transport team are working with WeCount Cardiff to explore how the WeCount traffic data can be utilised to inform a feasibility study for Low Traffic Neighbourhoods in the city. The feasibility study will be undertaken at the end of 2021 and into 2022.
- Cardiff City Council transport team connected WeCount Cardiff to their school's active travel initiatives and active travel officers. Subsequently, as a pilot, WeCount Cardiff has traffic sensors in the vicinity of three primary schools across the city and the project team have created a schools activity pack for the children to link into the STEM element of the curriculum and other elements such as Geography, Art and Creative Writing.

Figure 4: Examples of social media posts by the Cardiff stakeholders promoting WeCount Cardiff



2.3 WeCount Cardiff Introduction and Scoping Workshops

The processes of scoping, identifying problems and co-designing solutions was carried out through participatory online workshops at Phase 1 of the case study. The objectives of these workshops were to:

- to meet participants;
- introduce the project and its objectives;

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- outline the proposed timeframe and structure of the co-design process;
- understand the issues and concerns associated with transport and urban planning in specific local areas; and
- to gain an initial understanding of the methods of data analysis, which could help to address local mobility and environmental issues.

Due to Covid19 lockdowns and the early decision by the project team to deliver the participant facing activities online, no face-to-face meetings were run. WeCount Cardiff hosted four formal introduction and scoping workshops, in addition to numerous informal discussions, held throughout November and December 2020. Three of the workshops were open to all Cardiff residents, with the first workshop targeted a specific neighbourhood (Grangetown). Participants were recruited through social media and targeted advertising through local universities, the council and community organisations. Every effort was made to reach more deprived areas of Cardiff. In total, 53 attended, with varied age ranges, genders, and a mix of professional stakeholders and potential counters. The predominant age range was 35-49 (25%, N=13) and more men attended than women (60%, N=26 of 43).

Table 2: Summary of attendees at the WeCount Cardiff Introduction and Scoping Workshops

		Workshop 1	Workshop 2	Workshop 3	Workshop 4
Registered		20	14	11	8
Attended		16 (80%)	14 (100%)	9 (82%)	6 (75%)
Age	<18			1	
	16-24	2	2	1	
	25-34	2	4	3	1
	35-49	**6**	**4**		**3**
	50-64	6			1
	65+		2	1	1
	Prefer not to say		2	3	
Gender (M:F)		10:6	6:6	6:3	4:2
Participant type		Mix of potential counters, and professional stakeholders. 5 nominated local champions.	10 possible counters; 3 nominated local champions; 1 techie	1 techie; 5 possible counters; 3 nominated local champions	Mix of potential counters and professional stakeholders
Motivations		Road safety* (N=14); air pollution* (N=10); traffic changes* (N=8); transport policy* (N=8) other concerns* (N=4)	Road safety (N=3); Air pollution (N=2); other (N=1); traffic changes (N=1);	Road safety (N=6); Traffic changes (N=4); other concerns (N=1); tech (N=1)	Air pollution (N=4); road safety (N=3); tech (N=1); traffic changes (N=1)
Enjoyment		44% loved it; 56% liked it (N=9)	50% loved it; 50% liked it (N=6)	20% loved it; 80% liked it (N=5)	100% Loved it (N=6)
Input valued		4.3 out of 5	4.5 out of 5	4.4 out of 5	5 out of 5
*Road safety: speeding, active travel & children Air pollution: Local concentrations, public health & environmental justice Traffic changes: Increased volumes, traffic types & rat running Transport policy: Impact on local traffic & need to lobby Other concerns: parking, urban design, impact of C19, noise					

Workshops were deliberately kept small so that everyone had a chance to be heard. Subsequently, sessions were seen to be "informing and engaging" by many. Participants were "made to feel welcome" and "listened to", liking the fact they were "referred to name" and that their contributions could "be helpful", "Everybody was included and understood" and it felt "personal". Because of this, participants scored the sessions a 4.5 out of 5 on average for input valued. Participants thought the project was explained clearly and in a concise way and the sessions well organised and well facilitated. It was commented that the small group size was key, giving everyone the time they needed to speak. By the end, there was a real enthusiasm among attendees: "[I] can't wait to get started!". As a result, all either loved (54%, N=14) or liked (46%, N=12) the sessions.

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Below is a selection of quotes from participants, highlighting their excitement and enthusiasm, and the relevance of the project to their lives.

"All explained very simply and clearly, great to be told where I could fit into the project. I felt it is something I can really get involved in the future. Collecting information will be really useful to [my area]"

"Really useful to meet like-minded folk and be part of this fascinating, useful and much needed project to help drive change towards more active travel"

"It made me feel empowered"

"I was a bit nervous about if I wanted to join but it was friendly and idiot proof"

"Really informative, great concept and love how flexible it can be to make sure we can make it work in all areas"

During the session, lots of exchanges were had between participants, either through the chat or during facilitated discussion. Many shared contact details, put forward ideas of who else could be involved and came to consensus on the main priority areas of concern for their community. Reaching consensus was much more straightforward in the targeted session with Grangetown, as the other sessions had representation from dispersed communities from across the city (Figure 5). At the end of each session, the host asked people to put their name forward to be a local champion. Each time, 3 or more people offered to set up. Participants were motivated to join for a variety of reasons, with road safety (N=26) and air pollution (N=16) ranking top among all participants. A few people showed a particular interest in addressing traffic around schools and the daily "obstacle course" children are faced with in navigating from home to the school gate (i.e. with no drop curbs and pavement parking, etc). For a father and daughter, their main traffic concern was "having fun", "Staying healthy" and living in a "safe and pleasant" place for walking and cycling.

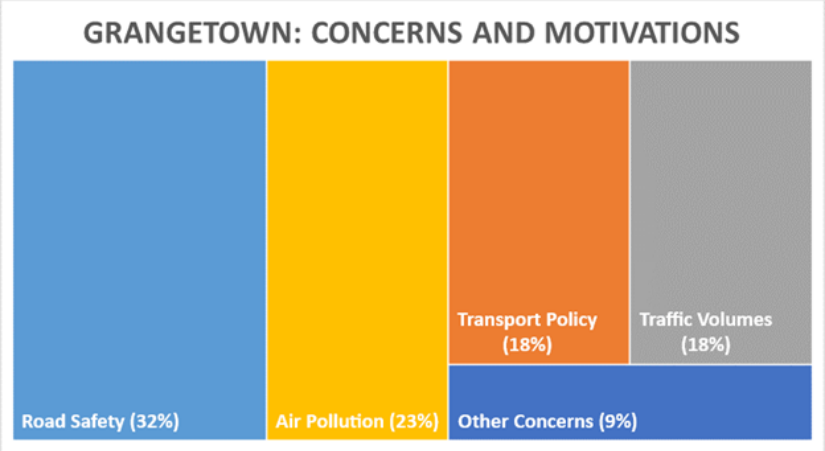

Figure 5: Concerns and motivations of Grangetown Community

2.4 Reflections on Phase 1

Undertaking the policy and stakeholder mapping activity was an essential first step as it allowed the project team to understand the landscape within which they were operating. This resulted in better informed debate

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during the workshops and as a result a closer connection and understanding of the participants concerns and motivations.

The need to move the entire process online, made community building more of a challenge. The full implementation of the methodology, the demonstration of the sensor, the actual promotion of the project, and, importantly, ensuring compliance with data privacy and ethics requirements, led to an engagement process that was not as straightforward as initially designed. The required task granularity of participants increased substantially, with several additional steps, emails, and forms that they need to read and fill. As such, learning from the experience of Barcelona and Madrid, we expected a significant drop off between the different steps. With the need to focus engagement through online means, instead of face-to-face engagement, the challenges of ensuring a broad cross section of society could participate increased. To overcome this, we engaged with local media, social media, pre-emptive online workshops where we could set out the purpose of the project, the sensors and the engagement process clearly, and in the case of engagement with schools, through personal contacts.

Overall, the team were really pleased with how the Phase 1 events went and the feedback verifies their impressions. Yet there is always room for improvement. One remark was made that the Introduction session was "overly long for a weekend" while another would have liked more time for discussion. One also struggled a bit using the MS Teams platform. The team thought that the balance was about right but agree that it would be useful to spend a few minutes at the start of the session with participants to familiarise themselves with the platform.

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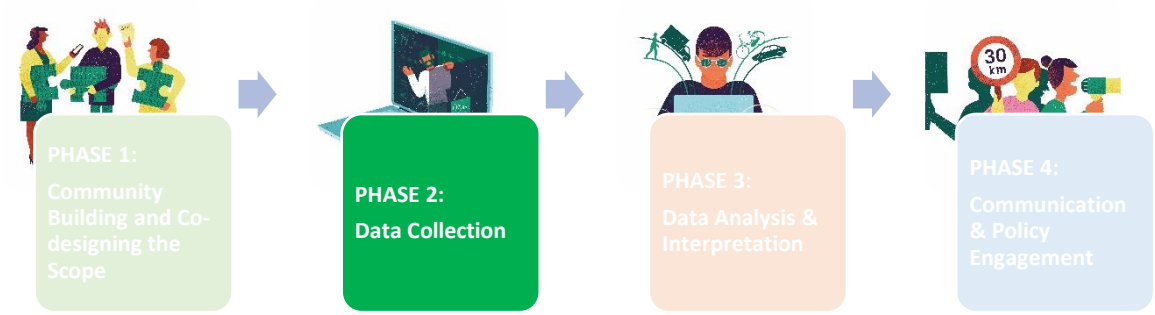
3 WeCount Cardiff Phase 2: Data Collection

This section provides a description of activities primarily related to the deployment of the Telraam sensors in Cardiff. It covers how we have tackled procurement, distribution, installation, and maintenance of the Telraam sensors to support data collection as well as how we have adapted to the exceptional circumstances of the Covid19-related restrictions. In summary, this section covers three key activities and provides a reflection on Phase 2 of the process:

- Summary of the WeCount Cardiff community generated by Phase 1 activities (Section 3.1)
- The Procurement, Assembly, Preparation, and Distribution of the Telraam Sensor Hardware (Section 3.2)
- The Data Collection Process (Section 3.3)
- A reflection on Phase 2 of the case study (Section 3.4)



3.1 Summary of the WeCount Cardiff Community

Community building is an ongoing process throughout the WeCount Cardiff case study. Formal and active recruitment of citizens is ending, but passive recruitment will continue as long as there is interest in participation from citizens. Figure 6 shows the membership registration over time. The webform for membership registration was first available at the beginning of October 2020. Registration rates were initially high from October until December and since then have been received at a relatively low, but consistent rate. The high engagement at the start of recruitment is likely due to initial advertising of the project on social media, through traditional media and though workshops that the WeCount Cardiff Team held online with prospective participants.

The membership webform is still open for WeCount Cardiff. At the time of writing (June 2021), the Cardiff case study had 263 registered members, of which 17 members were interested in participating as volunteers only. Of the registered members 103 completed the second webform, which collected the view from their window, their address and a small amount of demographic information, which has been summarized in Table 3 below.

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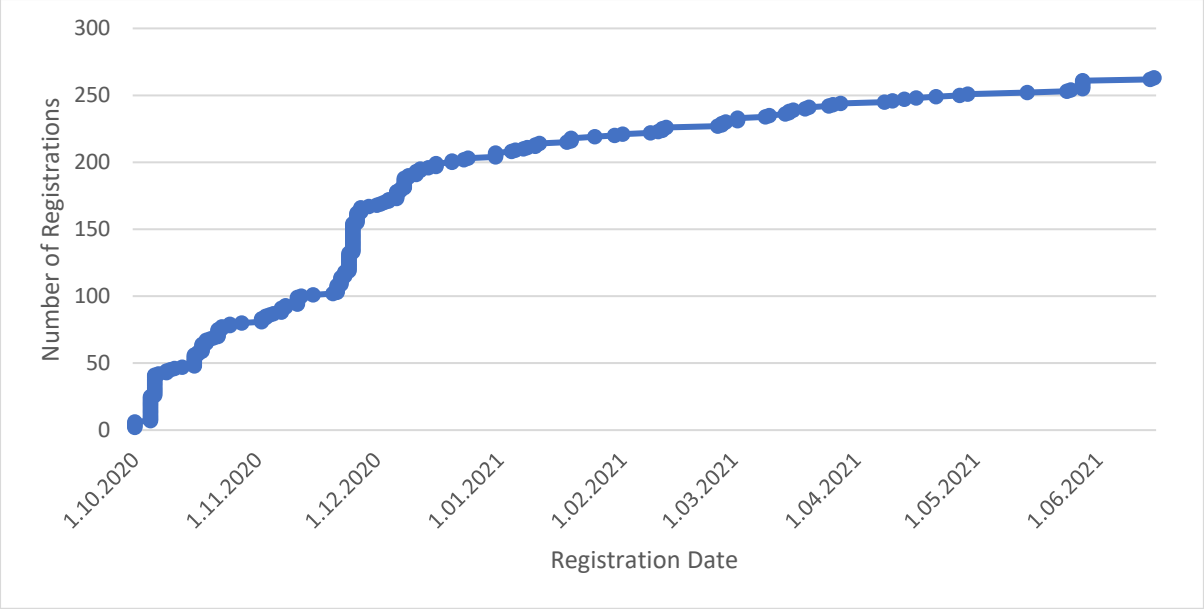

Figure 6: Growth of WeCount Cardiff membership

Table 3: Summary of gender and age information provided by WeCount Cardiff members

Variable	Category	Number (%)
Gender	Female	36 (35%)
	Male	65 (63%)
	not answered	2 (2%)
Age (yrs)	16-24	2 (2%)
	25-34	20 (19%)
	35-49	53 (51%)
	50-64	20 (19%)
	65+	7 (7%)
	not answered	1 (1%)

Almost two thirds of the registered members were male, and most registered members were 35 to 49 years old. The survey data also showed that the registered members tended to be highly educated (Figure 7), with 29% having an undergraduate degree and 53% having a postgraduate degree.

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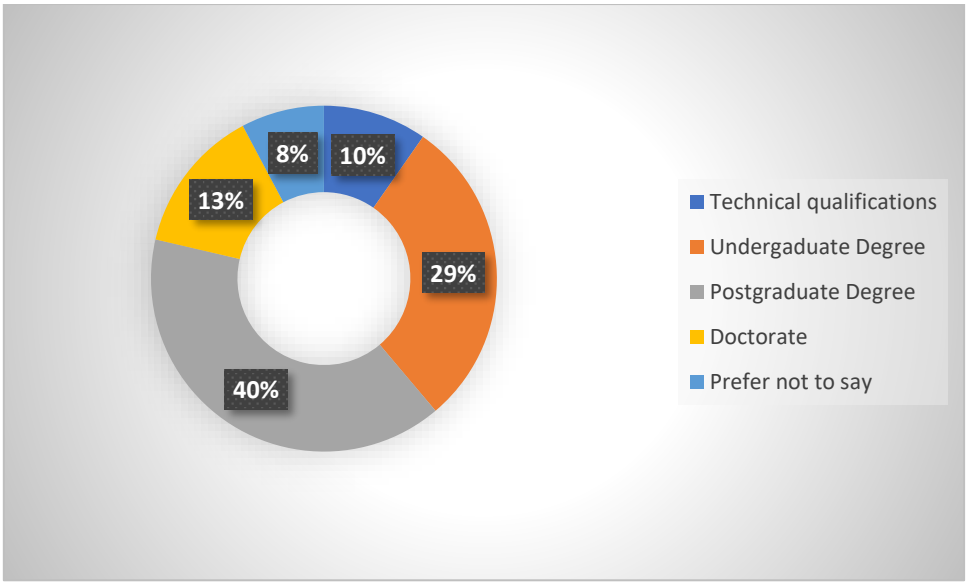

Figure 7: Highest education level reported by Cardiff members

However, members were widely distributed across Cardiff (shown in Figure 8). As shown by the Welsh Index of Multiple Deprivation (2019), there is a range of affluent and deprived areas within Cardiff, with more affluent areas typically to the north and more deprives areas typically to the south (see Figure 9). By comparing Figure 8 and Figure 9 the spatial distribution of members would capture a range of socio-economic levels across Cardiff, with concentrated areas in Grangetown and Roath. As the WeCount sensors provide information not just to individuals, but to all people living within the neighbourhood, we expect that ultimately the WeCount users is provided in Section 3.3.

We experienced a substantial drop off in registrations, as the online process involved an exchange of up to three emails, i.e. first notification email and confirmation of willingness to receive Telraam; second email following confirmation including information sheet and consent form to be sent back; third email once received the informed consent form with additional information to facilitate the delivery.

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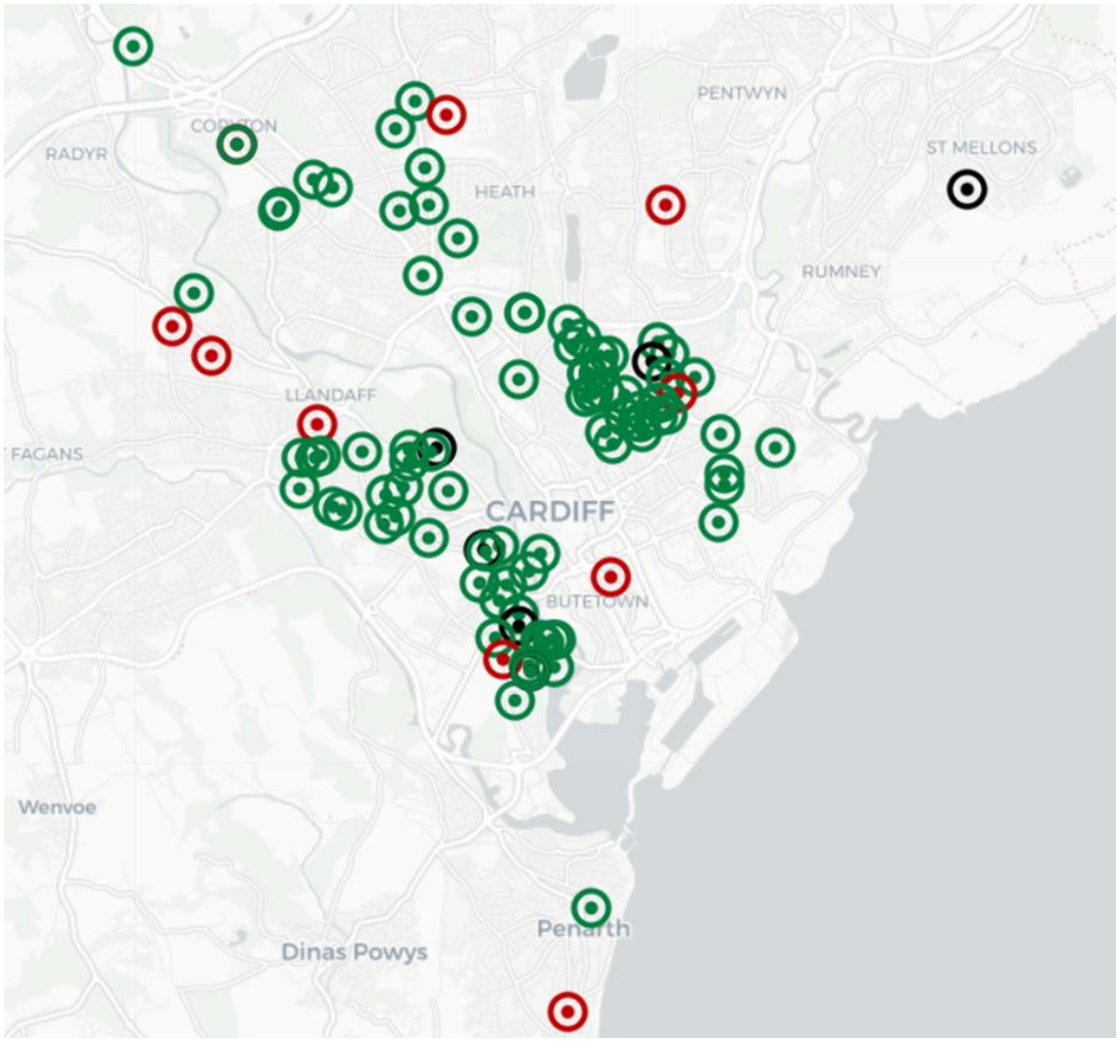

Figure 8: Screenshot of dashboard map showing members who provided address information

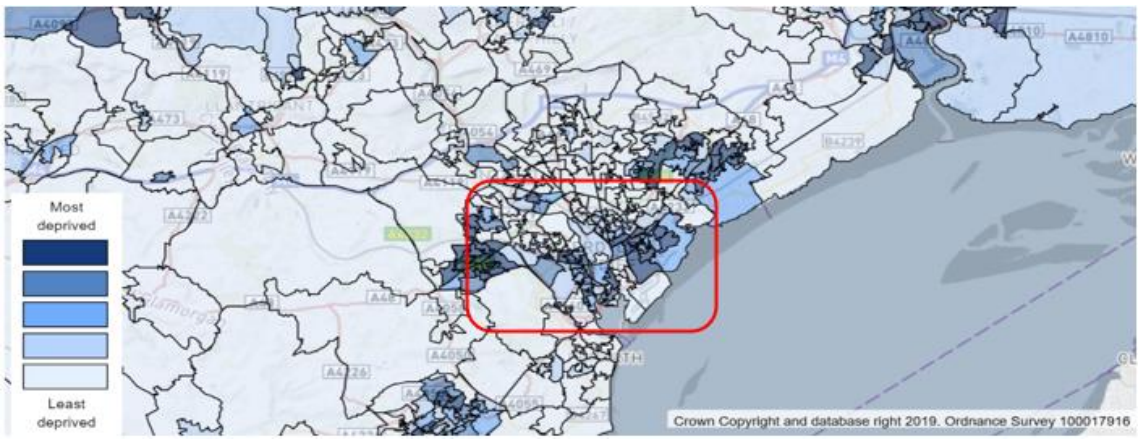

Figure 9: Indices of Multiple Deprivation status in Cardiff (at LSOA level – study area in red)

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3.2 The Procurement, Assembly, Preparation, and Distribution of the Sensor Hardware

For the Cardiff case study, we decided to purchase un-assembled Telraam sensors rather than pre-assembled sensors. While this did add some complexity for onboarding participants in that they had to assemble the sensors themselves, it did feel like the case study was being true to the principles of citizen science and that the participants were more knowledgeable about the components and functionality of the sensor should there be any issues (e.g. if an SD Card need the software to be reflashed then the participant knew where to find it, remove it and reinstall it).

Procurement: We initially order 100 of the Telraam sensors from the supplier (Gotron) recommended by the Project Coordinators and Leuven case study lead, but with the specification that the sensors needed three-pin electric plugs, to be able to connect to UK electrical outlets. We initially had some component issues with this order as the power cable provided was of poor quality resulting in the Telraam dropping out – alternative power supplies were provided by Gotron. Subsequently, we have order 50 more sensors from UK suppliers (The Pi Hut) as the cost of purchase and importation post-Brexit had increased. In this second order, we had a different Raspberry Pi casing which didn't have a dedicated slot to allow the camera cable out – this was easily addressed by cutting out a small slot using a Dremel. Additionally, we purchase 20 integrated air quality and noise sensors to collocated with Telraam sensors on busy roads (see Section 6 for more information on this). We also purchased a GoPro so that we could capture doorstop interviews with participants and stock footage of transport and cycling around Cardiff – these recordings plus soundbites from our online workshops will be used in an end of project video for the Cardiff case study

Sensor Packs: Each sensor was delivered in a WeCount Cardiff Sensor Package (Figure 10) that contained the following:

1. WeCount Cardiff Assembly, Registration & Installation Guide
2. WeCount Cardiff Postcards
3. Telraam sensor anti-reflection sheet branded with WeCount Cardiff
4. Power supply (3-pin plug with 1m cable)
5. Raspberry Pi 3A+
6. Raspberry Pi Casing plus screw
7. Camera module cable (0.8m)
8. Camera Module
9. Camera Casing
10. Micro SD Card with Telraam software already installed
11. SD Card reader adapter (if the software needed to be reinstalled)
12. Additional velro fasteners to attach the camera casing and/or Raspberry Pi to the window.
13. Participant Information Sheet and Consent Forms

Distribution: As we could not run face-to-face sensor building workshops, we created several support tools to help the participants in a socially distanced manner (during the highest lockdown restrictions, sensor delivery was postponed). First, we adapted and updated the handbook created for the Madrid case study to create a WeCount Cardiff Assembly, Registration & Installation Guide (Figure 10) to help the citizens build, register and install their sensors. Second, we installed the Telraam software on all the SD Cards prior to the delivery because we could not guarantee that participants would have access to a computer with a SD card writer. Third, all sensors were hand delivered by the case study lead (Prof Enda Hayes) allowing him to spend anywhere from 15 to 30 minutes with each participant to talk them through the sensor components, how to build it, register it and install it, helpdesk details, discuss common issues that have emerged and also manage expectations usually with the opening statement: "I am giving you the

components to build a low cost sensor, I am not giving you an iPad". All sensors were delivered by bicycle which also created some interest on social media (to date >500 miles covered delivering sensors)(Figure 11). These steps did slow down the roll out of the sensor packs slightly, but it was essential to ensure that the participants were fully informed, and it was appreciated as it gave a "human connection" between the project and the participants which may have suffered due to Covid19 restrictions.

Figure 10: Contents of the WeCount Cardiff Sensor and Information Package

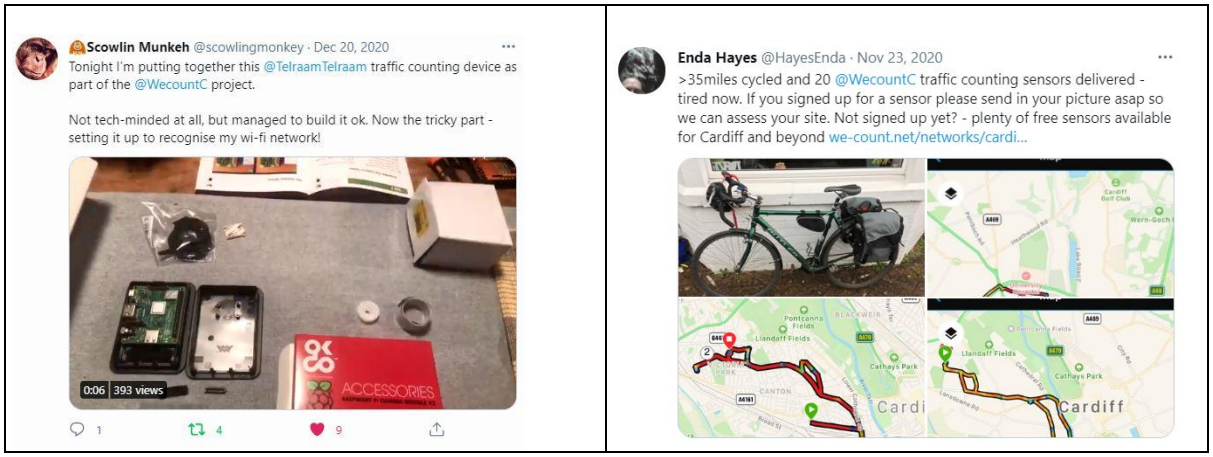

Figure 11: Examples of social media during Phase 2 activities

3.3 The Telraam Sensor Installation Challenges

Despite detailed instructions many participants encountered difficulties when assembling and installing the sensor. Step 16 in the installation guide showed instructions on where to find further help, and on how to contact the Telraam helpdesk (https://telraam.zendesk.com/hc/en-us). Some participants followed these instructions, while others contacted us directly via email when encountering problems. Table 4 below lists difficulties reported to us. Participants did not encounter all these problems during a single installation, but different participants may encounter one or more of these problems. The most common problems encountered were 'no image showing' and the 'Telraam sensor stopping counting'.

Table 4: Lists common issues reported by participants

Issue	Description	Solution
Camera Cable not working	the set-up pages do not show an image just a white square where the image should be.	Provided the participant with a longer camera cable
Need to update the SD Card	SD Card needs updating but no port to update it on a Mac	Participant exchanged sensor for one with an up to date SD card
Sensor stops counting	Provided guidance via FAQs	On occasion this works, on other occasions a replacement sensor was provided. Telraam system administrator provided support
Picture not showing/No image available	Image is not showing on their mobile phone during installation	Provided links to the FAQ
Telraam not counting HGVs	The Telraam data wasn't accounting for HGVs	Explained to the participant that Telraam requires several weeks of calibration before HGV measurement occurs
Sensor not visible on the dashboard	The participant couldn't identify if their sensor was visible on the dashboard, but wasn't working	An offer was made to attend a live workshop to discuss the issues with Telraam system administrators and a new sensor was also provided
camera displaying as viewing wrong side of road	The road segment was incorrect and was on the wrong side of the road	An update was made by Telraam system administrators that allowed for a

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Issue	Description	Solution
		segment switch and subsequent data migration
Challenge finding the wifi	Participant could not find the wifi	Provided a link to the appropriate FAQ.
Sensor does not send data	The sensor stopped sending data	Participant restarted the device a few times and the problem resolved itself

In a small number of cases we were not able to resolve the challenges faced by participants through the FAQs or through support provided by the Telraam system administrators. In these instances, participants exchanged their sensor, or specific components, for a working device. The two most common challenges faced by participants was that the street image was not showing or visible during installation and that the Telraam stopped counting. For the former of the two challenges, there is likely to be two sources of the problem, a language bug which prevents completion of the installation process, or an issue with the flashing of the SD Card. The guidance set out in the boxes below are those instructions sent to participants who encounter this problem, via Zendesk. Where these did not work we provided replacement sensors or components.

Table 5: Further instructions sent to participants who had difficulties

Try a different language: In the steps before you get to the camera image you are asked to choose a language. Try choosing a different language to see if the camera is still blank. The steps after choosing the language are fairly intuitive so if this works then you may be able to complete the installation process. Once installed, you can choose English on the Telraam website / dashboard.

Try to reflash the SD Card. This is relatively straight forward to do. You will need an SD card port on a laptop/PC (if needed you can use the large SD card adapter that we provided). You will have to download a piece of software called Etcher (this is the software that flashes the SD card) and download the Zip file with the Telraam software. It takes about 5-10 minutes to flash the SD card. All the details are here - https://telraam.zendesk.com/hc/en-us/articles/360025328311-Assembling-Telraam-yourself.

For the latter problem, participants were directed towards two FAQ support pages, as follows:

- The connection between my Telraam and the wifi is (sometimes) lost
- Data from my Telraam suddenly stops coming through

Where we were informed that both approaches were unsuccessful, contact was made with the Telraam system administrators to obtain their support and where this was also unable to resolve the problem, a new sensor was exchanged for the inoperable one. In addition to support via e-mail, a technical support session was offered to participants via video call. This session was organised and hosted by Telraam and participants could directly explore their challenges with the technical support staff. All participants who attended these sessions were either able to resolve their issue or were provided with a replacement sensor.

3.4 Data Collection Process

A summary of the registered users in the Cardiff network is shown in Table 6. In total 263 members registered on the WeCount Cardiff Dashboard. Of those, 247 registered with a desire to be a sensor user

and subsequently received a follow-up e-mail from the Telraam system asking for a picture, some demographic data and an address. Of these, 99 participants provided the required information and 89 of these were in appropriate locations for sensor deployment and were accepted for delivery of the sensor and 10 were in inappropriate locations and consequently rejected. Two of the 89 sensors are in use by project colleagues and are excluded from the table below. Sensor uptake by Cardiff citizens is ongoing and therefore the corresponding data are likely to change with time, including the sensors yet to become live on the platform, with 3 of these having only received a sensor within the last two weeks.

Table 6: Summary of registered Telraam users in the WeCount Cardiff network

Description	**Number**
Sensor not visible on the platform	10 (excluding 3 that have received their sensor within the last two weeks and not yet installed)
Installation complete, but no data has been sent	10
Installation complete and data received at some point	63
Outboarded Sensor	1
Total number of users	87

It is important to note that the sensors that are not visible on the platform are not necessarily those that have yet to be installed. Some of these sensors may be installed but if they do not select to join the Cardiff Network then they're not visible on our system. In all instances where a sensor is not visibly installed, contact is made with the participant to help understand and resolve any challenges they face. The e-mail we use to reach out to these participants is below with the offer to correspond on the problem in both Welsh and English.

Hi [Participant Name]

I hope you're well.

Our system tells us that you haven't managed to install the Telraam sensor yet. I've attached a video showing how the assembly works, below, if that's the problem, but please let me know if you have any other problems and I'll be more than happy to help you get the sensor up and running.

Assembly video: https://www.youtube.com/watch?v=QiO4BJAXnSg

Best wishes,

Ben

WeCount Cardiff Team

Ysgrifennwch ataf yn Gymraeg neu yn Saesneg

One participant completed the outboarding process, removing themselves from the case study. The rate at which sensors were deployed to participants was closely aligned with the date at which they registered and responded to the request for an evaluation picture and some demographic data. Sensors were delivered by hand to each registered participant to ensure they had engagement with a member of the team, had the process explained to them clearly and provided an opportunity to complete appropriate consent forms.

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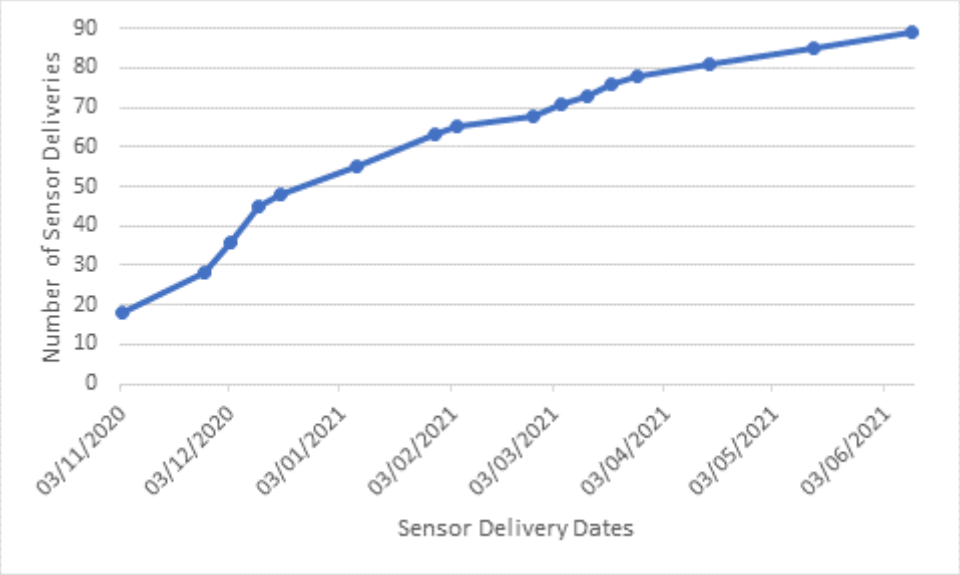

Figure 12: Growth of Telraam sensors counters in Cardiff

3.5 Refection on Phase 2

The following key themes have emerged upon reflection on the Phase 2 activities.

Broad considerations: Recruitment of participants into the study during the pandemic has been a challenge, as engagement with communities has been forced online. This has reduced to an extent the ability to reach widely across Cardiff communities. Nevertheless, many citizens have engaged with the project and recruitment via social media and through traditional media has been successful.

Onboarding: Recruitment of citizens onto the project has been successful from the perspective of their initial registration interest. There was a significant attrition rate of participants proceeding to provide us with additional information required to assess the suitability of their location for a sensor. This may be for several reasons. 1) e-mails from the system were being diverted to their spam folders and therefore they do not see the request; 2) they do not wish to share the requested information with the team; 3) they forgot to engage with the e-mail; and 4) some other reason. To address point number 3, a second, follow-up e-mail was sent to participants to remind them to sign-up. This would not be able to resolve points 1, 2 and point 4. The sensor delivery approach did slow down the roll out of the sensor packs slightly, but it was essential to ensure that the participants were fully informed and it was appreciated as it gave a "human connection" between the project and the participants.

Ongoing participant management: Once citizens receive their sensor it is, when there are a small number of users, straightforward to manage their presence on the dashboard, however there are several challenges as numbers increase which mean the dashboard visualisation isn't wholly representative of the case study membership:

1) A citizen who has yet to apply for a sensor can seemingly register their presence on the Dashboard without having to register as a member.
2) Multiple entries can be created by a participant whilst installing a sensor
3) At least one citizen had joined the platform after buying and installing their own Telraam sensor

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4) Some participants have set up the sensor under a different name to the original registration or using a different e-mail address, making it difficult to track installations and identify the 'owners' of the sensor.

From a support perspective, the Zendesk has been invaluable in assisting those who contact the team with either installation problems or challenges with sensors dropping in and out of operation. The support from the Telraam system administrators and technical staff has been excellent throughout, not only in supporting Cardiff citizens with their challenges but in supporting the Cardiff team with our queries and requests. There are, however, some challenges in managing any sensors that are yet to be installed or appear to have difficulties, at a distance.

- As noted above, some participants who appear not to have installed a sensor, have, but have not connected to the appropriate network on the platform. These are only identifiable if we actively follow up with these participants and they choose to engage with that e-mail.
- If a sensor is consistently not measuring, the system will send out an e-mail once a week. We also follow up with these citizens, but are only able to address challenges identified if the citizen engages with the regular support e-mail or with our direct communication

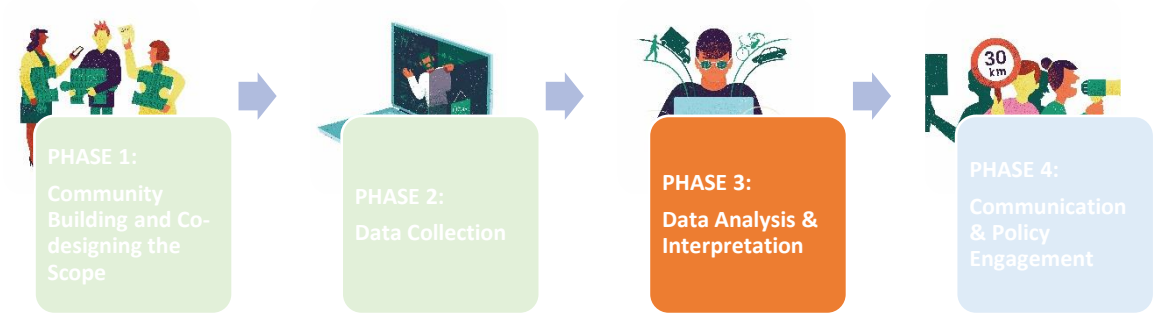
Outboarding: To date, only one participant has completed the outboarding process, however this wasn't identified immediately as there is no e-mail or alert, prompting the team to follow up with the citizen. To solve some of the challenges set out above to facilitate a smoother user management experience for others, it may be appropriate to introduce the following steps:

- Require the same name and e-mail be used on both the registration and set-up pages
- Restrict the set up of multiple segments for the same sensor and make it easier/clearer how to reset and restart the installation process should an installation go awry
- Provide a specific code so that case study participants can be clearly separated from others who may join the dashboard through their own means.

4 WeCount Cardiff Phase 3: Data Analysis and Interpretation

This section provides an overview of the approach take for the Data Analysis and Interpretation Workshops and a high-level overview of the Telraam data that has been collected in Cardiff to date and how it may be used. In summary, this section covers two key activities and provides a reflection on Phase 3 of the process to date:

- Data Analysis and Interpretation Workshops (Section 4.1)
- High-level overview of Cardiff Telraam Data (Section 4.2)
- A reflection on Phase 3 of the case study (Section 4.3)



4.1 Data Analysis & Interpretation Workshops

For the Cardiff case study we decided to hold three types of workshops:

1. Introductory workshops to identify area specific problems associated with traffic and to discuss the future direction of the project (see Section 2). Four of these workshops were held between October and November 2020 as part of Phase 1.
2. Data Analysis and Interpretation Workshops (aka Data Workshops) to help participants explore their own data and data from their local community. The first of these was held in April 2021 with a further workshop to be held at the end of June/beginning of July as part of Phase 3.
3. Citizen Advocacy and Communication Workshops to discuss the overall findings of the WeCount project. These workshops are planned for Autumn 2021 (See Section 5) as part of Phase 4.

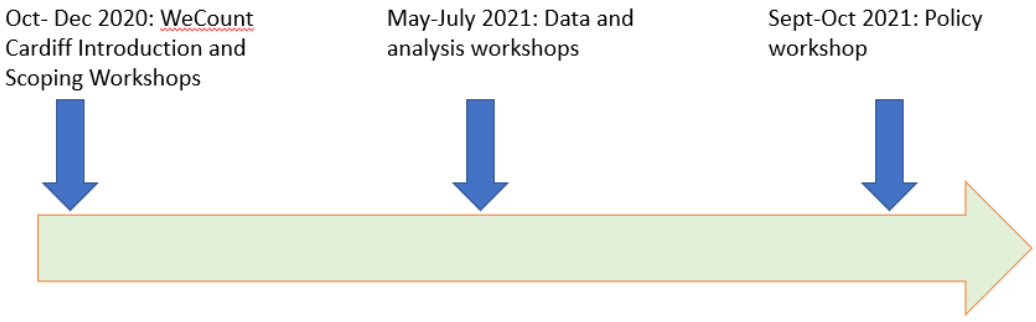


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Figure 13: WeCount Cardiff workshop timeline

Data Workshop Recruitment and Participation

Two Data Workshops have been planned for Phase 3. The first Data Workshop focussed on the Roath area of Cardiff (Figure 14 – blue box) and was held on the 27th April 2021 via Microsoft Teams. The design, recruitment, structure, results and feedback for this workshop is described below. A second Data Workshop, focussing on the Grangetown / Riverside / Canton areas of Cardiff is planned for the end of June / beginning of July 2021 (Figure 14 – orange box).

Why a data workshop in Roath?

As shown in Figure 14 (blue box), a significant number of Telraam users were present in Roath and adjacent parts of Cardiff. There are also a range of strategic and arterial roads in Roath and several very active and engaging citizens, known as our Roath WeCount Champions, were keen to express their thoughts, share their data and their perspectives with citizens of Cardiff. Whilst the data analysis was centred on Roath and its streets, the workshop was open to all, regardless of which part of Cardiff they reside in or whether they were from Cardiff or elsewhere.

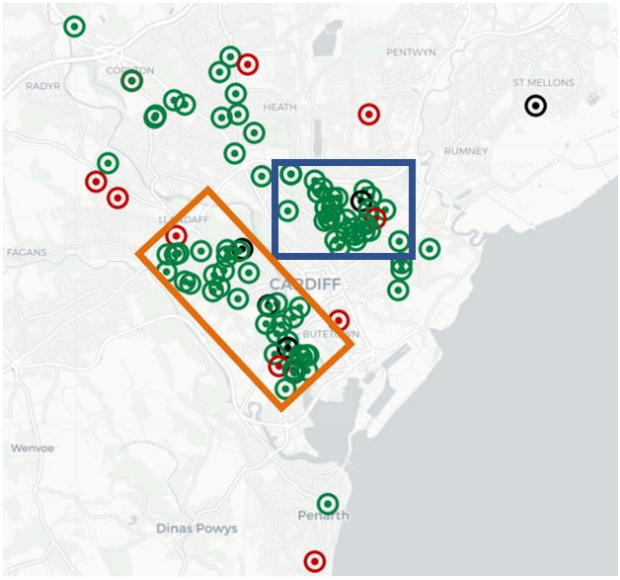

Figure 14: Geographical scope for the WeCount Cardiff Data Workshops

Recruitment of attendees for the Roath Data Workshop.

Invitations to attend the Roath Data Workshop were sent out to >200 register members through the WeCount platform and promoted on social media in order to increase the potential audience. As shown in the box below, invitations made clear that the invitations were for a Roath Data Workshop but that another workshop would be held in due course.

Dear Participant,

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We will be hosting a series of online data workshops across Cardiff over the next few months. The first of which will be centred on Roath. In this workshop, hear data stories from local residents, learn how to explore your data on the dashboard, and discuss how your community's data can be used to influence local decision making.

After a short introduction, we'll share examples from a local case study, led by two Roath residents, before moving on to a discussion on how you think you could use WeCount data for your own local needs.

The workshop will be held next Thursday (27th May) evening between 7 and 8pm. To attend this event, please register here through Eventbrite. If you encounter any difficulties registering this way, or have any other questions beforehand, please contact us at wecount.cardiff@uwe.ac.uk and we'll process your registration manually.

The workshop will, as usual, be a friendly and relaxed atmosphere. Please feel free to bring a cup of tea or a glass of wine with you as we explore local WeCount traffic data!

The invitation directed those interested in the workshop to register via an Eventbrite link, from which, in due course, they would then obtain a link to the event itself. 21 registrations were received via Eventbrite for the event, with 18 attending (81%). There was a mix of participants in attendance, from those already active in their communities (e.g. part of Playing Out or Roath Living Streets) to more passive members, interested in the data collection or the technological aspects of WeCount. There were 11 males (65%) and 7 females (35%) in attendance, and the majority in their 40s and 50s, except for one under 16 accompanied by their parent.

The workshop was organised on a weekday evening, between 7 and 8pm to ensure that it was accessible to as many participants as possible. Hosting it during 9-5 would have excluded many in work, holding it between 5 and 7pm would exclude those commuting and those wanting to eat before attending and after 8 may exclude those with childcare responsibilities, or who are winding down for the night. Some with childcare responsibilities might also have been unable to make the 7-8pm workshop, but it is a compromise between other timeslots with additional competing priorities.

Workshop Structure

In keeping with the co-creation ethos of WeCount, citizens played a central role in the development and design of the Roath workshop with two Roath Local Champions put themselves forward to help design and deliver the workshop contents (Figure 15). Initially, a meeting was held with the two Roath Local Champions, to discuss the concept and purpose of the Data Workshop and the role they would like to play. From this, two key points were discussed: (1) the local champion's use of the sensors in-situ (challenges, solutions, observations, etc), and (2) their local knowledge beyond traffic measurement, including pedestrian movements and local infrastructure and safety challenges.

Consequently, it was agreed that the Local Champions would develop a series of slides presenting data from their sensors, supported by a discussion of the data from their local contexts and knowledge. The WeCount Cardiff team supported them in the development of these slides and incorporated them into the broader presentation.

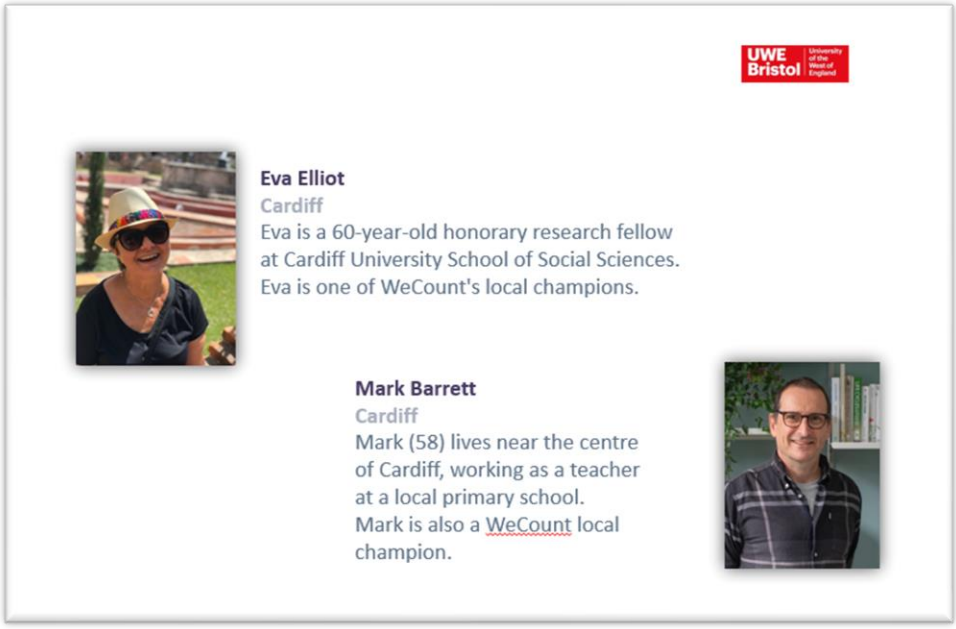

Figure 15: WeCount Cardiff local champions who supported the Roath Data Workshop

Co-designed with our Local Champions, the workshop contents, as presented to those attending was as shown in Figure 16. The workshop had four distinct sections:

1. Define and Constrain. This section focused on refreshing an understanding of the project, it's aims and objectives and the strengths and weaknesses of low-cost sensors. It would also educate attendees who had not encountered WeCount previously. At the end of this section, attendees would understand the purpose of WeCount, the parameters and the limits on the interpretation of the data and understand the focus of the workshop.

2. Roath's WeCount data in the context of lockdown and a specific case study of Shirley Road.

3. A consideration of air pollution particularly considering the impact of Covid19 restrictions.

4. A roundtable discussion with participants on:

    a. any other data they would have an interest in seeing on the WeCount dashboard

    b. how could the data help with local priorities and activities.

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Figure 16: Agenda for the Roath Data Workshop

Introduction

This section was delivered by the WeCount Cardiff project team. The workshop opened by introducing the attendees to WeCount's aims and objectives and where the data analysis workshop fits within the context of the wider project. The introduction also discussed the Telraam Sensor, ensuring that those who had not signed up to the project, but were interested in the platform, were able to understand the methods of data collection. Finally, the introductory section discussed the strengths and weaknesses of the sensor, to frame the conversation around data in an appropriate context.

Data in Action: The Shirley Road Case Study

This section was delivered by the local champions. This section initially explored the traffic levels during the period 1st January 2021 to the date of the Roath Workshop. Examples of how Wales-specific lockdown restrictions impacted, or not, the traffic volumes on the streets of Roath were presented (as shown in Figure 17), with caveats on data accuracy emphasised. A discussion of the relative contributions of different modes of traffic to the data were also made.

Following this section, the Roath Local Champions presented the data from their local perspective, ensuring that the data had a community feel and a local context and emphasising the co-creation element of the project. As Mark, one of our Local Champions set out at the beginning of his presentation, "I didn't set out to be so active. Speeding brought me to it. I've developed lots of interest – now I'm looking regularly [at the data dashboard]; it's fascinating. I will take forward our findings to Councillors, so they hopefully take action.", highlighting how citizens have been engaging with the data individually and at different levels of depth, since receiving the sensors.

The Local Champions presented data specific to their road, Shirley Road, to the attendees. Data from the sensor were presented and in addition a comparison with a manual count was shown (see Figure 18) around which the Local Champions discussed the relevance of this from their local context and knowledge.

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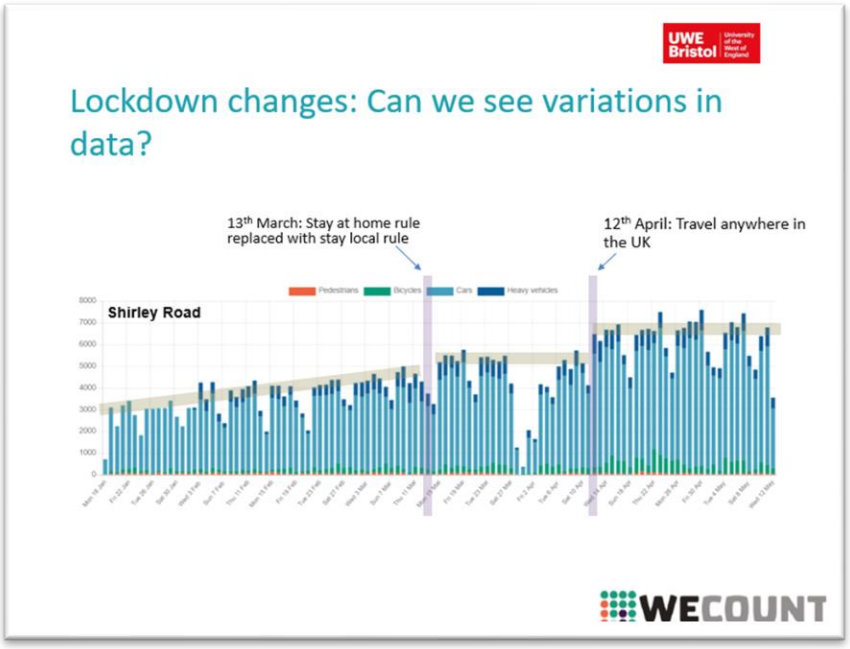

Figure 17: Example of data presented to encourage debate at the Roath Data Workshop

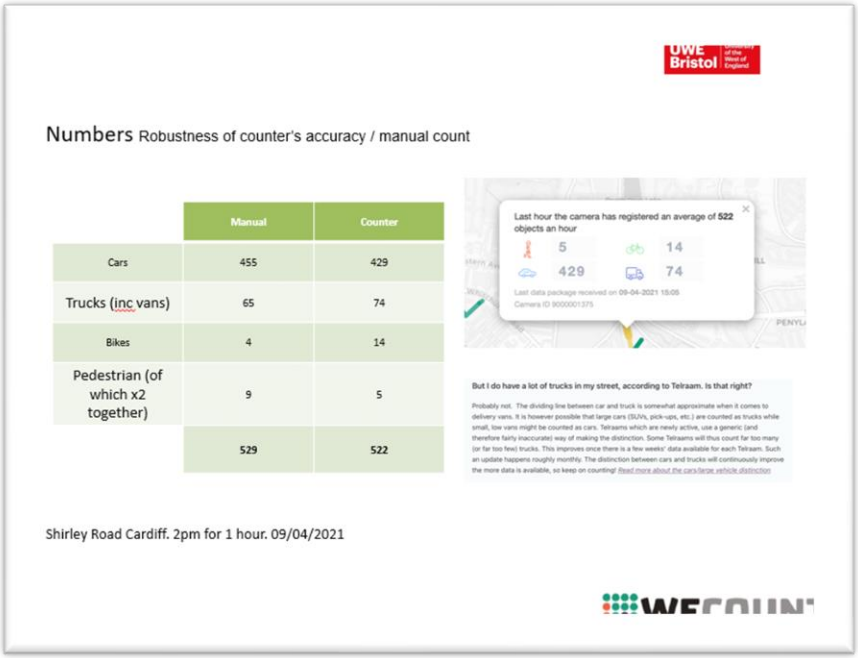

Figure 18: Comparison of manual and sensor counts by the Roath Local Champion

The Local Champions discussed a broad cross section of data gathered on Shirley Road and across the Roath area and in doing so introduced their local perspectives on the data. Issues discussed included:

- Daily and weekly traffic volumes
- Weekend and weekday traffic comparisons

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- Morning and evening traffic comparisons by direction of travel
- Speed and proportion of speeding vehicles.

Focus was given to speeding on Shirley Road. As shown in Figure 19 residents were keen to keen to highlight the proportion of vehicles speeding along their 20mph road, emphasising this by using a very conservative cut-off of 40kmph (indicated by the red line in Figure 19) to account for the tolerance and accuracy of the sensor.

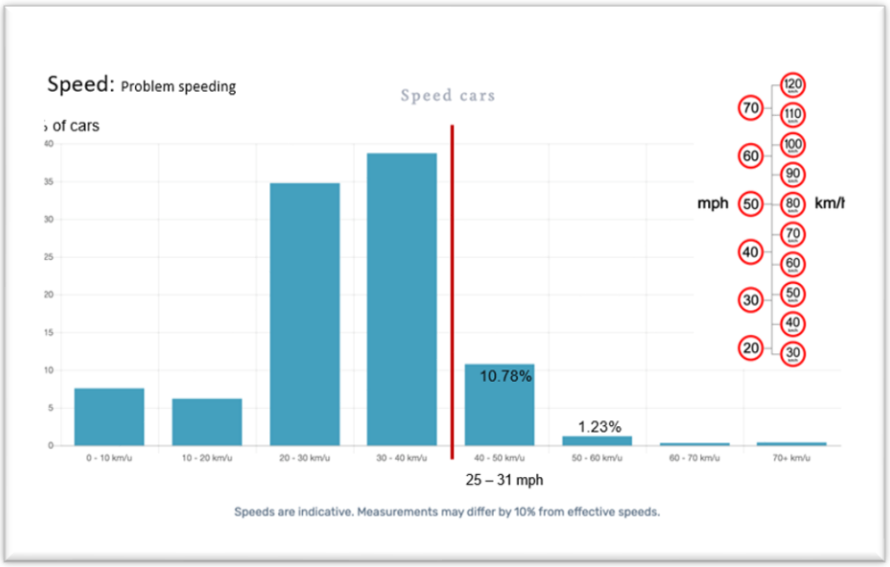

Figure 19: Example of speed data presented to encourage debate at the Roath Data Workshop

Comments in the chat box during this discussion also showed how the participants could relate to the speaker's findings on speeding and traffic volumes:

"*we have the same level or even more [here]*"

"*we see a similar issue*"

Air Pollution

An introduction to air quality data from the nearest reference air quality station on Richards Terrace, to the south of Roath was presented to participants. Data were presented showing pollutant trends for NO_2 and PM_{10} from January to the workshop and the possible implications of Covid19 restrictions on NO_2 and PM_{10} levels. Low-cost air quality and noise monitoring was also discussed, highlighting to participants that there will be an opportunity to host these sensors soon as part of the WeCount project.

Roundtable Discussion

The workshop closed with a roundtable discussion with participants on: (1) any other data they'd have an interest in seeing on the WeCount dashboard and, (2) how could the data help with local priorities and activities. The participants were invited to log in to Mentimeter, a live quiz, question and answer platform (https://www.mentimeter.com/) using a specific code, to access both questions and populate their answers and 10 participants entered suggestions that were livestreamed into the workshop. Some participants may

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have not participated in this section for several reasons such as they couldn't navigate to Menti for technological reasons (i.e. attending on a phone) and/or they did not want to provide suggestions. However, most participants participated in the discussion which surrounded these topics, either verbally or by writing in the chat box. Once examples were provided for both questions, citizens were asked to expand on their answers on the mic, to provide their local context and perspective to the short statements. This encouraged further dialogue between participants.

A subset of answers provided for the first question (any other data they'd have an interest in seeing on the WeCount dashboard) answered in Mentimeter are set out visually in Figure 20 and collated for ease of interpretation in Table 7.

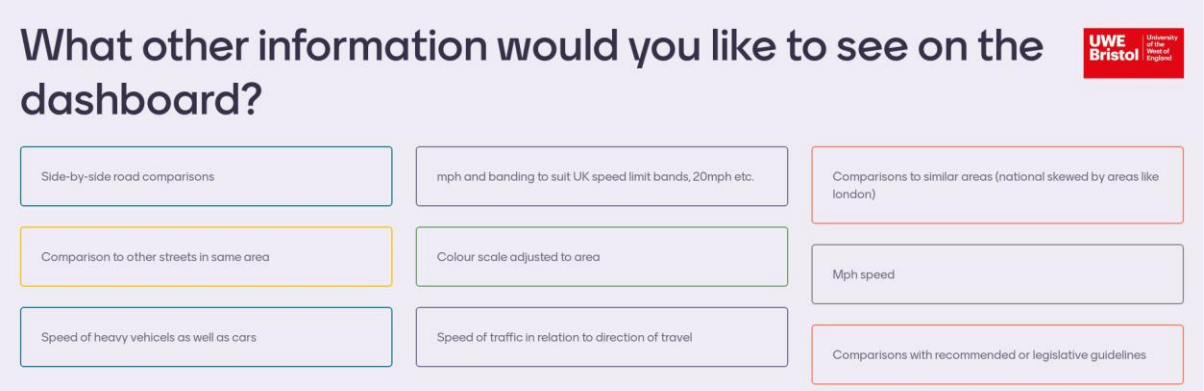

Figure 20: What other data would you like to see: feedback from Roath Data Workshop

Table 7: What other data would you like to see: feedback from Roath Data Workshop

What information would you like to see on the data dashboard?
Comparisons to similar areas; comparison with other cities; side-by-side road comparison (N=4)
Mph and banding to suit UK speed limit bands (N=2)
Speed of heavy vehicles; speed in relation to direction of travel; data on how many vehicles speed each day (N=4)
Map showing where LCWIP (cycling and walking) corridors and cycle superhighways are planned; RTCs mapped to streets to see accidents (N=2)
Colour scale adjusted to area (N=1)
Information on how to use data to apply for traffic calming measures, to encourage enforcement and to tell data stories to communities/different groups (N=2)

As shown in Table 7, the predominant request for other information is a comparison with similar areas and other cities. Whilst the dashboard does allow for comparisons of roads, side by side, it may be that this needs to be more clearly communicated. Comparison of city by city is only possible by extracting data and processing it manually. There may also be several caveats with such data, so care would need to be taken should this be developed further. Equally, speed of HGVs was raised as an important metric to measure, including clear data on how many vehicles speed per day.

For question two (how could the data help with local priorities and activities), again answered in Mentimeter, are set out visually in Figure 21 and collated for ease of interpretation in Table 8.

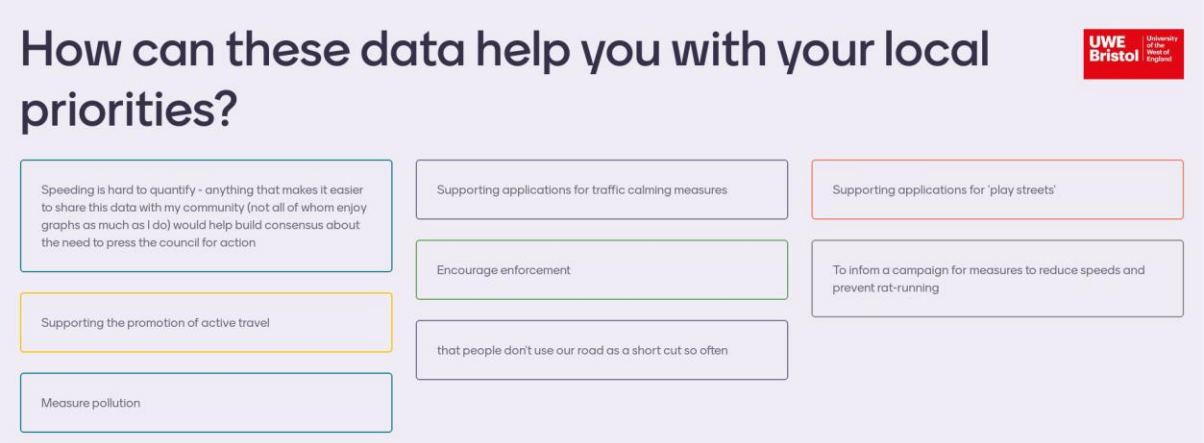

Figure 21: How can the data help with local priorities and activities: feedback from Roath Data Workshop

Table 8: How can the data help with local priorities and activities: feedback from Roath Data Workshop

How can these data help with your local priorities?
By supporting applications for traffic calming, play streets, etc
By encouraging enforcement
By deterring people from using road as a rat run and promoting active travel
By informing traffic campaigns
By measuring pollution levels

As shown in Table 8, there are a range of suggestions for how these data can help with local priorities. These suggestions cover the use of data to support information campaigns, creating safer and healthier neighbourhoods (e.g. enforcement of speed limits, play streets and promoting active travel) and as a dataset through which comparison with air pollution data can be compared (see Section 6). All suggestions from citizens for both questions will be collated and provided to colleagues once the second Data Workshop is completed ensuring that the citizen's incredibly valuable feedback is built in to future Telraam developments to enhance the value and usefulness of the sensor and data platform.

Workshop Feedback

Workshop feedback was captured through Mentimeter. Seven responded to the Menti evaluation poll at the end of the workshop. All loved (57%, N=4) or liked (43%, N=3) the session and all stated that they understand the data coming from the Telraam to some extent. In terms of data, 86% (N=6) were somewhat surprised by the numbers they saw for their street.

"The overall number of vehicles and potential associated air quality impact was higher than I had considered before"

"I knew there were patterns of traffic behaviour but my feelings about peak traffic levels and speeds were not correct. Having the data has helped me have a clearer picture"

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Since their involvement in WeCount the majority believe that their opinion on overall traffic-related issues in their street (85%, N=6) and in Roath (71%, N=5) has changed somewhat. WeCount has also changed how people feel about where they live:

"[I feel] more empowered and connected with the Cardiff community"

"[I feel] happier that the data is out there, and can be used to improve our lives. [And] worried that the data shows such a high level of car dependency."

85% (N=6) also feel better able to act:

"[It] has given me actual data with which to lobby the council for traffic calming measurements - I now have actual data to submit to the council not just my personal observation"

"Yes, better understanding of what's there we hadn't explored it so much before and seeing the other street share theirs really helped"

Although one participant did mention that they would feel bad about acting, as the focus needs to be on improving the worst affected areas, of which they felt theirs was not. 57% have already taken some form of action, from applying for funding for traffic calming measures, to approaching the police and sharing links with neighbours and 85% (N=6) plan on using the sensor after the project ends. After promoting the future policy workshops and pleasantries, two people from Public Health Wales and Sustrans who were yet to use a Telraam sensor, and were not residents of Roath, remained to discuss and connect with the project and UWE professionally. The individual from Sustrans, a UK transport charity stated:

"I love this whole thing. Wish it had been in Cardiff in previous years as would have taken part. I will be in touch about possibly doing it up here in [Sheffield,] England"

The workshop from the perspective of both the project team and the citizens who completed the evaluation was deemed a success and lessons learned from the workshop is being integrated into the development of the second data analysis workshop. These are reflected upon below.

Plans for future Data Analysis Workshops

As noted previously, a further data analysis workshop will be held covering the Grangetown / Riverside / Canton area, where there is a significant uptake of Telraam sensors. We will ensure that the workshop follows the same logic and process as the Roath workshop. Local Champions will again play a central role in the workshop considering the success and importance of this initiative of the Roath Workshop. We may need to extend the length of the workshop to 1.5 hours to ensure that Grangetown, Riverside and Canton's perspectives are presented by the Local Champions, but this is not though to be a problem with respect to attendee engagement.

4.2 Descriptive Analysis of WeCount Cardiff Network Data

When engaging with participants of the WeCount Cardiff network we describe the data spatial scales in simple terms as: "My sensor, My street, My community, My city". In doing so, we are illustrating the value that the Telraam sensor data can have at different geographical scales and for different audiences. For example:

- "My street" data may be of interest to the sensor user and their immediate neighbours.

- "My community" suggests the value that a high network density of sensors could have on local community groups and activities.
- "My city" alludes to the value that several sensors could have across a city region and feed into city level policy and data analysis.

The Telraam platform offers a range of summary statistics in a readily available format. The website offers the opportunity to look at data from any street segment to members of the public, even if they are not WeCount participants. WeCount participants can log into their Telraam account and access a monthly report for their own sensor, which includes summary statistics of traffic as well as performance data of the sensor. WeCount network administrators can access summary statistics for all sensors in the network, as well as for individual street segments. The information shown in this section will be based on summary data accessed via the network administrator accounts. Further information on the data provided in participant's account and in the public domain is provided in Section 4.1, as this was part of the introductory WeCount Data Workshops. The following illustrates the value that the traffic data can offer using the lifting of Covid19 lockdown restrictions as an example.

Comparison of Absolute Numbers

The first overview that is available when accessing the network administrator dashboard is a comparison of the total counts by mode during this week and during last week, an example screenshot is shown in Figure 22. It should be noted that the weeks are rolling 7 day periods, i.e. "this week" are the 7 days prior to the present day and "last week" are the 8-14 days prior to the present day. This overview graph also shows the average increase or decrease in percent from last week to this week. On a week-to-week basis we would expect this change to be relatively small. Any major changes over such a short time period would indicate a major change in the road or a problem with the sensors. In think particular instance, we observed a growth in cars and HGVs across the Cardiff network which may be linked to a week-on-week growth of vehicle movement since Covid19 lockdown restrictions have been gradually lifted.

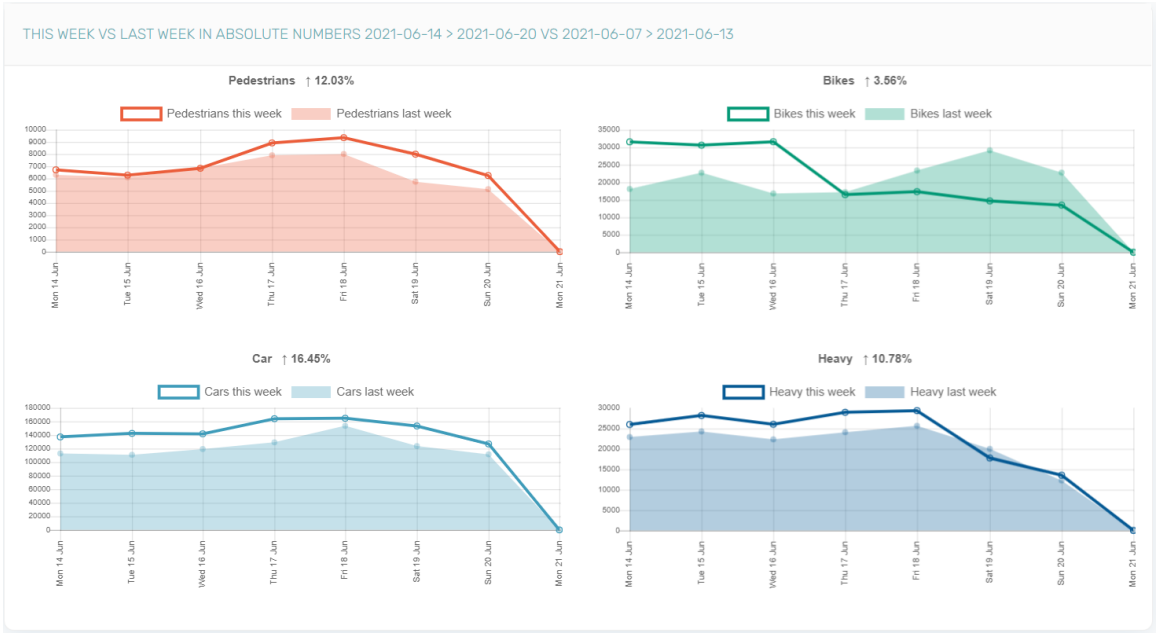

Figure 22: Screenshot of the weekly comparison provided by the platform

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Comparison of relative traffic

The Telraam platform also offers an overview of the relative traffic for a given period set by the user. The relative traffic is defined as the percentage of observed traffic relative to the typical traffic. The typical traffic is the average of the observed traffic over the past year in the network for the same hour and day of the week. Since all the sensors in the Cardiff network have been operational for less than one year, only the available data for hour and day of week were used. As an example, the graph below (Figure 23) shows the relative counts (in %) of cars and large vehicles in the Cardiff network from 20th April 2021 to 20th June 2021 (i.e. two months). It can be seen car counts have remained relative steady in the last two months with a rather typical weekly profile although an increase in car counts in June is observed as businesses reopen and people go back to work. Conversely, we have seen a reducing in peak large vehicles counts in June compared to May which may illustrate a reduction in online deliveries as people are home less and are returning to supermarkets.

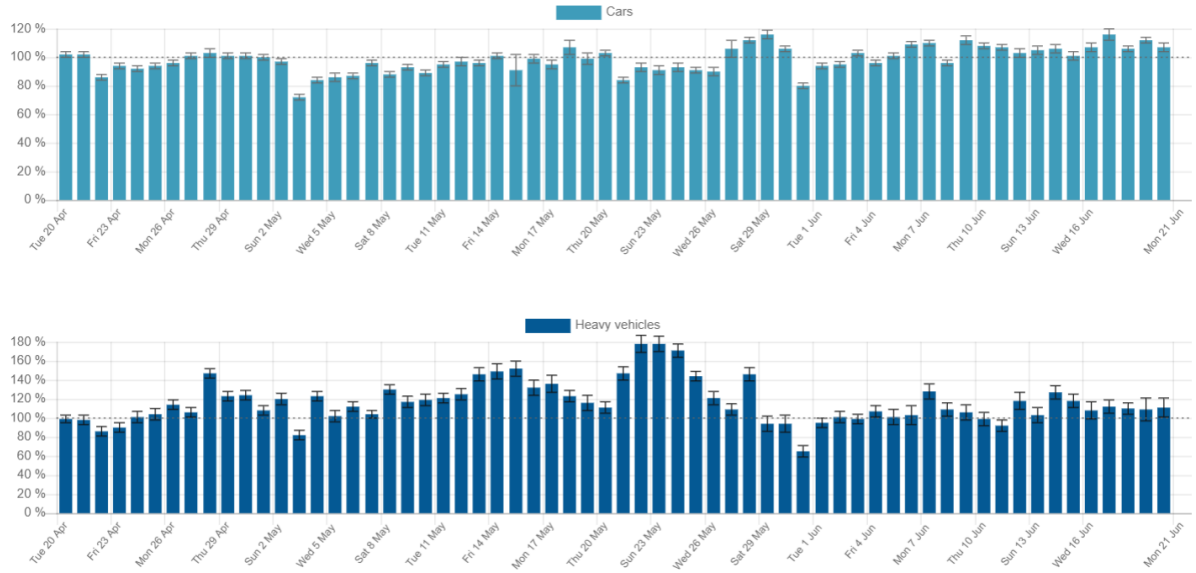

Figure 23: Screenshot of relative car and large vehicles for the last two months (May/June 2021)

Comparison of time periods

Another feature offered by the Telraam platform for network administrators is a comparison between two different time periods. The user can manually set two time periods and graphs showing average hourly counts by time of day for each transport mode and time period will be shown. This can be further refined by using only data from weekdays or only data from weekends. An example graph is shown below (Figure 22), which shows counts in February & March (green) against April & May (blue). There were more cars and more van/large vehicles as we move out of Covid19 lockdown restrictions which also corresponded with a reduction in cycling numbers.

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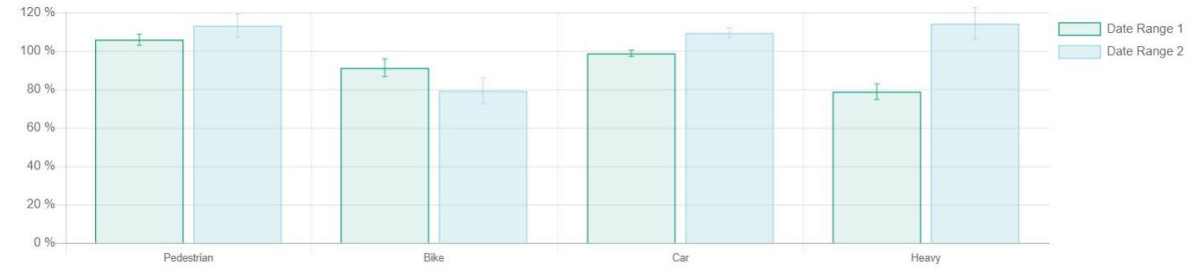

Figure 24: Screenshot of comparison of average hourly heavy vehicles count provided by the Telraam platform

Traffic Speed Data

In addition to traffic counts the Telraam platform and API also provides hourly speed measurements in 10km/h intervals. One of the primary issues we have in using Telraam in the UK is that our speed limits are mph not kmph which means the data has to be adjusted. For indicative purposes we assume that 40kmph = 20mph which allows us to be conservative and provides us with a margin of error. Figure 25 shows the car speed data again for the last two months (20th April 2021 to 20th June 2021 (i.e. two months). We can see that the increased traffic coming out of lockdown has not resulted is a notable reduction in car speeds although the speeds appear to be 'smoothing out'. What is noticeable is that a worrying percentage of cars (approx. 15%) are travelling above 40kmph (20mph) but most Telraam counters in Cardiff are based in 20mph zones. If we are not conservative and assume that 30kmph = 20mph then this jumps from 15% to 40%. This indicates that better regulation of speed limits especially in the 20mph zones are required.

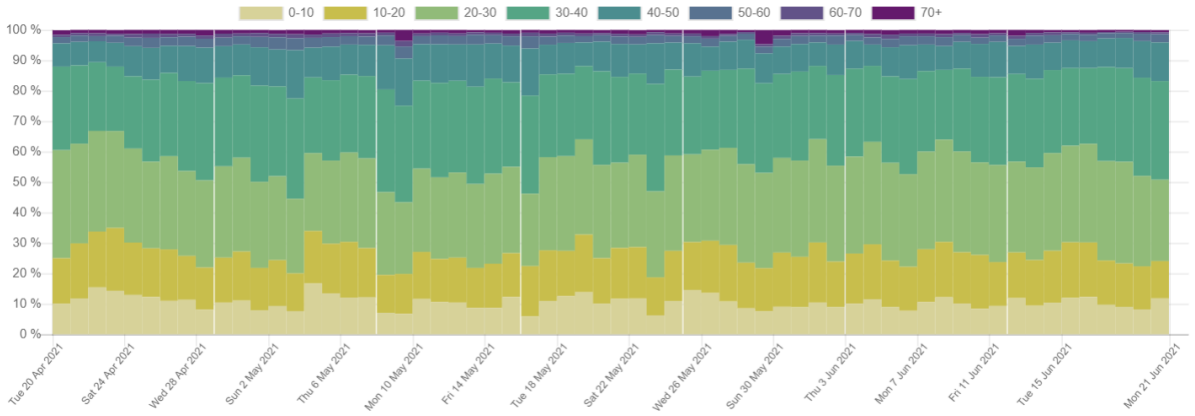

Figure 25: Screenshot of car speed data for the last two months (May/June 2021)

Citizen Data Analysis and Communication

This section has primarily focussed on the data analytic functionality of the Telraam platform but the value of citizen led analysis cannot be unvalued especially for communication purposes. Many Cardiff participants, with different motives, have also undertaken data analysis. For example:

- Figure 26 illustrates a data visualisation by a 9 year old in Cardiff who used his parents Telraam counter to inform his school maths activity.
- Figure 27 illustrates how the Telraam data can summarised and used as a regular update of a local community group.

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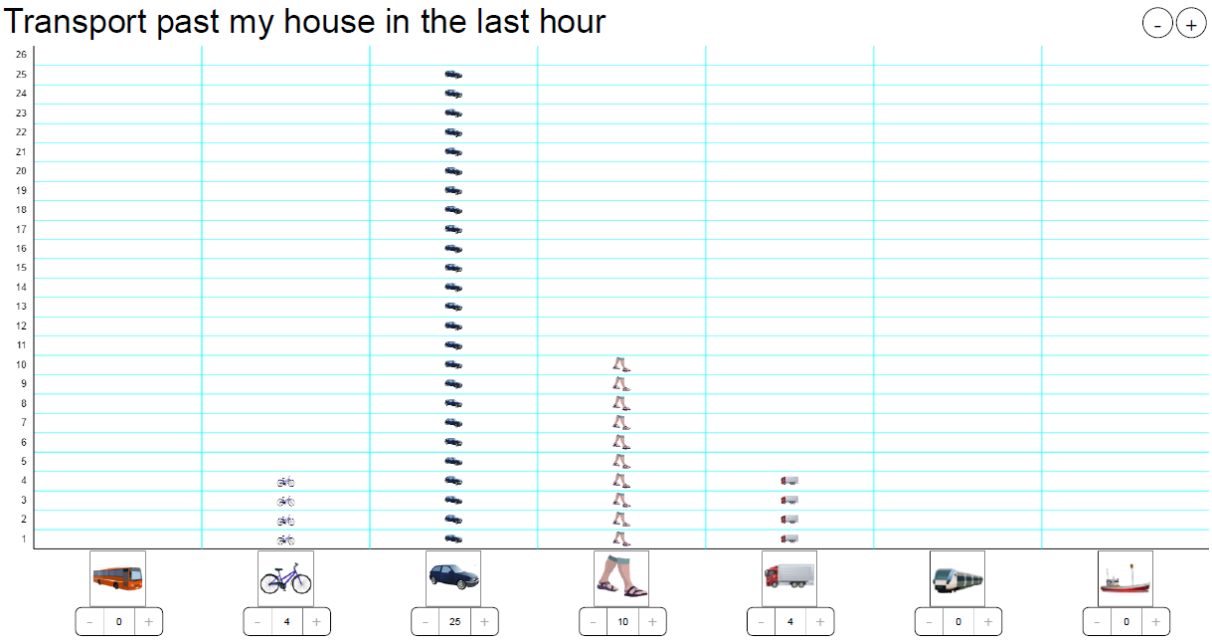

Figure 26: Data analysis by a 9-year-old student as part of their school homework.

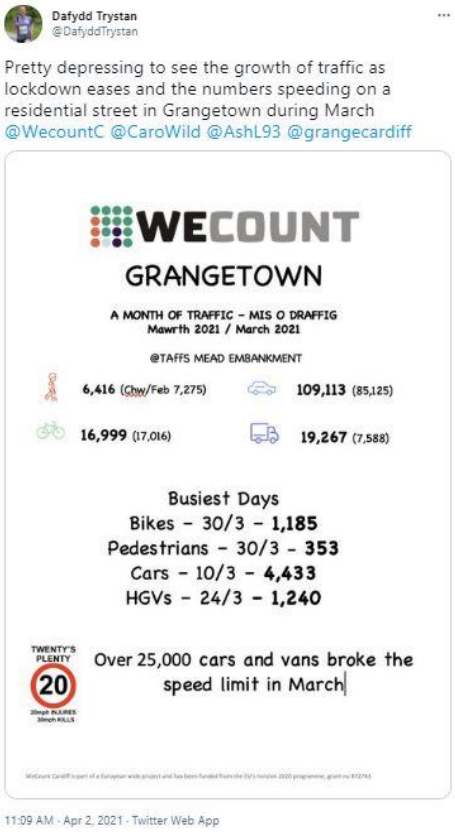

Figure 27: Data analysis by Grangetown participant as part of a regular community update.

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4.3 Refection on Phase 3 (to date)

When reflecting on Phase 3, several themes emerge:

The value of co-deigning with citizen scientists: Working with the local champions for the Data Workshops was very valuable and popular as it ensured the citizen voice was not only heard but lead the discussions. It also ensured that the lived experience of the participants was being properly conveyed and was not presented as anecdotal evidence by the project team. Whilst the project team may have more knowledge of the sensor and data platform than citizens, we do not have a local perspective on what the data represent and mean for citizens. Co-creating the workshop with our Local Champions allowed for the Roath community to both see the data from a broader perspective but also understand the local personal experience of the data, which is likely more relevant as a comparison to their own personal experiences. The co-creation of the workshop also benefitted the project team in several ways. We were able to understand how the data matter from a local context and identify additional challenges in the interpretation of the data before presentation.

Moving to online workshop hosting: Much like Phase 1, ensuring that the workshop was as accessible as possible was always likely to be a challenge during a pandemic, however, providing online access and attempting to host the workshop during a timeframe with the least expected impact on attendance went some way to mitigating this. There will be some who cannot attend due to technological reasons, however, as noted, best efforts were made to reduce this. The workshop itself was divided into several distinct sections to provide attendees with an overview of the technology and its limitations, a local context and an interactive section to generate ideas and conversations. The first section was important in framing the sensor and, as set out in the previous section, several attendees did not know of the sensor and its strengths and weaknesses. Without this section, they may not have opted to speak with the team about future opportunities after the workshop finished. The central section of the workshop presented by our Local Champions was very well received by participants and provided the Local Champions to provide their local stories, challenges and opportunities as framed by the data. The final section, provided all participants with an opportunity to engage either on mic, in the chat box and via Mentimeter. Allowing different means of engagement allowed those with different levels of comfort in talking on the mic and opportunity to participate. Whilst in-person workshops would have provided an additional layer of interactivity and engagement between the project team and the attendees, it may have introduced other challenges in participation, such as a requirement to reach a particular venue, which is not experienced by having to attend an online event from the comfort of our own homes and fit it around existing obligations.

WeCount Cardiff Team Reflection: The team were happy with how the Data Workshop unfolded. The involvement of the Local Champions in the design and presentation of the workshop were a particular highlight, making a potentially abstract workshop more relatable. The interactive session at the end of the workshop also allowed further conversation with attendees was valuable in drawing out key information for future use. The team agreed that the Workshop was a little 'slide heavy' and a little light on the conversation and that these could be enhanced in future workshops. For the future workshop additional preparation would be made to provide some city comparisons to give a broader overview of the data and we will spend more time on the roundtable discussions. An icebreaker at the beginning may have also added a bit more fun to the session, but this wasn't and isn't necessarily needed.

Data Analysis & Interpretation: The Telraam platform is continually improving in the services that it offers but this increased functionality also required increased support in helping citizens and data users to interpret the data accurately and sensibly. Additionally the value of the citizen data analyst should not be underestimated.

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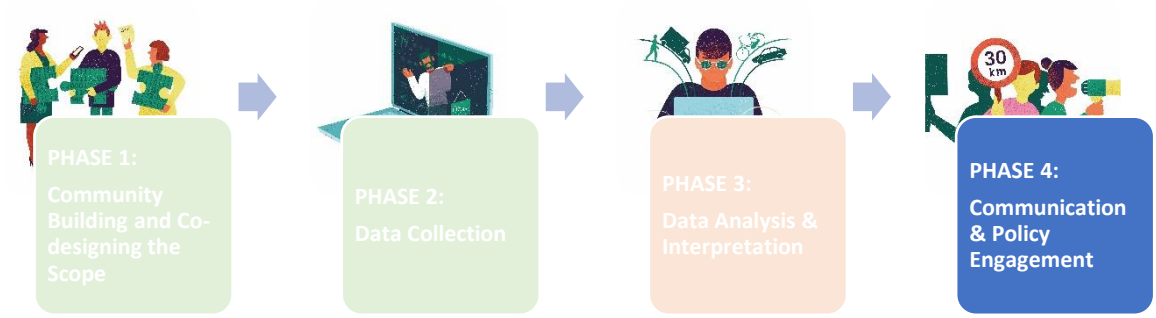
5 WeCount Cardiff Phase 4: Communication and Policy Engagement

This section provides an overview of the plans for Phase 4 to be implemented in Autumn 2021. This includes an introduction to the third series of workshops primarily focussed on supporting citizen advocacy to use the data generated in communication campaigns and to map out possible interaction pathways with local transport, environmental and public health policy. In summary, this section covers two proposed activities:

- Citizen Advocacy Workshops (Section 5.1)
- Policy Interaction Pathways (Section 5.2)



5.1 Citizen Advocacy Workshops

The final series of workshops will be a selection of citizen advocacy workshop which will draw from the experience of the ClairCity Project (www.claircity.eu). The workshops will provide practical resources, guides, and tips to support local groups working for better urban mobility, clean air and a net zero carbon future. The workshops will provide advice for citizens on how to communicate their data (quantitative and qualitative) and ensure that they maximise the scope and reach of their activities.

The workshops will result in a co-designed WeCount Community Activator Pack which will incorporate:

1. An activist decision tree helping to guide participants towards appropriate action.
2. Fact sheets on local transport issues and related environmental impacts.
3. Practical tips on establishing a campaign group.
4. Guidance for adopting a hybrid of the WeCount / ClairCity approach in your community.
5. Guidance for running events, managing social media, capturing marginalised voices, working with younger and older people and digital approaches.
6.

5.2 Policy Interaction Pathways

Three key pathways to influencing local transport policy for the WeCount Cardiff case study has emerged recently. They vary in scope and reach but all allow the WeCount data and resources to support local community groups, local schools activity and Cardiff Council. The three pathways are:

- Support schools active travel and STEM activities.

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- Monitoring data for the reopening of Castle Street
- Supporting the Cardiff Council Low Traffic Neighbourhoods (LTN) feasibility study.

Support schools active travel and STEM activities

Through the WeCount Cardiff network and a strategic alignment with the DETI initiative (see Section 6) we have engaged with several Cardiff and Bristol based primary and secondary schools to support them with their active travel initiatives while also providing co-benefits for STEM learning. Three primary schools in Cardiff and twenty secondary schools in Bristol are piloting these activities. All schools will be given a Telraam sensor and a digital pack containing activities that can be done in class. The types of lessons and guidance for the teachers are outlined in Table 9 below. These activities will be aligned to community and Council plans to support policy interventions such as School Streets.

Table 9: Lesson plans for KS2 teachers (Primary Schools)

Lesson Name	Description	Discipline
Assembly: Introduction to WeCount (engineering for sustainability)	Overview of transport and mobility in cities – the problems (e.g. air pollution and climate change) and the solutions (e.g. 15-minute neighbourhoods, walking and cycling)	General
1. Mobility and me	A deep mapping task for pupils to document how they feel on their route to school (using a map and key)	Geography and Art
2. How does your street move?	A drawing exercise to depict how our streets look like today and envision how we would like them to look in the future	
3. Data explorers	A data interpretation and graph making activity to understand street-level traffic data in a given street	Science, IT
4. Machine learning	A simple algorithm exercise to understand how the Telraam counts traffic	IT
5a. Counting traffic	An exercise to read and interpret Telraam data for our school/area	IT/Science
5b. Counting traffic (manually if window not suitable/no Telraam)	An exercise to count transport outside school gate (+ optional additional activities to measure (4b) noise, (4c) speed, (4d) smells and (4e) document obstructions if preferable and you have the resources)	Science
5. Travel matters to me	A reading and critical thinking task to compare different opinions on local traffic issues	English
6. A postcard for our future	A writing challenge to persuade the authorities about things they should to make our vision for the future a reality	
7. Clean air top trumps	A debating card game to assess which transport mode is best, according to several factors, and why	
8. Bonus/extension – view from your window	Drawing and observation exercise to sketch what pupils see from their window at school/home	Art

Table 10: Lesson plans for KS4 teachers (Secondary Schools)

Lesson Name	Description	Discipline
Assembly: Introduction to WeCount (engineering for sustainability)	Overview of transport and mobility in cities – the problems (e.g. air pollution and climate change) and the solutions (e.g. 15-minute neighbourhoods, infrastructure to support walking and cycling)	General
1. How technology has shaped us, and how we shape technology	Video, exercise and discussion on history of the car and how we have shaped its proliferation.	History and DT
2. Observing traffic, working scientifically	Exploring the different technology and methods used for traffic observations; thinking about how we sense the environment. An exercise to understand some key scientific concepts and the scientific method	Science
3. Computer science for sustainability	Exploring e.g. algorithms, functions, and Boolean logic with the Telraam sensor – understanding how it works (data values collected through a camera (hardware)	IT
4. Desktop research: sustainable travel where we live	Exploring what the current travel issues affect our city/town and what is being done about it	Science, Geography
5. Data diving and storytelling	Exploring existing WeCount datasets, working out mean, median, mode, creating graphs, etc	Science, Maths, IT

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6. Counting traffic	Using our Telraam data and counting manually to understand the extent of the problem; with discussion on data accuracy. Extension to discuss complementary datasets and homework to gather additional evidence	Science, Maths, IT
7. Citizen participation in sustainable travel	Discuss forms of citizen participation in a democracy. Encourage pupils to think of examples and times when they might have been an 'activist'	Citizenship
8. Local travel matters	Surveying local residents on their views. Discuss the importance of involving different stakeholders.	English, science
9. Designing sustainable solutions	Using evidence from previous weeks to put forward an intervention for change, using the engineering design process – vote on winning design based on certain criterion. Invite residents/stakeholders in to vote	Engineering, DT
10. Communicating to our audience	Exploring different forms of communication, persuasive writing and what works for different audiences, + a writing exercise	English
11. Future mobility news	Either homework from the previous class or an independent session to write a newspaper article about the future of travel around the school	English
13. Presenting the facts - evidence-informed decision making	Gather all research and put together a convincing argument for why change needs to happen. Develop a presentation to convince your audience/write to headteacher, MP, etc.	English, citizenship

Monitoring data for the reopening of Castle Street

During 2020 and Covid19 lockdown, Cardiff Council closed Castle Street, a key east-west route in the city centre to private cars (Figure 28). The road initially had 4 lanes of traffic all used by buses, taxis, private cars and cyclists. When the street was closed pop-up outdoor seating and cafes were established along with a dedicated cycle lane. This initiative received mixed reviews. The active travel, healthy communities and environment campaigners welcomed the closure and the reclaiming of the road space for pedestrians and cyclists. Conversely, while regular car users did not support the initiative citing congestion, displaced traffic / pollution, accessibility and longer travel times. In June 2021, the Council announced the result of a public consultation with options to reopen Castle Street to private car use – 53.8% voted in favour of this[6] - as a result two lanes will reopen to all vehicles, one lane for buses / taxis and one dedicated cycle lane. Subsequently, the Council have announced the logic behind this reopening with Councillor Caro Wild, cabinet member for strategic planning and transport, stating: "The modelling showed that while air quality issues were generally better off across the whole city, there were some areas of concern that officers had, particularly around some of the residential areas around the city centre." One argument the Council is making is that the planned changes will reduce demand for private car use. Critics however argue that reopening Castle Street could induce more people to drive cars. The road will be reopened in October 2020 and therefore we have an opportunity for WeCount to provide baseline and reopened data for the surrounding neighbourhoods to understand the impact of the policy decision.

[6] https://www.bbc.co.uk/news/uk-wales-57452181

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Figure 28: Location of Castle Street in Cardiff.

Supporting the Cardiff Council Low Traffic Neighbourhoods (LTN) Feasibility Study.

Cardiff Council has received funding from Welsh Government to undertake a feasibility study and possibly implement a pilot Low Traffic Neighbourhood(s) in the city. The preferred locations of the pilot LTNs cannot be disclosed in this report as it is embargoed by the Council, however, the WeCount Cardiff team was consulted and the WeCount Cardiff network does have several Telraam sensors in the two preferred locations. WeCount Cardiff has offered to support Cardiff Council with the provision of traffic data, linkages into the WeCount user networks hosting communication and consultation workshops. The WeCount project team did attend the launch of the feasibility student which brough key stakeholders, community groups and NGOs together in June 2021.

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6 WeCount Cardiff: evolution and legacy

This section covers the growth and evolution of the WeCount Cardiff network over the coming months including the extension of the network to include Air Quality and Noise Sensors (Section 6.1), the expansion of the case study to include school's engagement activities and links to the DETI Initiative (Section 6.2), and legacy activities to ensure the maintenance of the network beyond the project lifetime and publication plans to disseminate the results (Section 6.3).

6.1 Extending WeCount Cardiff: Air Quality and Noise Sensors

Comparing traffic measurement data collected using Telraam, and air quality data using low-cost sensors has been planned by the WeCount Cardiff project team since Autumn 2020. As noted in the Data Workshop, some Roath participants were also keen to gather air quality data to accompany their ongoing traffic measurement campaigns using Telraam. Air quality sensors will be deployed during Summer 2021 to ensure measurement during a period of the year when PM_{10} concentrations are not heavily influenced by other sources such as solid fuel burning.

The air quality sensor to be used as part of this measurement campaign is the Smart Citizen Kit 2.1, purchased from and supplied by FabLab, Barcelona and initially developed as part of the Horizon 2020 iSCAPE Project. This is also the sensor being used in the WeCount Dublin case study which will allow for intercity comparisons and knowledge exchange. The sensor components and their respective measurands, of which 20 have been purchased for this phase of WeCount Cardiff, are set out in Figure 29.

Metric	Units	Sensor
Air Temperature	°C	Sensirion SHT31
Relative Humidity	%rh	
Noise Level	dBA	Invensense ICS43432
Ambient Light	lx	Rohm BH1721FVC
Barometric pressure	kPa	NXP MPL3115A2
Equivalent Carbon Dioxide	ppm	AMS CCS811
Volatile Organic Compounds	ppb	
Particulate Matter (PM1/2.5/10)	$\mu g/m^3$	Plantower PMS 5003

Figure 29: The air quality sensor components and their respective measurands

These sensors will continuously monitor air temperature, relative humidity, noise, ambient light, barometric pressure, carbon dioxide, volatile organic compounds and particulate matter. Measurements are uploaded to an online platform via a WiFi connection and are openly accessible. Images of the Smart Citizen Kit are shown in Figure 30.

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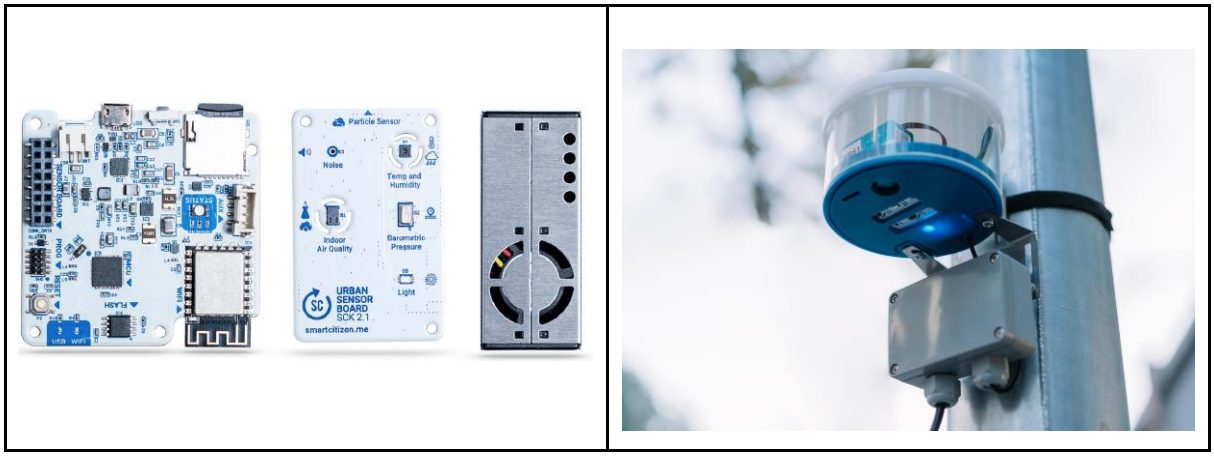

Figure 30: The Smart Citizen Kit sensor suite and outdoor installation housing

Air quality sensors will be in use at up to 20 locations across Cardiff outside the residence of current WeCount participants. Criteria for their deployment will include:

- The volume of traffic on roads
- The suitability of the address to host a sensor
- The presence of a Telraam sensor

Citizens will be asked to install the sensors in an area with clear, unobstructed airflow. Both the Ambient Air Quality Directive (AAQD 2008/50/EC; Annex III; Section C & 2015/1480/EC) and UK Technical Guidance (LAQM TG16) will be used to frame siting criteria, however, as this is a citizen science project and citizens are unlikely to live in nor have access to sites that match such criteria, there will be a need to be very flexible. A sensor will also be collocated at UWE and South Gloucestershire's air quality 'Supersite' on Coldharbour Lane beside the UWE Frenchay Campus. This will enable a comparison between the data generated by this sensor, reference analysers and a range of other medium and low-cost sensors. This will allow for any adjustments in concentration data to be made retrospectively as required.

As well as receiving support from UWE with respect to installation, there will also be an opportunity for citizens to attend a webinar hosted by FabLab Barcelona technical staff to support the understanding, deployment and analysis of data derived from these sensors. This webinar has an estimated duration of three hours and will include the following contents:

1. Sensor commissioning and overall description
2. Basic sensor maintenance and installation considerations
3. Use of the data platform.
4. Status Report. Data analysis workflows and sensor calibration considerations.
5. Diagnosis, replacement of components, assembly and validation.

There will also be an opportunity for citizens to attend a technical air quality data workshop should they wish to understand the statistical tools available for the analysis of such data. This more technical workshop will include:

1. Understanding the overall platform structure.
2. Introduction to the python4 package for data analysis.
3. Advanced python package tutorial.
4. Sensor calibration workflows.
5. Sensor validation workflows. Joint creation of a validation report.

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Both the introductory workshop and the statistical workshop will facilitate engagement at an introductory and advanced level for citizens, depending on their individual data wants and needs. As well as providing the sensor for measurement, citizens will also be able to use and experience the following via a live and easily accessible data platform:

- Configuration and management of the sensors.
- Real-time data visualization through graphics and the possibility of selecting time intervals.
- Possibility of downloading the data in .csv format.
- Automatic alerts via email of irregularities in the functioning of the sensors.
- Geolocation of the sensors.
- Possibility of creating interfaces and custom applications using the open API.

Combined with the Telraam data dashboard, citizens with both low-cost sensors installed will have a powerful suite of easily accessible traffic and air quality data for their streets. These data could then be used to further support their discussions with friends, family, community groups and local authorities.

6.2 Schools Activities: alignment with DETI

The initiative for Digital Engineering Technology and Innovation (DETI) Skills Team is led by UWE Bristol and brings together the University of Bristol, University of Bath, Centre for Modelling and Simulation, Digital Catapult and the National Composites Centre in the West of England Combined Authority area (WECA). To achieve net zero and a low carbon global economy, everything we make and use, from aircraft to cars, batteries to wind turbines, will need to be completely re-imagined and re-engineered. The digital revolution is boosting the potential for engineers' design thinking to optimise not only the development process but also the potential for collaborative citizen engagement. DETI aims to identify and develop the tools, technologies, processes, and skills needed to rapidly accelerate and embed digital engineering to deliver energy transition and clean transport.

DETI Skills, with the support of WeCount Cardiff, is therefore focussing on delivering curriculum-linked outreach activities which explore digital engineering for sustainability, engaging the next generation of innovators by highlighting the future of green jobs and how technology can contribute to sustainable development. Working across industry, academia and education, DETI Skills aims to inspire future engineers by representing and highlighting the diverse people who are working in engineering, and the creative opportunities that engineering offers to solve global problems. WeCount Schools is one of the DETI Skills activities, providing a Telraam sensor to schools and curriculum-linked materials for children in primary schools (aged 8-11 years) and secondary schools (aged 11-16 years). The project will trial the uptake and reaction to the materials and will report back to the WeCount consortium.

6.3 WeCount Cardiff: Conclusions & Legacy

Although it is still working towards its primary aims and objectives, overall, WeCount Cardiff can be considered a successful case study. While continuing to align to the ambitions of WeCount Project and the core principles of citizen science, the case study has adapted and adopted different methods and processes to ensure a flexible yet scientifically robust approach. It could be argued that this adaptation was inevitable during the Covid19 lockdown restrictions but the case study has also illustrated that the adaptation was also essential for the Cardiff citizens to meet their needs and expectations.

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The initial proposal for WeCount Cardiff was primarily focussed on transport and air pollution - this core aim has not changed. However, adaptation in approach was required as the core objectives was to focus on (1) locations of the city with poor air quality, (2) schools, and (3) businesses. During the Covid19 lockdown restrictions the focus on schools and businesses had to be tempered. We have reengaged with schools towards the end of the case study primarily through strategic alignment with DETI but the business focus had to be paused due to the notable impact of Covid19. Consequentially, we focussed on the broader transport / air quality challenges in the city with particular focus on location that experience the double jeopardy of poor air quality and social deprivation.

The feedback gathered from the engaged local communities was invaluable and helped in improve the user experience with the Telraam sensors and platform. The local communities provided a lot of useful feedback on issues related to technology and the delivery of workshops. Not being able to run face-to-face workshops was a setback, especially for sensor deployment, but hand delivering the sensors did ensure a human connection with the project and gave each participant a sense of personalised and bespoke support. A notable success was the inclusion of citizen scientists in the delivery of the workshops as it made them less formal, more engaging and connected to the lived experience of the local communities.

Overall, WeCount Cardiff was carried out consistently with the latest knowledge on citizen science and following the lesson learnt from the case studies in Madrid / Barcelona and Leuven and ongoing knowledge exchange with Dublin and Ljubljana. Participating citizens have been actively involved throughout the different phases, and it can be argued that the approach has been fully citizen centric. Citizens have guided and informed each phase of the research project, from problem formulation, through the co-design of the intervention and, in future, within the analysis, advocacy and legacy phases. This ensures alignment with PE1, PE3, PE10 of the MORRI dimensions. Similarly, the main scope of our activities has not changed and thus is expected to contribute, directly or indirectly, to the UN Sustainable Development Goals.

In terms of legacy, one of the main objectives of the project was to leave a set of knowledge transfer resources as well as research and innovation tools to enable other communities to replicate the experience. The WeCount Citizen Engagement Toolkit (WP2) includes and even growing resource of materials that can be used in different contexts. For example, the resources include videos and printed tutorials for assembling and installing the Telraam sensor; a series of data analysis tools that can be used by non-technical people to extract valuable insights from the data; citizen advocacy packs are under development; schools lesson packs are being deployed; and several other resources that have been used at difference stage in different case studies. As part of WP2, these resources will be uploaded online into existing citizen science platforms and will also be included in the local website, so it can become a one-stop place for future adopters where all information and resources needed to replicate WeCount can be found, accessed, downloaded, and adapted.

Because of the high interest from local communities, we believe that the WeCount approach can be further expanded across the UK. In fact we have already seen smaller initiative pop up in different cities (e.g. Manchester, Bristol, London etc). The themes of more adequate cycling infrastructure, reduced pollution, lower traffic volumes, reduced speeding and more liveable communities are common denominators for most of the local communities we engaged and we strongly believe, due to the feedback on social media, that these would be the catalysers for a further expansion of the work in the UK.

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WeCount: Citizens Observing UrbaN Transport

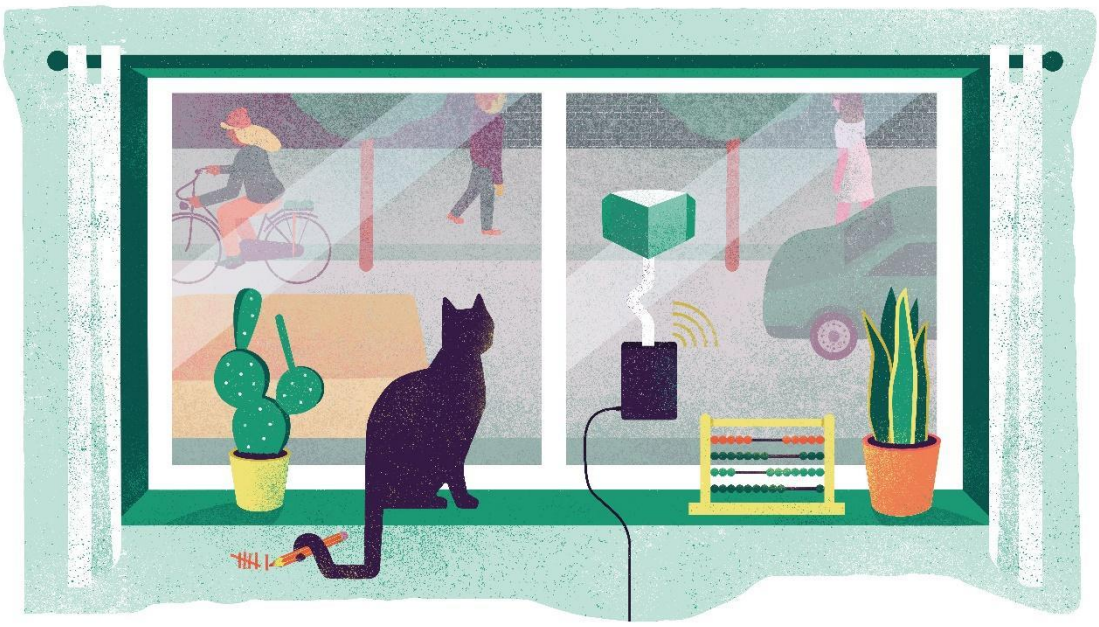
Deliverable 4.2: Summative Case Study Report – Dublin

PART C: Dublin, Ireland

Report for:
European Commission
Research Executive Agency (**REA)**

Date: May 2021

Authors: Anna Mölter, Francesco Pilla, Daniel Tubridy



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Document Details

Authors	Anna Mölter, Francesco Pilla, Daniel Tubridy
Contact	
Creation Date	May 2021
Date of Last Revision	June 2021
Description	This report provides a detailed description and reflection on all activities and outcomes from the WeCount case study in Dublin. The report follows the structure of the tasks within the work package, i.e. scoping and community building, co-design, data collection, data analysis and awareness, and reflection and legacy.

Version History

Version	Updated By	Date	Changes / Comments
1.0	Anna Mölter, Francesco Pilla, Daniel Tubridy	May 2021	First version

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1 Introduction

The Dublin case study started in May 2020 and has been carried out for more than 12 months. Consistent with the citizen science approach adopted, participating citizens have assumed a proactive role across all phases of the case study, from its problem formulation and co-design, through data collection and analysis, until planning and implementing the resulting actions informed by the case study's outcomes and experiences. Much of the Dublin case study is still ongoing, and we are expecting to collect valuable data during the summer and autumn when lockdown restrictions will be lifted and schools will re-start.

Traffic and transport infrastructure are well-known problems in Dublin. Prior to the pandemic Dublin was reported to be the 6th most congested city in Europe[1], with Dublin road users spending on average 213 hours sitting in rush hour traffic during 2019. This is related to the growth of the city since the 1990s and its insufficient public transport system. On the national level the number of registered vehicles in Ireland has almost doubled over a 20 year period, with 1.4 million vehicles registered in 1997 to 2.6 million vehicles registered in 2016[2]. Although only around 1/5th of vehicles are registered in Dublin itself, a considerable proportion of vehicles commute into Dublin on a daily basis, despite many roads lacking the capacity for this degree of traffic volume.

In Dublin a wide range of transport related stakeholders exists, ranging from high level policy makers, such as local council, via private businesses and industry, to local schools and community groups. Some of these stakeholders, e.g. Dublin City Council have been involved in WeCount since the proposal stage; however, local community groups have been very actively involved since the start of the project and have provided valuable support (see section 2).

At the time of writing this report, the Dublin case study had 457 members and 185 users. Data has been collected since August 2020; however, the majority of traffic sensors have been active since February 2021 (see section 3 & 4). We are currently in the process of carrying out a second wave of sensor deployment, which will specifically target schools, and also include air pollution sensors. We are hoping that this will increase the number of active sensors in the Dublin area to 200-300 by September 2021.

In addition to the stakeholder engagement activities described in section 2, we have held a series of introductory workshops, which helped us to co-design the next steps within the citizen science process. These workshops provided important insights on (1) local problems encountered by citizens and (2) how citizens would like to address these in terms of data analysis and outputs from WeCount. We envisage that the second workshop will provide further insights on data analysis needs and capabilities of the citizen scientists, and that this will enable us to provide the citizens with long-lasting tools for knowledge exchange and transfer.

COVID19 had a large impact on the Dublin case study. First and foremost, it stopped most face-to-face interactions we had planned to have with participants. Secondly, it changed traffic patterns in Dublin due to businesses being closed and most people being encouraged to work from home. We tried to adapt to these new circumstances as best as we could, by changing most interactions with participants (and stakeholders) to online formats. We will carefully evaluate the data from the traffic sensors to take into account different patterns during the lockdowns, and if possible to identify formal change points.

[1] https://www.thejournal.ie/dublin-traffic-congestion-4985027-Jan2020/
[2] https://data.cso.ie/

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This report provides an extensive description of the activities carried out in the Dublin case study. It provides an overview of the community building, co-design and initial engagement activities in section 2. Section 3 describes the data collection process, while section 4 provides an initial overview of the data being collected and explains the structure and findings from the first series of workshops. Section 5 concludes this report with a reflection on the current legacy of the Dublin case study. However, it should be noted that the Dublin case study is still ongoing and important parts of it, such as the school deployment and data analysis, will be carried out over the summer and in the autumn.

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2 Scoping, community building and co-designing the local citizen science activity

This chapter provides a detailed description of actions and interactions carried out throughout the case study with respect to scoping and co-designing the intervention, as well as the continuous effort in exploring, building, establishing, maintaining and leveraging diverse communities of different stakeholders in WeCount Dublin and the spread-out to the Greater Dublin Area and the rest of Ireland.

In summary, actions started with mapping and engaging of a number of strategic high level stakeholders in Dublin to facilitate the access to local communities in the Ringsend area (Section 2.1). The engagement with high level stakeholders and the activities on social media opened the avenue to more extended citizen science activities with local communities in the Greater Dublin Area and in the rest of Ireland (Section 2.1). The widespread of the activities at national level presented several challenges which were further aggravated by the COVID pandemic, so the team had to quickly adapt its engagement strategy by integrating it with a series of online tools (Section 2.2, 2.3, 2.4) to deliver the co-design workshops, provide support with the installation of the sensors and other engagement activities. The continuous dialogue with the local communities highlighted a common traffic related challenge around local schools, so it was decided to run a second series of citizen science activities focusing specifically on schools and integrating the traffic sensors with particulate matter sensors (Section 2.5). The whole range of activities has been supported by a multimedia communication strategy, which involves promoting the citizen science activities through national television, local and national newspapers, NGOs and local groups channels, local authorities, national authorities, social media and other channels (Section 2.6).

2.1 Stakeholders Mapping and Engagement: from Ringsend to the Greater Dublin Area and the rest of Ireland

The activity in Ringsend started with mapping and engaging with several high level stakeholders which would be critical for the various activities with the local communities in the area, starting from the identification of interest groups and focal local organizations. Ringsend is an area in the centre of Dublin city characterised by heavy traffic, because of the proximity to the financial district and the Port area, limited cycling and pedestrian infrastructure. Dublin City is entering another economic boom period pushed also by the increased presence and investments of Tech companies in what the inhabitants call the Silicon Docs (Dublin Docklands). This is bringing prosperity, but is also further enhancing the disparity between rich and socio-economic deprived neighbourhoods, such as Ringsend. The latter are mostly experiencing the negative impacts of the increased economic activities in the Silicon Docs with an increase of both private and commercial traffic with related negative impacts on local noise and air pollution.

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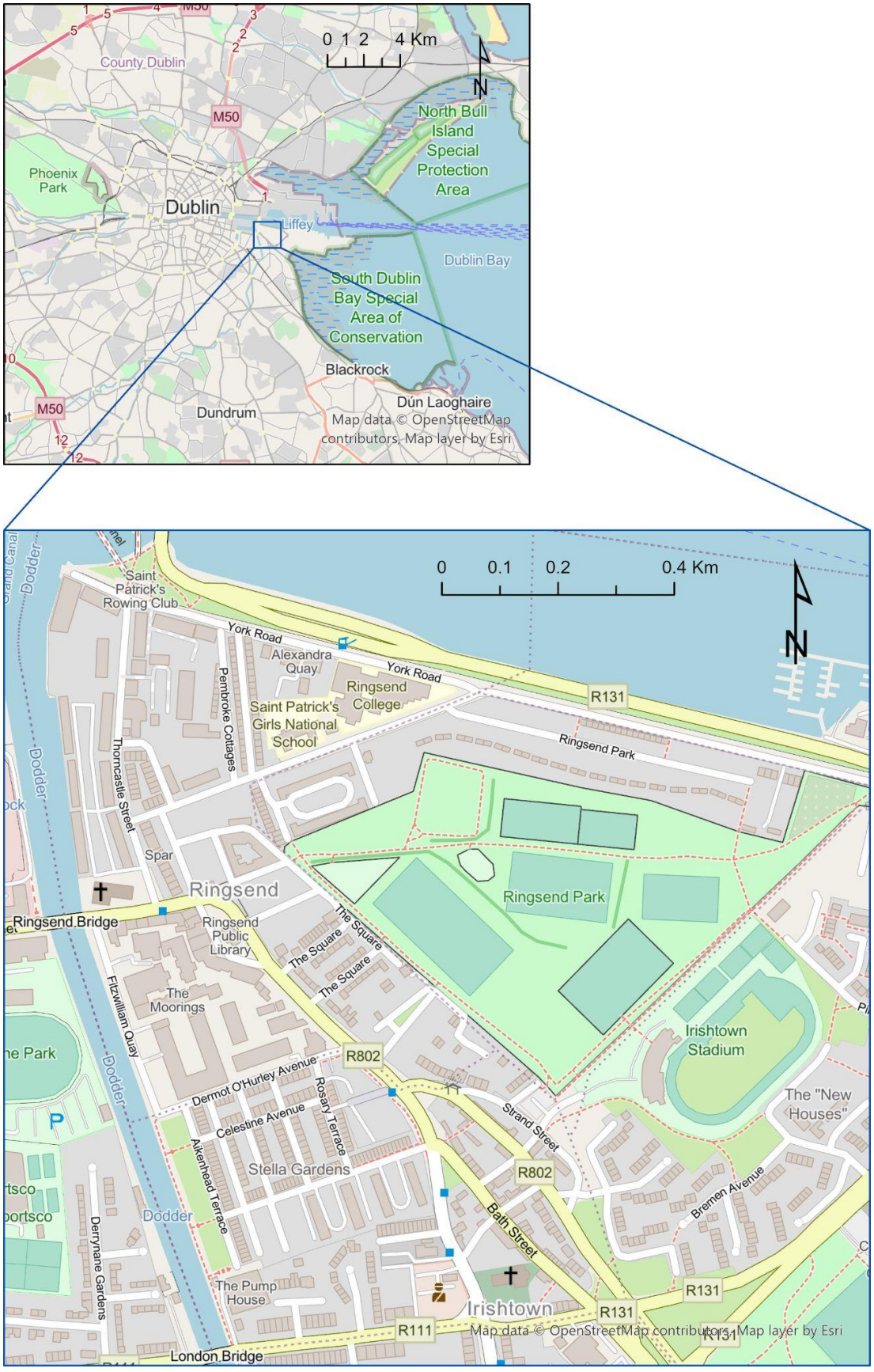
Figure 1: Map of Dublin and the Ringsend area



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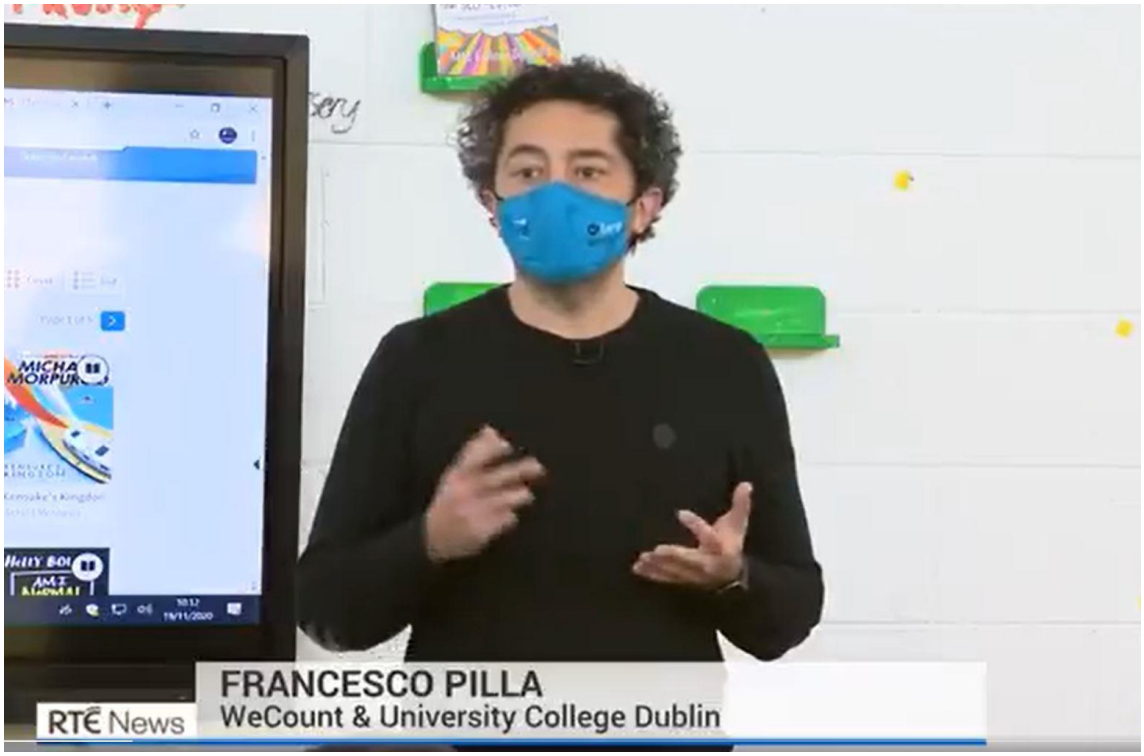
The stakeholders mapping activities allowed the identification of local community organisations in Ringsend which are actively voicing their concerns about the liveability of their local area, because of the lack of data to support their claims. They are concerned about the heavy traffic in the area, both at day and night time, which is potentially related also to on-road freight transport from/to the nearby Dublin port. Some examples of these active local groups are: Dublin Cycling Campaign, Dublin Friends of the Earth, Tidy Towns, and A Playful City. The conversation with these stakeholders and with the local authority allowed to further extend the stakeholders engagement activities, and to identify broadly some local traffic related challenges as it is detailed below. In specific, it made evident that traffic issues are a widespread problem, which is affecting the liveability in several areas in the Greater Dublin Area. Once the engagement activities with the stakeholders mentioned above were started, several local communities around the Greater Dublin Area requested to take part in the WeCount citizen science activities as they were concerned about the high volumes of traffic in their areas and the impacts on health and safety around the local schools, the lack of suitable cycling infrastructure, their local community being used as a traffic corridor, the impacts of new public transport routes (Bus Connect), etc.

The expansion of the activities to other local communities in the Greater Dublin Area resulted also in the engagement of a wider pool of high level stakeholders and local community groups, including local authorities and industry. More details about this are provided in the subsections below. As it appeared evident from the initial discussions with the engaged local communities that the local schools were focal points for the local community engagement, it was decided to run a series of workshops with primary and secondary school children with the aim to use DIY activities with the sensors as a starting point for a discussion around sustainable local mobility and active travel, to be concluded with some sensors to be hosted by the local communities in private dwellings. Because of COVID and the lockdown restrictions, it was possible to run only three workshops in three local schools before the Level 5 restrictions (complete lockdown) started in December 2020. The three engaged schools were Trinity Comprehensive Primary School in Ballymun (deprived area), St.Michael's College Secondary Schools in Donnybrook and Ringsend College Secondary School in Ringsend.

The workshop in Trinity Comprehensive was featured in the national news on RTE News and on local and national newspapers (Figure 2)[3].

[3] https://www.rte.ie/news/dublin/2020/1126/1180713-traffic-dublin-camera-sensor/

Figure 2: workshop in Trinity Comprehensive as featured on RTE News



The announcement on RTE News further changed the dynamics of the activities as it attracted the attention and interest of local communities all over Ireland. As such, the support of a National authority, the Irish Environmental Protection Agency (EPA), was sought to expand the activities and engage with the interested local communities in the rest of the Country. The financial support of the Irish EPA allowed the purchase of more traffic sensors for the local communities outside the Greater Dublin Area.

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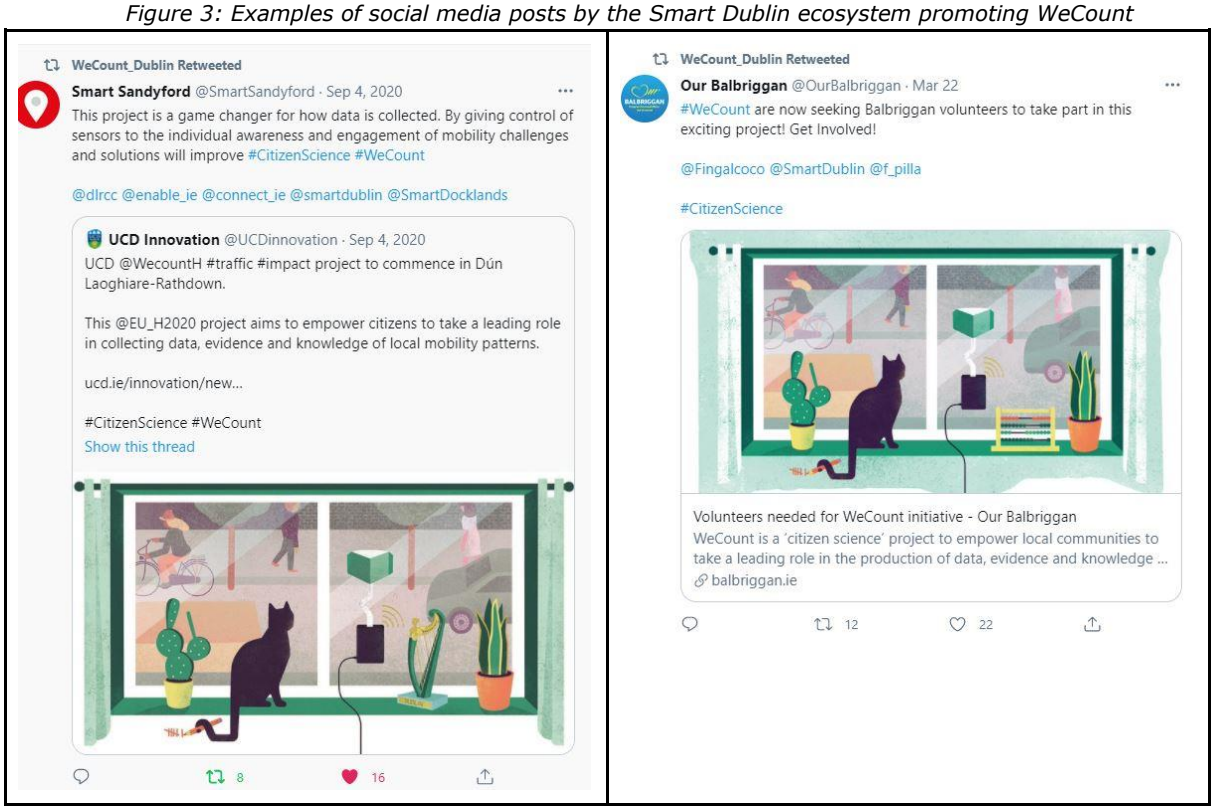
Figure 3: Examples of social media posts by the Smart Dublin ecosystem promoting WeCount



2.1.1 Citizen Communities and Civic Society

This stakeholder category was central to the case study in Ireland. We actively engaged with community champions and local community organisations to make them aware of WeCount, to show them the potential of using sensors to collect evidence, and to involve them in the case study. While doing so, an important component was about transferring tools and templates so they can act as boundary spanners in their communities (and beyond through their own networks) and in turn involve more participants in an informed way. Importantly, tools and templates included specific communication material to be reused, as well as general knowledge about the project, the process, the sensor, and the ways through which citizens can participate. In total, we identified and contacted over 50 community organizations across the Greater Dublin Area. Several other organisations contacted us after learning about the project through social media, national news or personal contacts, allowing us to reach local communities in various areas around Ireland. These ranged in nature from very localised communities interested in advocacy actions in favour of a more sustainable environment (e.g. *Tidy Towns, Educate Together, Green Schools*), other communities involved in citizen science activities (e.g. *Dublin Friends of the Earth, Volunteers.ie*), civic associations (e.g. *Dublin Cycling, d12cyclists*), and broader initiatives and associations already involved in nature based solutions and other actions against climate change (e.g. *Greentravel, Changebydegrees, ChangeX*). In addition, the support of the Smart Dublin ecosystem was critical in engaging active community groups interested in smart technologies and the use of them for sustainable living. The engagement was mostly carried out through social media and interactions with comments and direct messages (Figure 3). The approach was extremely successful and encouraged the contacted parties to propose other potential organisations or influencers to further expand the network. Of particular success was the engagement with local groups of activists in the area of active travel and sustainable mobility. These groups were extremely excited from the very beginning about having access to technology to monitor traffic, with the purpose to use the evidence to make a case for better infrastructure for active travel. In general, all have (to different extents) helped with dissemination and recruitment activities through communication actions in their own networks. While we could keep

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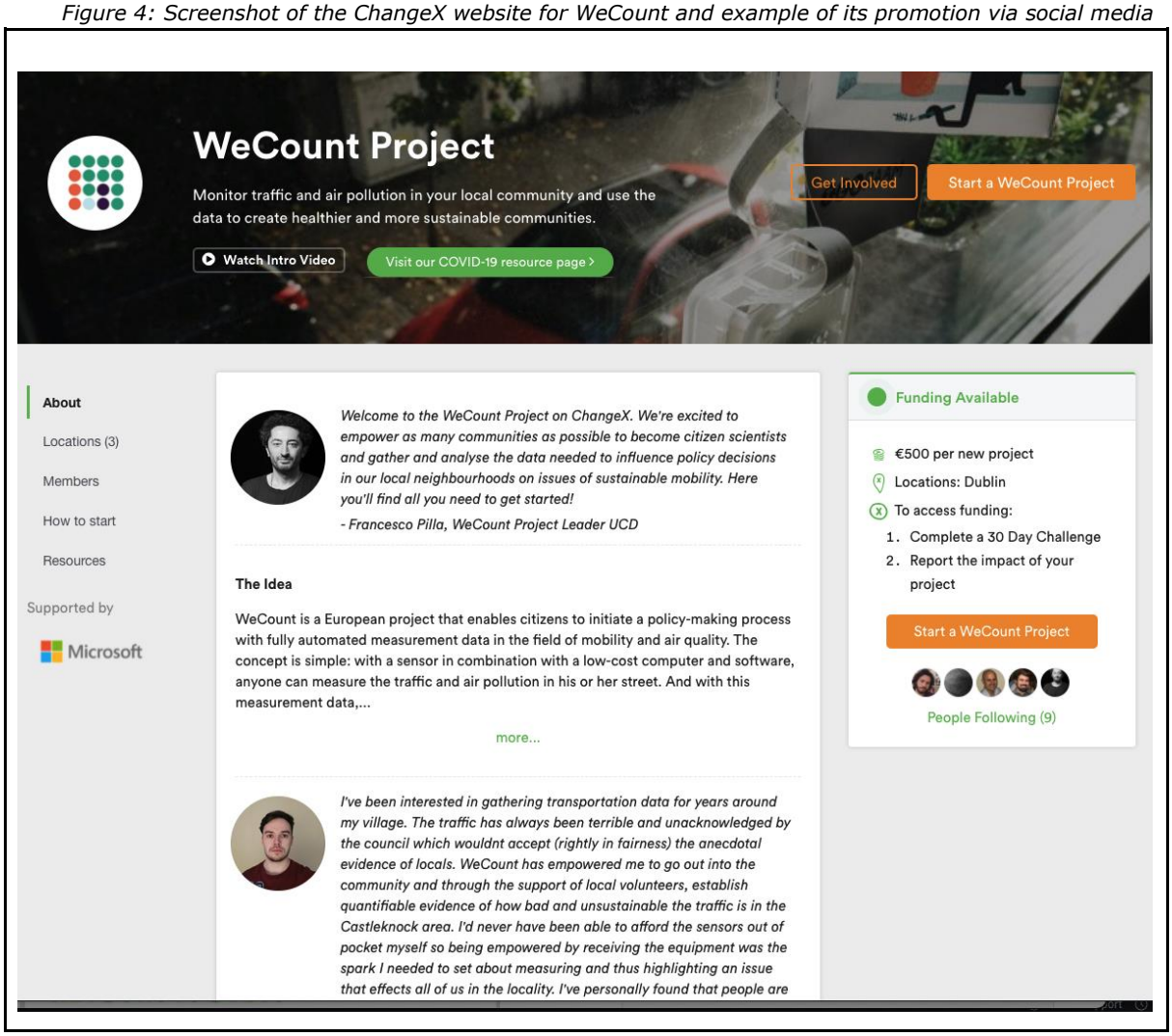
track of some of these efforts, we believe we were not able to capture all the communication activities that they have conducted independently. Most people we talked to in this cluster have shown interest and enthusiasm in the project. The approach was successful so we were presented with the need to raise more funds to purchase more sensors and accommodate more local communities. This is why we engaged with ChangeX, a company supporting grass root and community driven initiatives in the area of sustainability. The company was able to secure some financial support from Microsoft and use it for an open call for local communities to take part in WeCount. The idea was to provide €500 to each local community applying for the support fund, which would allow them to buy a traffic sensor and an air quality sensor for their local community. The whole approach integrates several steps of codesign to mimic the WeCount engagement framework. The open call is still ongoing and so far 3 local communities applied for the fund (see https://www.changex.org/ie/wecount-project).

Figure 4: Screenshot of the ChangeX website for WeCount and example of its promotion via social media



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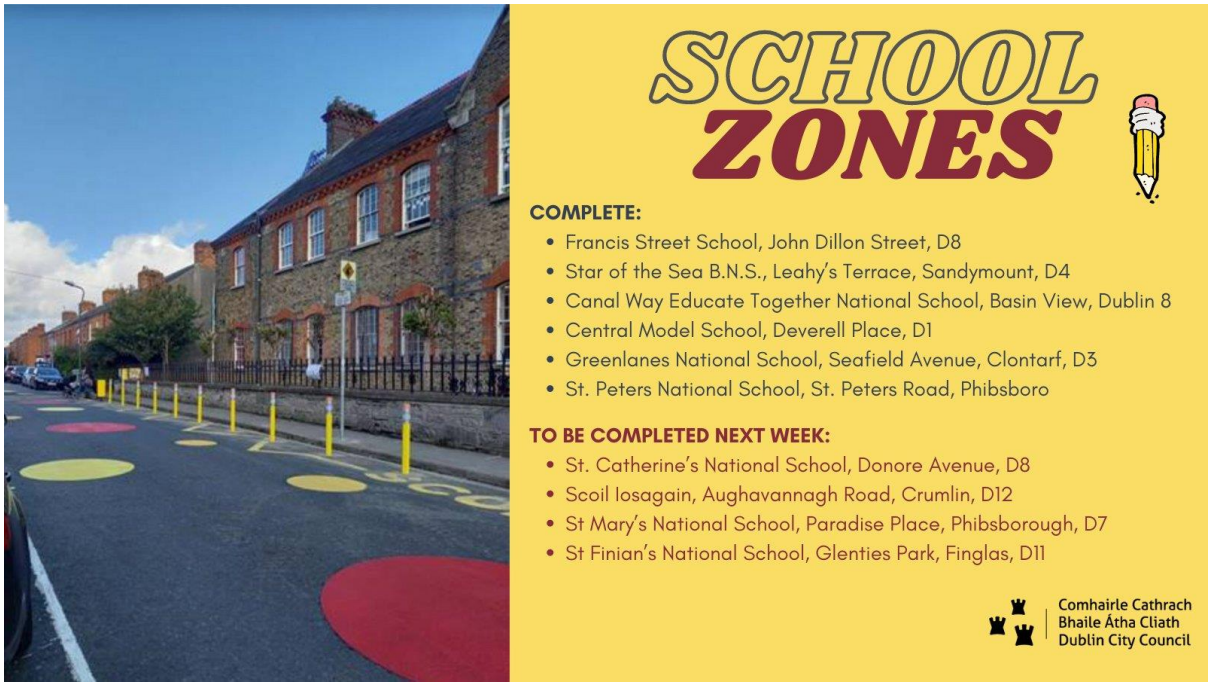
2.1.2 Public Sector

The support of local and national authorities has been critical to the success of the WeCount Irish pilots. Dublin City Council has been engaged since the proposal preparation to define the high level challenges and select the most appropriate pilot and local community. Together with citizen communities, targeting relevant public sector agencies has been one of the key engagement objectives for several reasons, including: (1) ensure from the very beginning positioning of WeCount within existing activities, interests, and policies; (2) make sure that results are up-taken and used. This is why Dublin City Council has always been considered a strategic stakeholder, as it is critical to have local policy makers engaged since the inception phase to guarantee a smooth path from bottom-up evidence gathering to community led policy proposal acceptance. Dublin City Council has also been instrumental in providing contacts in the other three local authorities part of the Greater Dublin Area: South Dublin County Council, Fingal County Council and Dun Laoghaire Rathdown County Council. Furthermore, it is important to note that the four local authorities are currently running a programme to increase sustainable mobility and active travel in schools, called School Zones. The School Zone "treatment" will consist of a series of both traffic calming and visual interventions to improve road safety around schools (see Figure 5).

Figure 5: Example of the School Zone treatment



The data collected as part of the citizen science school pilot detailed in Section 2.5 will be used for several purposes:

1. to collect baseline data before the School Zone treatment
2. to collect data after the School Zone treatment
3. to use the data from air quality and traffic sensors as a way to inform the discussion on negative impacts of traffic with children

The support of the local authorities and the collaboration as part of the School Zone initiative is critical to ensure that the data will be used as evidence for future traffic policies.

The WeCount Irish pilots also received support from several regional and national authorities, such as the Irish Environmental Protection Agency, the Climate Action Regional Office, and the Department of the Environment. This support will allow us to scale out the findings to the national level. Each local authority, the Climate Action Regional Office and the Irish Environmental Protection Agency provided financial support for the pilot focused on schools which is detailed in Section 2.6.

2.1.3 Private Sector

The engagement with industry was carried out by leveraging the network part of the Smart Dublin ecosystem. Smart Dublin brings together technology providers, academia and citizens to transform public services and enhance quality of life. In order to accelerate innovation, Smart Dublin has adopted a 'Smart District Approach', concentrating new technology pilots in targeted locations across Dublin. Smart Districts are strategically selected locations where innovation projects are fast-tracked. The first Smart District, Smart Docklands, was launched in 2018, with four further districts having come on-stream to date; Smart DCU, Smart Sandyford, Smart Balbriggan and Smart D8. At the heart of the Smart District Approach is the idea of collaboration. Smart Dublin has endorsed the 'Quadruple Helix Model of Open Innovation': this means government, industry, academia and citizens are brought together to work together to identify local challenges and co-create solutions. This novel approach helps ensure that a diversity of perspectives,

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experiences and voices are part of each district programme – essential ingredients for impactful innovation. Each Smart District delivers a bespoke portfolio of projects designed to meet the needs of the people who live and work there. Through outreach and engagement with local communities and businesses, the Smart District teams identify real-life challenges experienced in the area (Figure 6).

Figure 6: The WeCount project is promoted on the Smart Dublin webpage

The engagement with the Smart Dublin ecosystem provided access to further funds for the schools pilot, which were provided by Smart D8 to support the citizen science activities in 10 schools in the Dublin 8 district (a socially deprived area in the city centre). Their communication channels' outreach has helped in growing substantially the member's base. Their help and support, however, was meant to be beyond communication, dissemination, and active involvement in the case study as partners. As such, the Smart Dublin staff provided opportunities to present at community meetings and events organised by the Districts. One example was the Smart Balbriggan community event in April 2021 and the Smart Dublin Forum in May 2021. Each district also facilitated the distribution of sensors to the citizens in their local area. Unfortunately, it was not possible to have sensors installed in offices of the businesses part of the various Smart Districts, despite the great interest, because of the prolonged complete lockdown in Ireland (most of the businesses are still closed in May 2021). The engagement with the companies in the Smart Districts showed that most of them, especially those that do not operate in the field of social innovation, strongly valued the narrative of "empowering citizens for sustainable mobility". This, sometimes, happened to a point in which they aimed at gaining a level of ownership of the project to legitimise claims about their company being active in social, open, and responsible innovation. In some cases, these offered to host WeCount events (at their expenditures) without being clear on who was driving the agenda. These, however, did not happen in the end because of COVID-related restrictions.

2.1.4 Schools and Academia

Following the input from other consortium members, schools and academic institutions (primary, secondary, university) were an important target for the case study. In general two types of stakeholders in this cluster were approached and engaged: (1) academic research centres with focus in specific relevant

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areas, such as transport and sustainable communities; (2) schools and students to be part of the overall case study.

Regarding the former, two National Research centres funded by Science Foundation Ireland, namely Lero and Enable, provided financial support for the activities in schools as part of their Education and Public Engagement (EPE) remit. The two National Research centres are consortia of Irish Academic Institutions and companies: Lero activities focus specifically on the theme of mobility and transport, while Enable activities focus on smart communities and smart cities. Specifically, each centre provided funds to support the citizen science activities around traffic and air pollution monitoring in 10 schools (Figure 7).

Figure 7: Webpages for Lero and Enable showing the academic partnerships.

With respect to involving actual schools, these were seen as strategic partnerships as they could act as gatekeepers to younger generations to get involved with participatory traffic and air quality sensing activities and citizen science processes more generally. In particular, we started dedicated mini case studies with three different schools: a primary school (students between 9 and 10 years old and staff members), two secondary schools (students between 13 and 15 years old and staff members). Each of these involved a dedicated face-to-face workshop where the students built the DIY Telraam sensors, which is detailed in the following section. As mentioned above, one of the workshops was featured on the national news television on RTE News on November 26, 2020. This resulted in raising a lot of interests in schools and local communities all over Ireland, and thus further extended the scope and scale of the Irish pilot.

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With respect to the primary and high schools, the plan developed through the initial meetings with the teachers was to build the DIY sensors with the students and ask their families to host the sensors in their homes. As school catchment areas in Dublin are very localised, the logic behind this approach was to have a dense cluster of sensors around each school to be further expanded with other sensors hosted by other members of the local community. The idea was also to follow up on the installation of the sensors with a series of face-to-face workshops to look at the data with the children and use this as an opportunity to discuss themes such as traffic related pollution, active travel and climate action. Unfortunately because of COVID restrictions, a total lockdown started from December 2020 so it was not possible to follow up with these workshops. The two engaged secondary schools, the Trinity Comprehensive secondary school and Ringsend College Secondary School, are in socially deprived areas and listed as DEIS (Delivering Equality of Opportunity in Schools) schools. Launched in 2005 by the Department of Education and Skills, DEIS (Delivering Equality of Opportunity in Schools) is the most recent national programme aimed at addressing the educational needs of children and young people from disadvantaged communities. Around 20-25 students in each secondary school were engaged in the DIY workshops.

2.2 Face to Face Engagement

As mentioned above, it was possible to run only three face-to-face workshops because of the total lockdown which started in December 2020. The 3 engaged schools were Trinity Comprehensive Primary School in Ballymun (deprived area), St.Michael's College Secondary Schools in Donnybrook and Ringsend College Secondary School in Ringsend. A total of around 70 students were engaged as part of these workshops. The preparation, set-up and workshop delivery activities followed a similar framework for the three schools:

1. the teacher in each school was contacted and the format of the workshop, the length and the follow-up activities were discussed either via email or on a conference call system;
2. the material to be used for the workshop was shared with the teacher;
3. consent forms were sent to the teacher to be shared with the families of the students to get signatures;
4. a date for the workshop was agreed;
5. sensors and material for the workshop were prepared;
6. the workshop started with an informal chat about the traffic in the area, to gather some feedback from the students;
7. it was followed by a brief discussion about the links between local air pollution and local traffic;
8. then a brief overview of the core ideas on empowering people to act on traffic pollution was given;
9. the DIY part of the workshop then started by dividing the students in groups of 2 and by showing them a step-by-step tutorial video on Youtube on how to build the sensor;
10. once the sensors were built, the follow up activities were discussed with the students.

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Figure 8: Students assembling DIY sensors during workshops in schools

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As a general reflection on the DIY workshops in schools, we observed that having a face-to-face physical interaction with children is much more effective. Mobility and traffic counting are complex topics to understand and appreciate. The students were initially afraid to engage in the DIY sensors activities, because they felt they could damage the sensors. Once the activities started, the students realised that assembling the sensors was quite easy and started to enjoy the workshops. We realised that the students had a feeling of empowerment and pride once the sensor was successfully built, which led to more engaging conversations and active discussions on the topic of local traffic and pollution. In other words, we realised that in order for students to become highly motivated in participating, they would need to get involved in practical and hands-on activities. These interactions gave the opportunity to engage in conversations with students individually (or in small groups of 2 or 3), and the reactions were found to be almost all supportive and positive.

2.3 Problem Formulation and Co-Design Workshops

The processes of scoping, identifying problems and co-designing solutions was carried out through participatory online workshops. The objectives of these workshops were to 1) to meet participants, 2) introduce the project and its objectives, 3) outline the proposed timeframe and structure of the co-design process, 4) understand the issues and concerns associated with transport and urban planning in specific local areas, and 5) to gain an initial understanding of the methods of data analysis, which could help to address local mobility and environmental issues. It is important to note that introductory workshops did not take place exactly as foreseen within the Dublin pilot for various reasons including delays in obtaining and distributing sensors and the impact of COVID and associated lockdowns, which have meant that no face-to-face meetings were possible. Instead, a series of local co-design workshops were held online in April in order to achieve the objectives set out above. This meant that the workshops held in April represented the first substantive meetings between project participants and researchers. As a result, these workshops also functioned as hybrid introduction and data analysis meetings, and therefore will be discussed in detail in section 4.2.1.

2.4 Reflections on Co-Designing the Case Study

An important part of co-design of the case study with citizens happened through the interactions with the community champions using different channels, such as social media, emails and online workshops. These allowed to co-design the overall intervention with them in terms of: (1) timing (e.g. some communities expressed the preference to start in January 2021 rather than waiting for the school deployment); (2) specific focus of the project. With respect to the former, the decision has been taken to launch the wider case studies in the Greater Dublin Area and the rest of Ireland in two different rounds: the first in January 2021 focusing only on traffic monitoring with local communities and the second in June 2021 focusing on both traffic and air quality monitoring with schools.

Another important element ingrained in the experimental nature of this case study, was about a continuous gathering of feedback from all participants especially to improve: the software side of the sensor, the overall user experience, the data platform and visualisation, and the registration and installation processes. From one perspective, engaging participants in these phases, allows them to express their opinions from their previous knowledge and their experience in WeCount, and taking these on board for improving these elements, are considered as contributing to the co-design (i.e. proactively engaging participants in the

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design) of the overall technical architecture. Unfortunately, the impossibility of running physical workshops, whereby participants could get hands-on experience with the hardware components and their assembly, limited the possibility of co-designing with them hardware-related improvements.

The online delivery of the workshops resulted also in greater effort in the logistics side of the project as the sensors needed to be delivered to the participants by post before the workshops, rather than a simpler collection of the sensors at the face-to-face workshops as originally planned. Moreover, different participants offered to undertake different roles based on their skills, interest, and availability. For example, some individuals, mainly those with technical expertise, assumed a more specific role around providing feedback on the technology, hardware and software, and the overall process. One participant in the local community of Castleknock designed an outdoor environmental enclosure for the traffic sensor, in order to solve the issue of lack of visibility because of boundary walls and allow for the sensor to be installed at the perimeter of the gardens. This solution was particularly impactful as it allowed to overcome another limitation of the sensor related to the maximum distance between the window and the monitored road (around 10-15m), which made most of the schools and some private homes unsuitable for the installation of the traffic sensor. The community champion also prepared a set of instructions to allow other users and schools to easily manufacture the enclosure. Others committed more to communication, recruitment, and diffusion tasks. Enabling them to conduct these activities and facilitating them to do so, entailed establishing dedicated bilateral communications (either through email conversations or, in some cases, through online meetings) and dedicated support resources (e.g. a communication template to support *participant x* in engaging a specific school, entity, or public department). In general, understanding and appreciating differences in people's motivations, skills, and resources to be brought to the case study, and time availability, have helped to design the case study in a way that accommodates their needs and interests.

As another important element, the complex and multifaceted domain of mobility has been broken down into more specific traffic-related matters of concern. By doing so, the case study does not only address the mobility related investigation, but also advances the citizens' research agenda by including what they appeared to be concerned the most about, i.e.: the relationship between traffic and air quality and the impacts around schools. This guided the decision to run a second pilot focusing specifically on schools. The interactions with citizens also guided the selection of data analysis tools to be prepared for them, which is detailed in Section 4.

2.5 Extending Community Building and the Scope through Deploying Air Quality and Traffic Sensors in 150 Schools

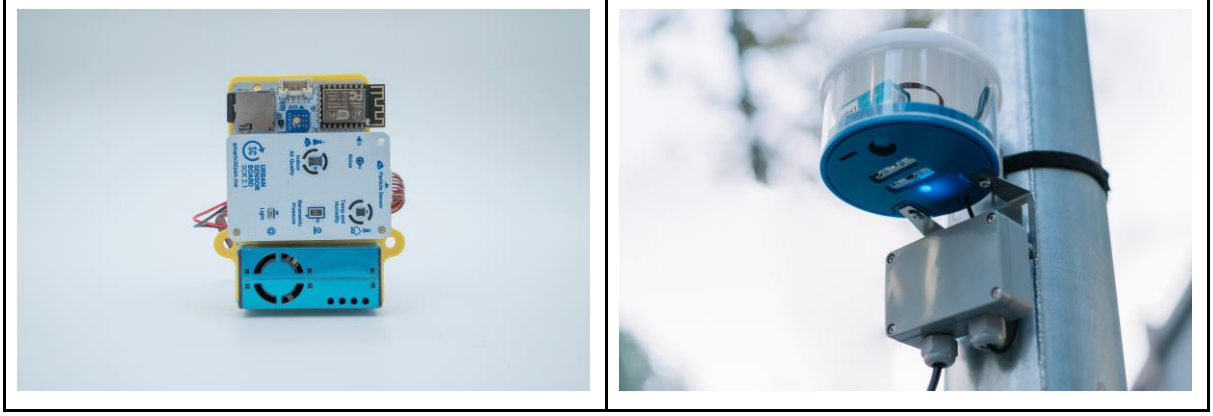
With respect to the focus of the action, linking traffic data from Telraam with air quality data emerged as being the theme that interests and concerns citizens the most during both the introductory workshops as well as from the other actions explained above. The main concern of the citizens was related to poor air quality around schools, because of high volumes of traffic. While adding an additional sensing element to the intervention was part of the initial plan indicated in the proposal, the focus of the interventions changed. In the proposal we stated that we were going to focus on local communities in the Ringsend area in Dublin city. Because of the extremely high interest from other local communities around the Greater Dublin Area and Ireland, the spatial focus changed as described above. Furthermore, because of the feedback from the engaged local communities, the target of the pilots changed over time focusing more on schools in specific.

The engagement of primary and secondary schools was mainly carried out through the following channels:

- *community champions and members of the local community*: they provided contact details and directly engaged with staff in their local schools. This channel was extremely effective as it allowed to identify schools in areas where the local community was already actively participating in the WeCount activities;
- *promotion on social media*: several posts were made on Twitter targeting specific school networks and national agencies which resulted in several school principals getting in touch to be included in the WeCount pilot in schools (Figure 10);
- *RTE news*: after the project was featured on the national news on RTE News, several schools got in touch through social media or direct emails;
- *Local authorities*: local authorities in the Greater Dublin Area have been very supportive of the WeCount activities with local communities and in particular of the pilot with schools, as it aligns and would provide critical data for initiatives such as "*School Zones*", which is run in the Greater Dublin Area, and "*Safe Routes to School*" which is run by the Department of Transport at National level. These provided an avenue to use the community generated data and insights to have a long lasting impact on policies, as detailed in Section 4.3.

The air quality sensor used as part of the schools pilot is the Smart Citizen Kit 2.1, which was developed as part of the H2020 iSCAPE project. The air quality sensors have been described in detail in section 3.2 in deliverable 3.2. In brief, they continuously monitor air temperature, relative humidity, noise, ambient light, barometric pressure, carbon dioxide, volatile organic compounds and particulate matter. Measurements are uploaded to an online platform via a WiFi connection and are openly accessible. Images of the Smart Citizen Kit are shown in Figure 9.

Figure 9: The Smart Citizen Kit sensor board and outdoor installation



Because of COVID-related restrictions, the distribution of the sensors to schools has been delayed due to issues and delays with the supply chain. The workshops will have to be delivered online also in this instance, because of the high number of schools and their wide spread across the country. The pilot in schools is still at an initial stage so results are still pending.

Figure 10: Example of engagement with schools via social media

2.6 Local Communication and Dissemination

A considerable effort in the case study was placed on communication and dissemination activities.

First, leveraging the ongoing effort in mapping and engaging stakeholders, a local communication strategy was developed. The strategy included: (1) Definition of the main communication actions, target areas and groups of interest; (2) Definition of the key messages for local activities tailored for different audiences; and (3) Definition of the channels to be used for the dissemination of the project. With respect to the latter, we have established:

- Social media: we created a dedicated Twitter account @DublinWecount for the interactions with the local community through social media. We decided that this would allow the local communities to identify themselves in a broader "movement" to act on local traffic.
- Web page: we decided to rely on the existing WeCount webpage as the main language is English.
- A dedicated Email address (wecount@ucd.ie) was created and used to interact with participants and have a fluent communication with them.

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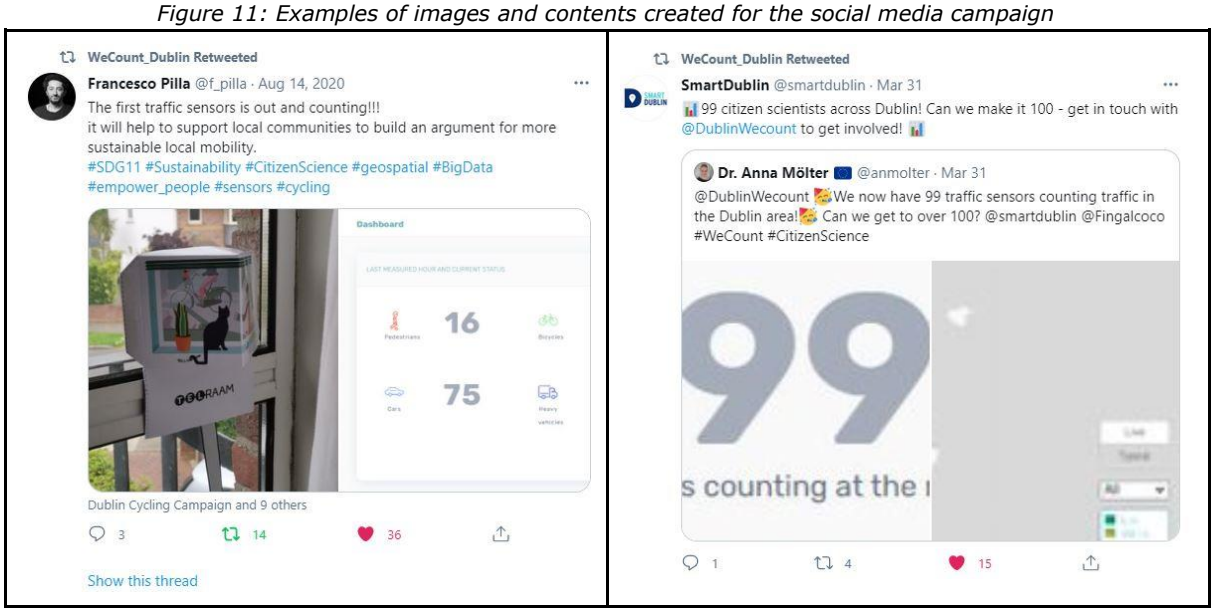
Figure 11: Examples of images and contents created for the social media campaign



In addition, before starting the mass and targeted communication campaigns, two surgical actions were carried out to facilitate the dissemination of the project. First, several alliances were built with active communities of citizens interested in exploring the links between mobility and pollution in the Greater Dublin Area. Second, communication alliances were also established with some key stakeholders who endorsed the project, such as local authorities and national agencies as mentioned above.

The launch of the communication campaign had two components. First, a dissemination campaign was launched aimed at groups and communities potentially interested in sustainable mobility and citizen science. Second, a mass communication campaign was carried out targeting both the general and specialised media. This resulted in the broadcast of one of the initial workshops in schools on the national news on RTE News and in the project being featured in local and national newspapers, such as the Dublin Inquired and the Irish Times (Figure 12).

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Figure 12: Example of media uptake and diffusion.

Dublin InQuirer Log in

Dubliners Collect Their Own Data on Neighbourhood Traffic

by Claudia Dalby

Facebook / Twitter / Respond

A follow up national broadcast has already been arranged with RTE News to feature the results of the border pilot in schools. This will take place in September 2021.

Figure 13: Image captures of the pieces broadcasted by RTE News

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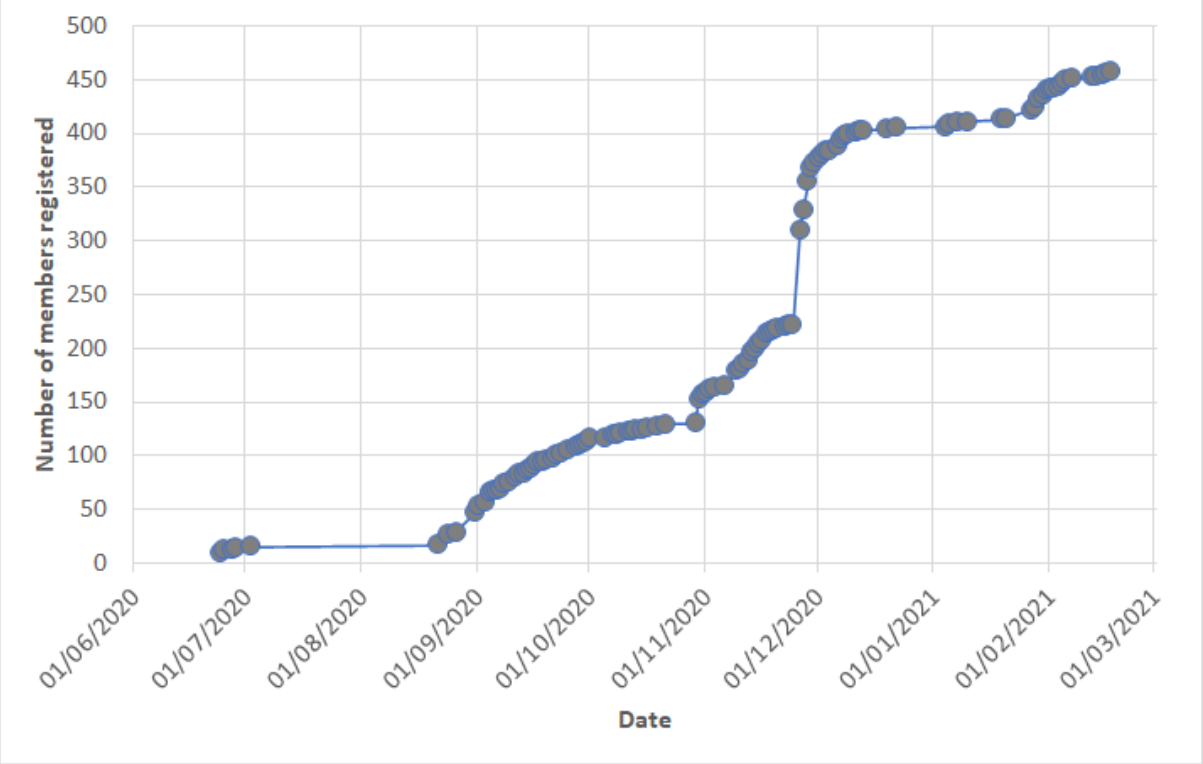
Furthermore, throughout the duration of the case study, several presentations and lectures were given to spread the word about the project and reach a wider audience from the academic, scientific, industry, and civic society fields. Due to the COVID restrictions, these were all delivered online.

2.7 Summary of Community Building

Community building is an ongoing process throughout the WeCount Dublin case study. Despite having stopped formal recruitment into the study, we are still receiving requests from citizens to participate in the study and interested citizens are added to a waiting list.

Figure 14 shows the membership registration over time. The webform for membership registration was first available in late June 2020. Initially, registrations were slow, but a steady increase started to occur from September to November. This was mainly due to engagement with the stakeholders and an increasing number of posts on social media. A steep increase in the number of people registering as members occurred at the end of November, during the days following the RTE broadcast (Figure 2 & 13). During this time the number of members almost doubled within one week.

Figure 14: Membership registration over time



We closed the membership webform for Dublin in February 2021, due to the fact that most traffic sensors were deployed in January 2021. At the time of closing the membership webform, the Dublin case study had 457 registered members, of which 28 members were interested to participate as volunteers only. Of the registered members 137 completed the second webform, which collected the view from their window, their address and a small amount of demographic information, which has been summarized in Table 1 below.

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Table 1: Summary of gender and age information provided by members

Variable	**Category**	**Number (%)**
Gender	female	61 (44%)
	male	73 (53%)
	not answered	5 (3%)
Age (yrs)	16-24	8 (6%)
	25-34	19 (14%)
	35-49	76 (55%)
	50-64	23 (17%)
	65+	8 (6%)
	not answered	3 (2%)

It can be seen that slightly more than half of the registered members were male, and the majority of registered members were 35 to 49 years old. The survey data also showed that the registered members tended to be highly educated (Figure15), with 27% having a graduate (third level) degree and 53% having a postgraduate degree.

Figure 15: Highest education level reported by members

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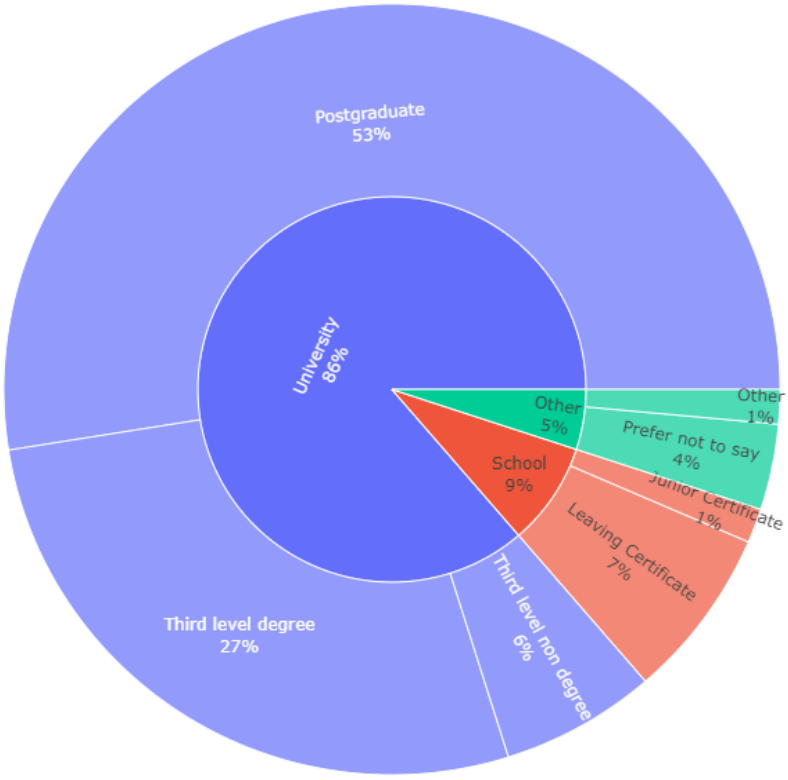

However, members were widely distributed across the Greater Dublin area (shown in Figure 16). The 2016 Trinity deprivation index, which is a measure of area level socio-economic status, shows that within Dublin a range of affluent and deprived areas can be found (see Figure 17 - decile 1 indicates the most affluent areas, decile 10 indicates the most deprived areas). By comparing Figure 16 to Figure 17 it can be seen that the spatial distribution of members would capture a range of area socioeconomic levels. As the WeCount sensors provide information not just to individuals, but to all people living within the neighbourhood, we expect that ultimately the data collected will benefit people from a range of socioeconomic backgrounds. It should also be noted that not all of the WeCount users were recruited via the membership site. Some were recruited directly, via schools, via community champions or via initiatives from the local council. More information on the WeCount users is provided in section 3.3.

Figure 16: Screenshot of dashboard map showing members who provided address information

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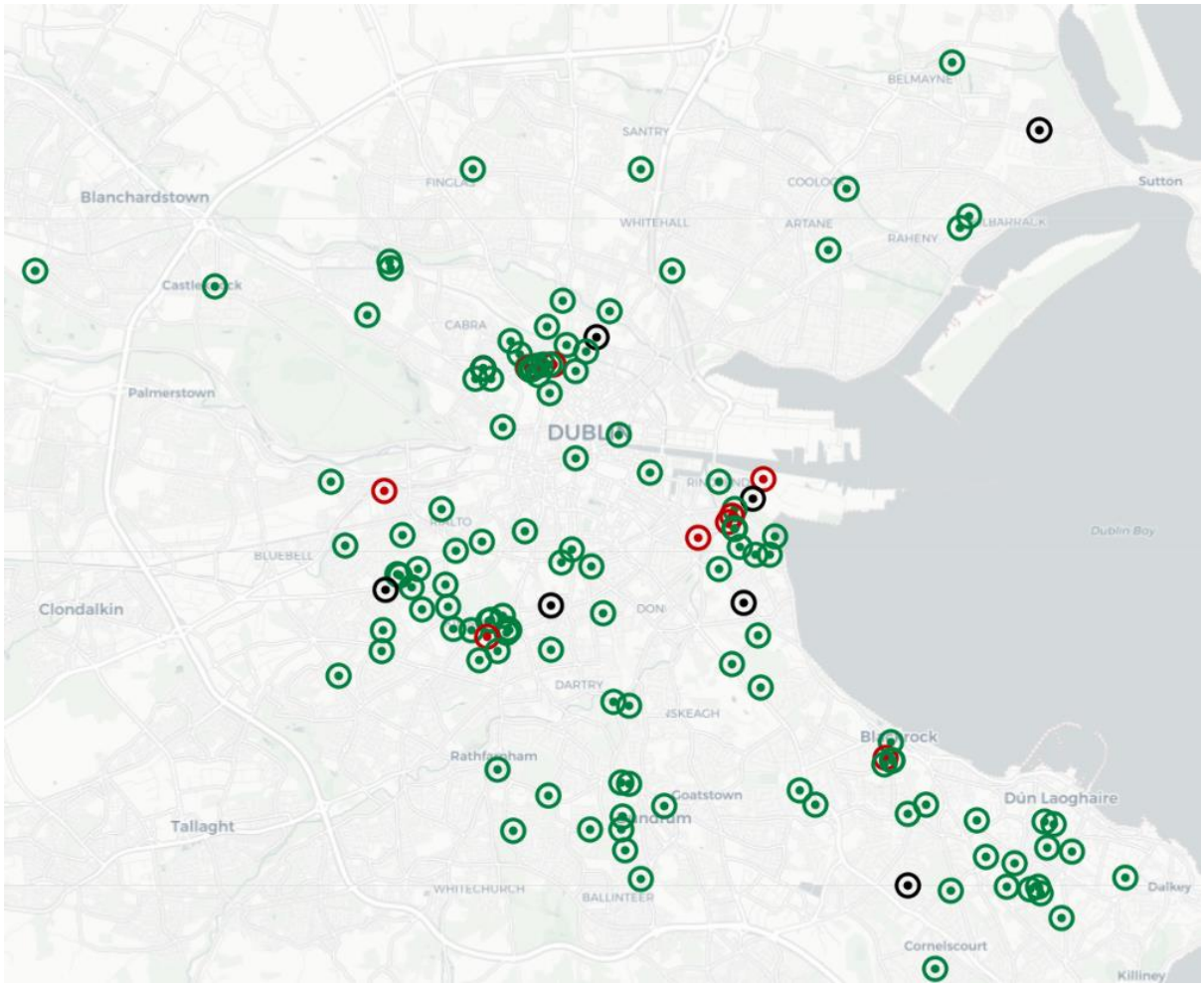

Figure 17: Area socio-ecenomic status in Dublin based on deprivation index deciles

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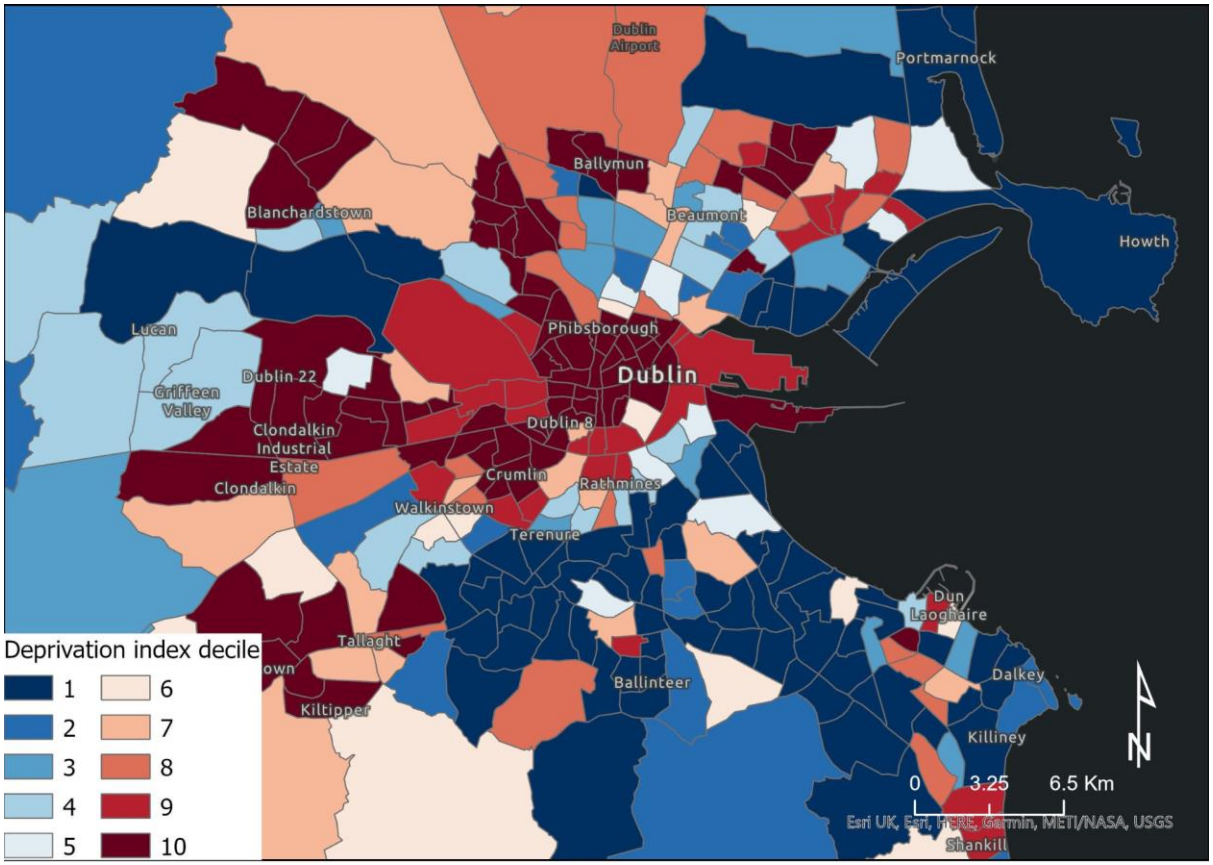

2.7.1 *Reflection on COVID impact on community building, participation, and sustained engagement*

The impossibility of organising face-to-face events and the need to move the entire process online, made community building more problematic. The full implementation of the methodology, the demonstration of the sensor, the actual promotion of the project, and, importantly, ensuring compliance with data privacy and ethics requirements, led to an engagement process that was not as straightforward as initially designed. The required task granularity of participants increased substantially, with several additional steps, emails, and forms that they need to read and fill. As such, learning from the experience of Barcelona and Madrid, we expected a significant drop off between the different steps. This is why we decided to focus our efforts on the most motivated local communities, where a core of people passionate about sustainable mobility and climate action greatly supported us to maintain the motivation and engagement of the members of their local communities. We also decided that the schools would be critical in maintaining the engagement of the community through all the different online forms and steps as schools are at the core of the traffic related issues in most of the engaged local communities. We still experienced a significant drop off in some instances, as the online process involved an exchange of up to three emails,i.e. first notification email and confirmation of willingness to receive Telraam; second email following confirmation including information sheet and consent form to be sent back; third email once received the informed consent form with additional information to facilitate the delivery. These resulted as added required actions to the previous tasks undertaken.

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3 Data Collection

This chapter provides a description of activities conducted as part of task 4.3. It covers how we have tackled procurement, distribution, installation and maintenance of the Telraam sensors to support data collection as well as how we have adapted to the exceptional circumstances of the COVID-related restrictions.

3.1 The Procurement, Assembly, Preparation, and Distribution of the Sensor Hardware

For the Dublin case study we bought a combination of pre-assembled and un-assembled Telraam sensors. Due to the travel restrictions imposed by the pandemic, we were able to re-allocate some of the funding for travelling to meetings towards buying more sensors. This meant we were able to buy 150 pre-assembled sensors and 150 un-assembled sensors, rather than the originally planned 200 sensors. We ordered the Telraam sensors from the supplier (Gotron) recommended by the Leuven case study, but with the specification that the sensors needed three-pin electric plugs, to be able to connect to Irish electrical outlets.

We bought a combination of pre-assembled and un-assembled sensors with the aim of using the un-assembled sensors in face-to-face school and community workshops, and the pre-assembled sensors for direct collection by or delivery to participants.

For the un-assembled sensors we installed the Telraam software on all of the SD cards prior to the workshops. We did this, because we could not guarantee that workshop participants would have access to a computer with a SD card writer during the workshop. Unfortunately, due to the COVID restrictions opportunities for face-to-face workshops were very limited: A small number of sensors were assembled by undergraduate students during an initial trial of the sensors. We were able to hold three school workshops during which children assembled sensors (see section 2.2). These sensors were initially left in the schools, to allow children to take one home, if their parents agreed to participate in the project. Twenty-two un-assembled sensors were sent to community groups in Limerick and Kilkenny. Twenty-four un-assembled sensors were sent to Fingal County Council for use in school workshops in the Balbriggan area in the North of Dublin. The remaining sensors were assembled by us in the UCD office. Each of the sensors assembled by us was tested to check that it was (1) sending out the Telraam WiFi signal, and (2) that the camera was operational. These sensors were set aside for a special deployment to schools in the Dublin area. In this special deployment traffic sensors will be co-located with air quality sensors in schools in proposed traffic calming zones (see section 2.5).

The majority of pre-assembled sensors were sent directly to the home addresses of participants who were selected via the membership site (see section 2.7 & 3.3). Prior to sending the sensors the Eircode (unique identifier for Irish postal addresses) of each participant was verified to ensure that the sensor would be delivered to the correct address. A small number of participants were sent two traffic sensors. These were participants who lived in a corner property, and had suitable windows to count on two separate street segments. Approximately 20-30 pre-assembled sensors were given to community champions, who were able to set up sensors in local businesses or to act as a local collection point for other participants.

The contents of the boxes sent directly to participants are shown in Figure 18. The box contained the pre-assembled Raspberry Pi with the camera connected and the micro SD card installed, the mains power adapter, velcro tape to attach the camera to the window, a SD card reader adapter, and the step by step

installation guide (further explained in section 3.2). A few larger packages containing several pre-assembled sensors were sent to community groups in Co. Laois and Castleknock, as well as to Fingal County Council.

Figure 18: WeCount boxes containing pre-assembled sensors

3.2 The Sensor Installation

With each sensor that was sent out we included a step by step installation guide leaflet (Figure 19). This installation guide was based on the installation guide developed during the Madrid/Barcelona case study (translated into English).

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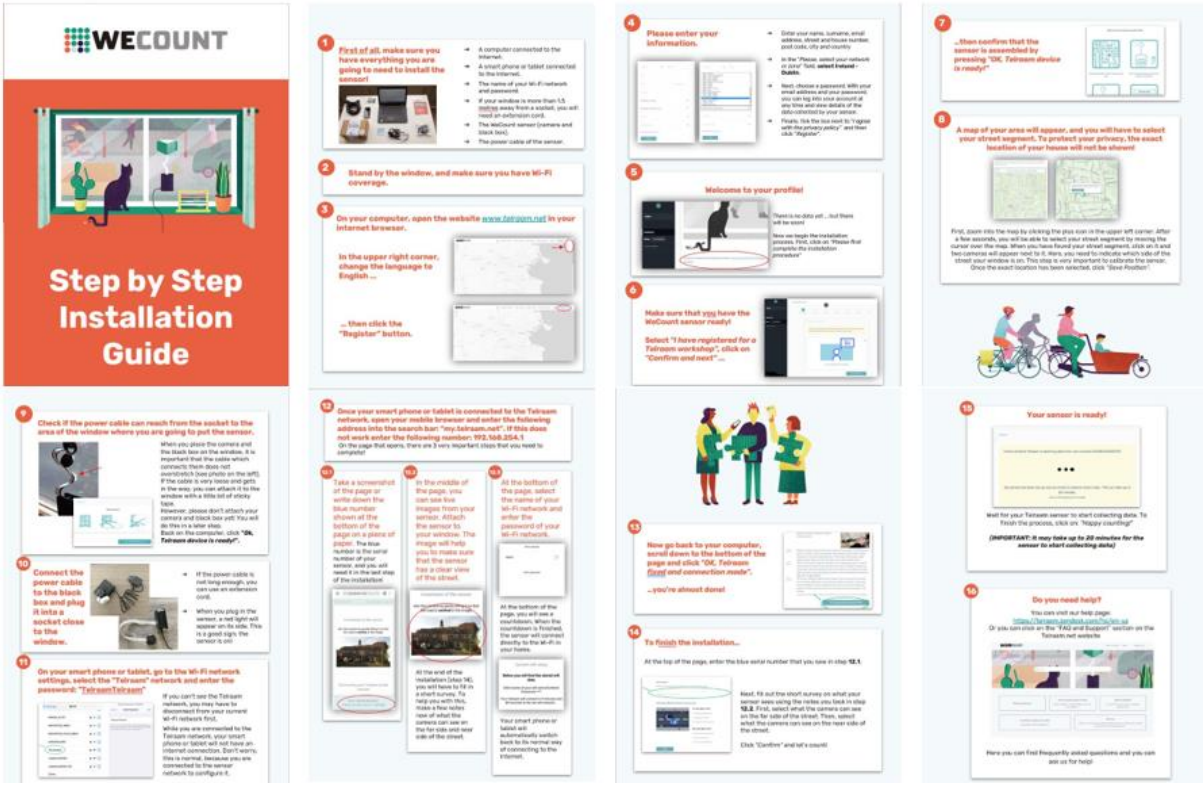
Figure 19: Step by Step Installation Guide for the Dublin Case study



Despite these detailed instructions many participants encountered difficulties when installing the sensor. Step 16 in the installation guide showed instructions on where to find further help, and on how to contact the Telraam helpdesk (https://telraam.zendesk.com/hc/en-us). Some participants followed these instructions, while others contacted us directly via email when encountering problems. Table 2 below lists difficulties reported to us. Participants did not encounter all of these problems during a single installation, but different participants may encounter one or more of these problems. The most common problems encountered were no Telraam WiFi signal from the device and the sensor not connecting to the Internet.

Table 2: List of issues reported by participants

Issue	**Description**	**Solution**
No software on SD card	No Telraam WiFi signal, but the participant was familiar with Raspberry Pi devices and noticed that the SD card was blank.	Participant installed software
SD card not in devices (pre-assembled sensor)	No Telraam WiFi signal, but participant noticed that SD card was not in device	Participant inserted SD card
Incorrect network	Participant selected wrong network in step 4 of the installation process.	Telraam system administrator moved participant into correct network
Map screen freezes when selecting segments	Participant could not zoom into map and could not select a street	Participant used different device

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Issue	Description	Solution
	segment.	
No Telraam WiFi signal	The Telraam WiFi does not appear in the list of WiFi networks	Further instructions were emailed (see below)
Sensor does not send data	The sensor does not connect to the router or does not connect to the Telraam server	Further instructions were emailed (see below)
Sensor stops counting	Sensor stops counting and the set up needs to be repeated.	Further instructions on how to monitor the power supply.

In a small number of cases the sensor did not send out the Telraam WiFi signal, because the SD card was not installed or the software was not installed on the SD card. In these cases the participant either solved the problem themselves by installing the software, or we provided a new SD card with the software installed. In most cases, we sent further instructions via email to participants. The standard template for these instructions is shown in Figures 20 below. While assembling and testing sensors for the schools deployment (see section 3.1 above), we also noted that the sensors take several minutes after being switched on to send out the Telraam WiFi signal. This information will be added to instructions in future emails.

Figure 20: Further instructions sent to participants who could not see Telraam WiFi signal

- Force your mobile phone to disconnect from your wifi, by clicking "forget connection"
- Switch the wifi on your mobile phone off and back on
- Switch the traffic counter off and back on (i.e. unplug and re-plug)
- Try to connect from a different device, e.g. a tablet or a laptop
- Flash the SD card with the latest version of the software (https://telraam.zendesk.com/hc/en-us/articles/360025328311-Assembling-Telraam-yourself)

Another common difficulty was the sensor not sending data to the Telraam platform. In the original sensor installation process there was no feedback to the participant at the the end of the installation. When reaching step 15 in the installation guide, participants did not know whether the sensor had been successfully installed or not. This meant that participants would often repeat the installation process and get frustrated, or leave the sensor and not notice for some time that the sensor was not installed correctly. Figure 21 shows further instructions that were emailed to participants whose sensor was not sending data. These instructions address a range of causes that could potentially stop the sensor from sending data: (1) Some of the other case studies reported issues with the power supply of the sensor. In the Dublin case study we used power adapters recommended for Raspberry Pi devices and none of our participants reported problems. Nevertheless, we still included this instruction in the email as the first thing to check. (2) Next, participants needed to ensure that the sensor was connected to their WiFi network via their local router. As troubleshooting steps we recommended to check that the correct WiFi network was selected and that the password was correct. We also added instructions showing participants how to check that the sensor was connected to their local router either by using free software or by using the command line. (3) The most difficult issue to address was, if the sensor was connected to the WiFi, but no data was received by the

Telraam server. For this we recommended that participants check that they have entered the serial number of the sensor correctly, and that they check that MAC filtering is switched off on their router.

Figure 21: Further instructions sent to participants whose sensor was not sending data

- **Check the power supply** – if the red light at the side of the black box is flickering a lot, this could indicate a faulty power supply. The Raspberry Pi uses a standard micro USB power supply, so if you think the power is the problem, you could try to replace it with e.g. a mobile phone charger, to see if that solves the problem.
- **Check the WiFi name** - make sure that you are trying to connect to the correct network.
- **Check/re-enter the WiFi password** – make sure that uppercase and lowercase letters, numbers, and symbols are all entered correctly.
- **Check the serial number** – make sure that the serial number has been entered correctly on the website.
- **Check that the traffic counter is connected to the router** –
    - the easiest way to do this is by using free software such as Advanced IP scanner https://www.advanced-ip-scanner.com/ . Install the software, then open it and click scan. In the Results table under Name look for telraam.lan. If this is there, it means the traffic sensor is connected to your router.
    - alternatively, you can log into your router from your computer to see which devices are connected to it. This website https://modemly.com/ provides instructions on how to do this for a wide range of routers.
    - finally, you can also use Command Prompt (Terminal on MacOS) to check that the traffic counter is connected:
        - On your computer open Command Prompt
        - In Command Prompt type *ipconfig*
        - In the Wi-Fi section, note down the number next to Default Gateway. the number will have four section and look similar to 192.168.1.1
        - Type in the following, but replace 192.168.1 with the first three sections from the number of your Default Gateway: *for /L %a in (1,1,254) do @start /b ping 192.168.1.%a >nul*
        - Type in *arp -a*
        - In the table that appears look under Physical Address for something that starts with b8-27-eb. This code identifies Raspberry Pi devices, so unless you have another Raspberry Pi connected to your system, this will be the traffic counter.
- **Check that MAC filtering is not enabled on the router -** log into your router following the instructions provided on this website https://modemly.com/ . Look for the MAC filtering settings and make sure that they are disabled.

In addition to support via email, two technical support sessions were offered to participants via video call. These sessions were organised by Telraam, and participants could directly describe any problem they were

having to support staff. All participants who attended these sessions successfully installed their sensors and provided positive feedback following these sessions.

3.3 Data Collection Process

A summary of the registered users in the Dublin network is shown in Table 3. In total 186 users registered. Of these 57 users should be classified as inactive, as these are administrative accounts, accounts used for testing (e.g. by undergraduate students), duplicate registrations, and people registering without having a Telraam sensor. The membership registration website was closed in January 2021, after the pre-assembled sensors had been sent out (section 2.7). However, a number of people then started to register via the Telraam user website, assuming that this was the membership registration for WeCount. We emailed these users to clarify whether they had purchased their own sensor or wanted to be added to the waiting list for a WeCount sensor. In addition, 14 people contacted us directly and were added to the waiting list.

The remaining users were participants who had been sent a sensor or who had received a sensor from a community champion. Of these users, five did not complete the installation (status 18/05/2021), 10 completed the installation, but their sensor has not sent any data yet (see section 3.2), and 113 users are actively counting traffic or have counted traffic for some time after the installation.

Table 3: Summary of registered users in Dublin network

Description	Number
Administrator accounts	2
Duplicate and test accounts	23
Registration without sensor	32
Installation incomplete	5
Installation complete, but no data has been sent	10
Counting and counting intermittently	113
Total number of users	185

In addition to the Dublin network, we have several sub-networks of traffic sensors across Ireland, in areas such as Kilkenny, Limerick, Ennis and Co. Laois (see Figure 22). A total of 33 users are registered in these networks. Of these users, six are duplicate registrations or have registered without having a traffic sensor. Five users have completed the installation, but the sensor has not sent any data yet, and 22 users are counting traffic or have counted traffic for some time after the installation.

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Figure 22: Screenshot of sensor distribution in Ireland

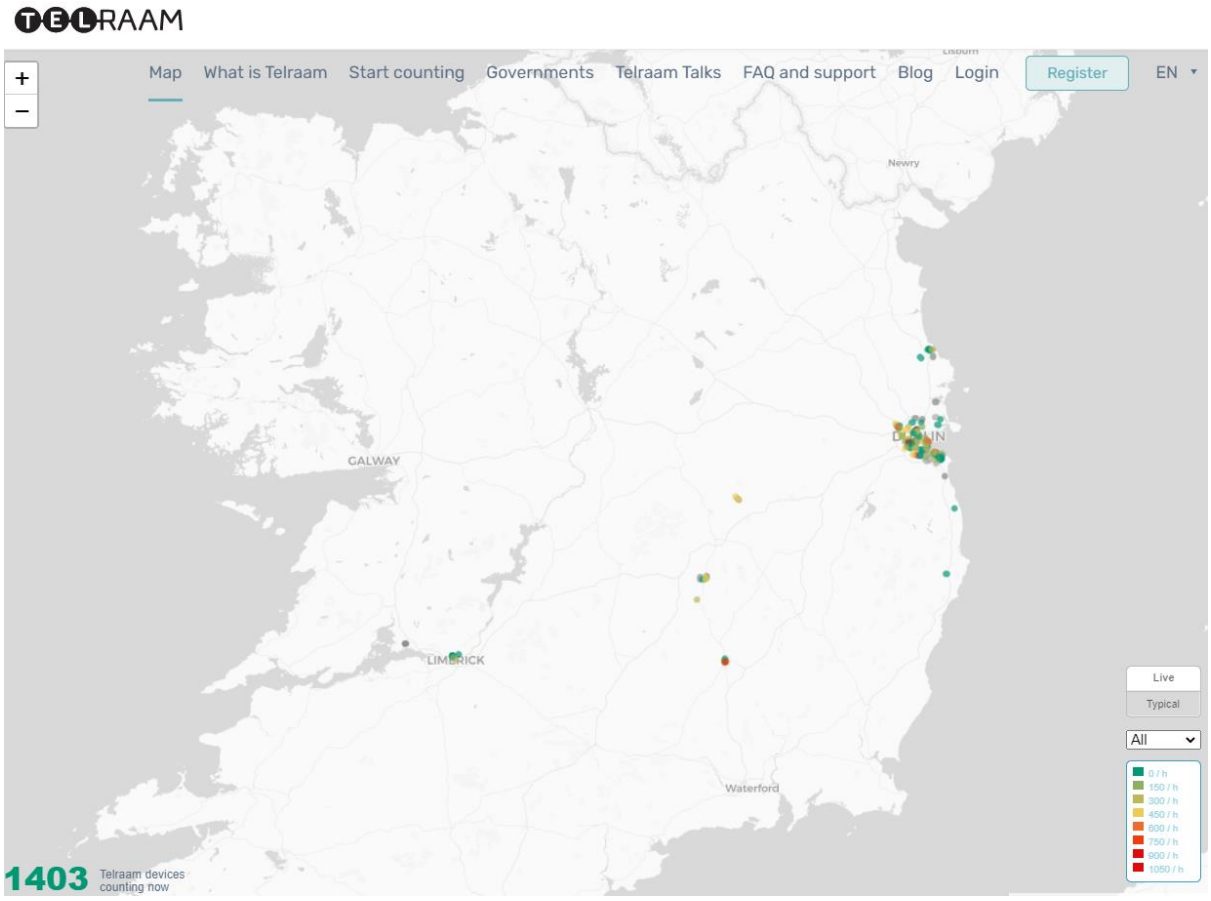

Figure 23 shows the increase in the number of sensors counting traffic in Dublin over time. The first sensors were installed in August 2020. A considerable increase in the number sensors counting occurred in November and December 2020, when sensors were distributed via school workshops and to community champions. The largest increase in the number of sensors occurred in January and February, when a large deployment of sensors was sent to participants directly.

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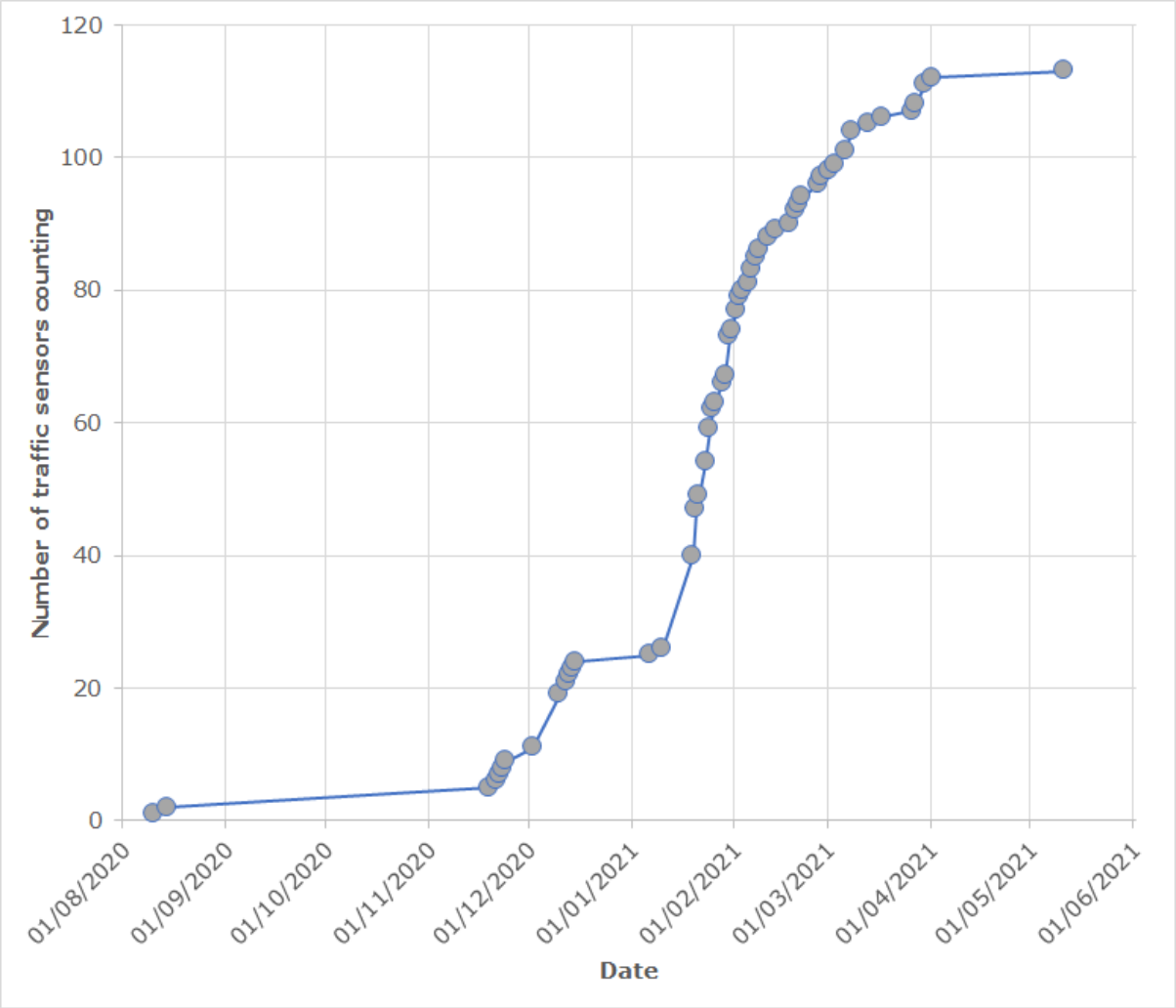
Figure 23: Total number of sensors counting traffic in Dublin over time



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4 Data Analysis and Awareness

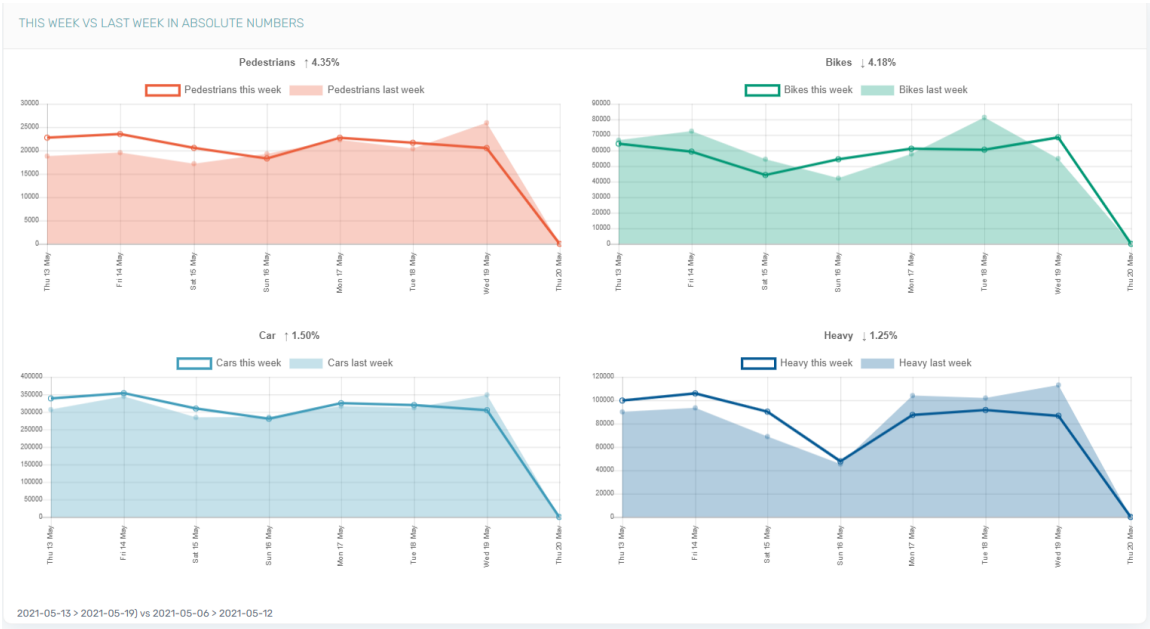
This section will provide an initial overview of the data that has been collected in Dublin so far. This will include summarised data available from the Telraam platform and descriptive analyses carried out by UCD. It will then explain the work that was done during the first WeCount workshops and the work that is planned for future workshops.

4.1 Descriptive Analysis

The Telraam platform offers a range of summary statistics in a readily available format. The website offers the opportunity to look at data from any street segment to members of the public, even if they are not WeCount participants. WeCount participants can log into their Telraam account and access a monthly report for their own sensor, which includes summary statistics of traffic as well as performance data of the sensor. WeCount network administrators can access summary statistics for all sensors in the network, as well as for individual street segments. The information shown in this section will be based on summary data accessed via the network administrator accounts. Further information on the data provided in participant's account and in the public domain is provided in section 4.2, as this was part of the introductory WeCount workshops.

The first overview that is available when accessing the network administrator dashboard is a comparison of the total counts by mode during this week and during last week, an example screenshot is shown in Figure 24. It should be noted that the weeks are rolling 7 day periods, i.e. "this week" are the 7 days prior to the present day and "last week" are the 8-14 days prior to the present day. This overview graph also shows the average increase or decrease in percent from last week to this week. On a week to week basis we would expect this change to be relatively small. Any major changes over such a short time period would indicate a major change in the road or a problem with the sensors.

Figure 24: Screenshot of the weekly comparison provided by the platform



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The Telraam platform also offers an overview of the relative traffic for a given time period set by the user. The relative traffic is defined as the percentage of observed traffic relative to the typical traffic (https://telraam.zendesk.com/hc/en-us/articles/360019400857-Netwerk-data-typical-traffic). The typical traffic is the average of the observed traffic over the past year in the network for the same hour and day of the week. Since all of the sensors in the Dublin network have been operational for less than one year, only the available data for hour and day of week were used. As an example, the graph below shows the relative counts (in %) of bikes and cars in the Dublin network from 6th May 2021 to 20th May 2021. It can be seen that bike counts tend to be higher than the typical count and car counts tend to be slightly lower than the typical count. Obviously, this data should be interpreted with caution as the majority of traffic sensors have only been counting for around two months and it is unlikely that a robust baseline has been established yet. Nevertheless, the increase in bike traffic seems logical as the warmer weather in May compared to March and April will encourage more cycling.

Figure 25: Screenshot of relative bike and car traffic provided by the Telraam platform

Another feature offered by the Telraam platform for network administrators is a comparison between two different time periods. The user can manually set two time periods and graphs showing average hourly counts by time of day for each transport mode and time period will be shown. This can be further refined by using only data from weekdays or only data from weekends. An example graph is shown below, which compares heavy vehicles during the second week of April 2021 and the second week of May 2021. It can be seen that there were more heavy vehicles during the second week of May, which is probably due to businesses re-opening as lockdown restrictions were gradually lifted. It can also be seen that the sensor measured for longer time periods in May, due to extended daylight hours and change from winter to summer time.

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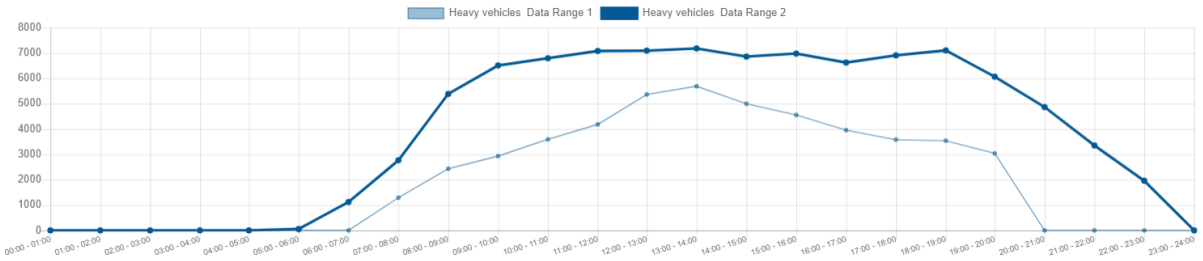
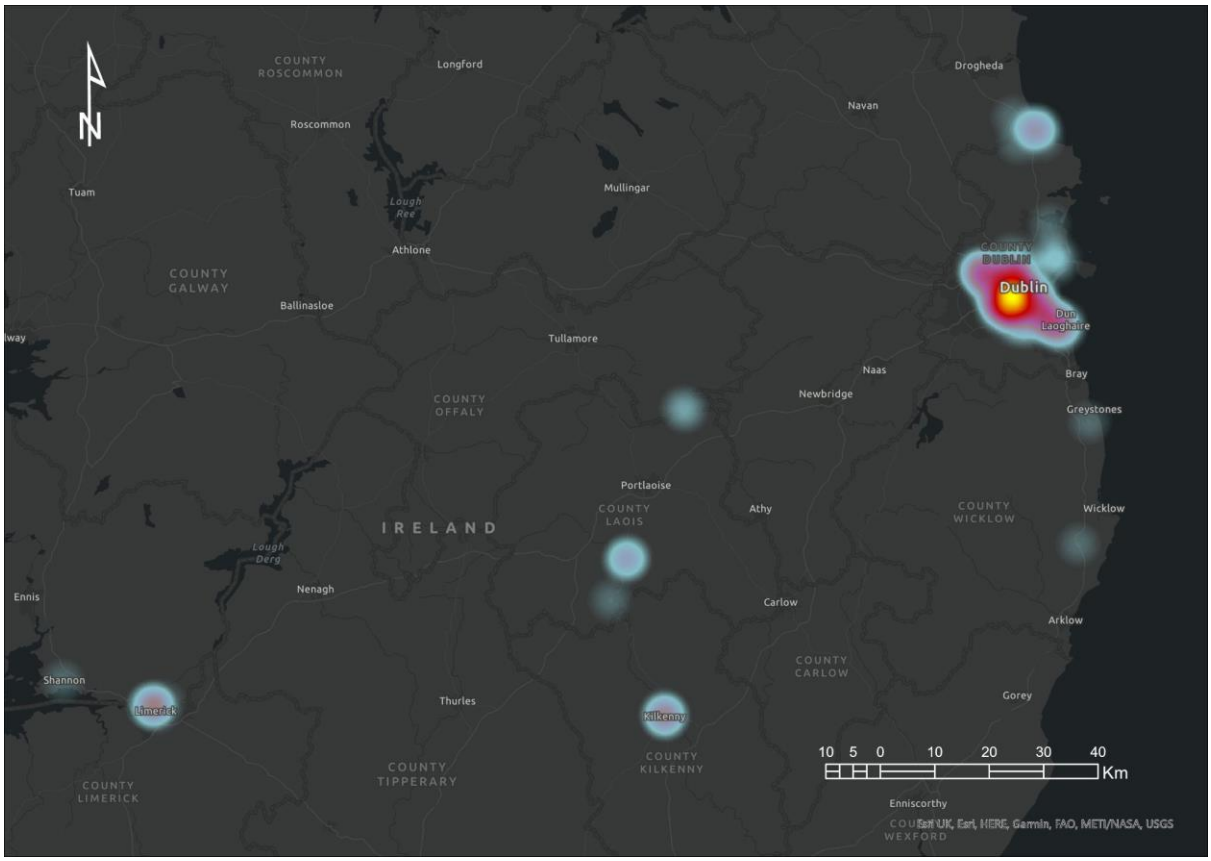
Figure 26: Screenshot of comparison of average hourly heavy vehicles count provided by the Telraam platform



At the administrative level the Telraam platform can also be used to download monthly datasets for the whole network. These can be in the form of summary reports or in a raw data format. However, hourly data from sensors can also be accessed via the Telraam API, and the following analyses are based on data downloaded via the Telraam API.

Prior to the descriptive analysis we created heatmaps to show the density of sensors counting across Ireland and in the Dublin area (Figure 27 & 28). These maps analyse the number of traffic sensors in a given area, not the traffic, with yellow and red colours indicating a high density of sensors. As per the aim of WeCount the highest density of sensors can be found in the Greater Dublin area. However, smaller sensor networks have also been established in Kilkenny, Limerick and Co. Laois.

Figure 27: Heatmap showing sensor density in Ireland



The heatmap of the sensor distribution in Dublin shows several high density clusters in Phibsborough, Crumlin/Kimmage, Castleknock, Sandymount and Blackrock. This data was helpful for organising the first workshops, as it allowed us to group participants geographically.

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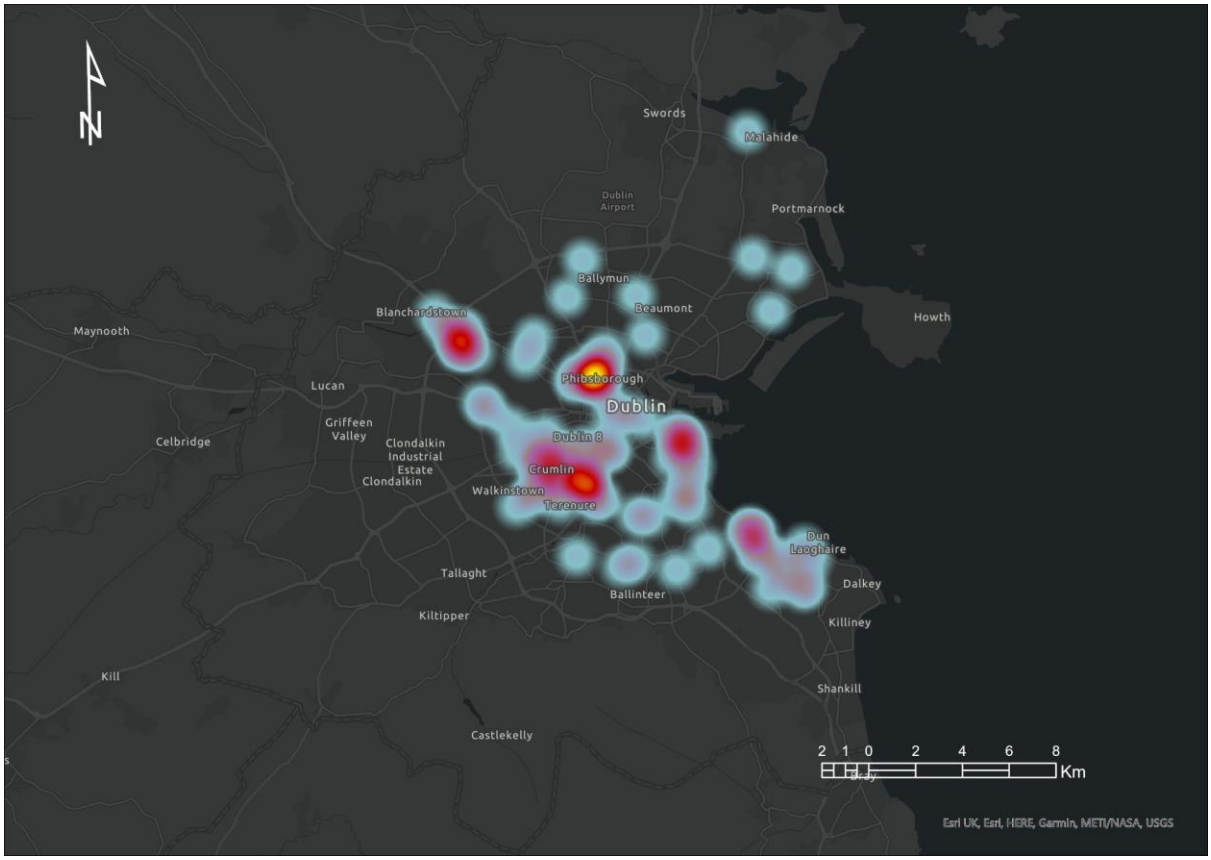
Figure 28: Heatmap showing sensor density in the Dublin area



Using Telraam's API we downloaded all data collected between 1/8/2020 and 30/4/2021 from sensors in the Dublin network who were actively counting or had counted at some point in the past. For quality assurance purposes we excluded data collected during the first 28 days that a sensor was operational, as the sensor typically takes 1-3 weeks to calibrate. We also excluded hourly measurements, if the camera "uptime" during the respective hour was less than 50%. This resulted in 66168 hours of valid traffic counts on 110 segments. Table 4 provides an overview of the total number of pedestrians, bicycles, cars and heavy vehicles counted during this time period.

Table 4: Total traffic counted from August 2020 to April 2021 in Dublin network

Variable	**Total number**
Number of segments used	110
Hours counted	66 168
Pedestrians	1 141 238
Bicycles	2 603 314
Cars	13 573 680
Heavy vehicles	3 444 394

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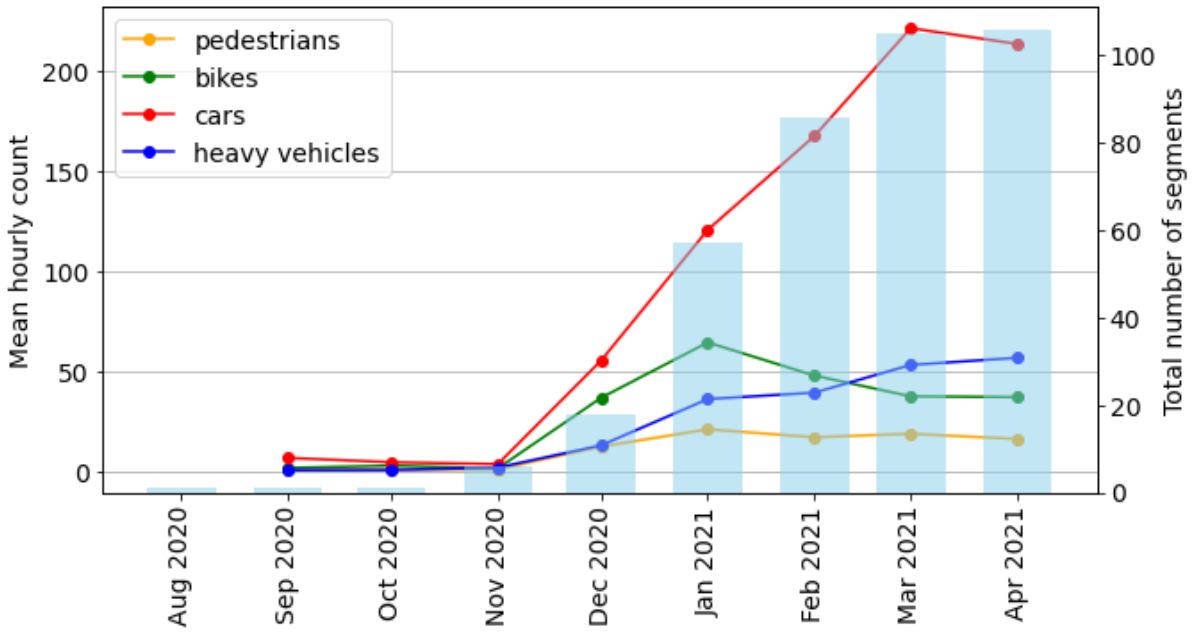
Figure 29 shows the mean hourly traffic counts per month since the beginning of the Dublin case study. It also shows the total number of street segments counting each month. It can be seen that in the first three months the traffic count was low, because initially only a few sensors were installed in quieter streets. From December onwards the number of traffic sensors increased rapidly. In parallel, the mean counts of pedestrians, bikes and heavy vehicles increased from November to January, and the trend then flattened, suggesting that the counters were now providing a more representative picture of the Greater Dublin area. In contrast, the mean number of cars being counted increased until March, before starting to flatten. This is probably due to the greater variability in car traffic on different types of street.

Figure 29: Mean hourly traffic and number of segments counting



The next graph shows the mean traffic by time of day. This is the mean across all street segments and for all of the data collected. The error bars represent the standard deviation of the data by time of day. For all transport modes the standard deviation is very large relative to the mean. This is due to a combination of spatial and temporal variability across Greater Dublin and across the time period measured. None of the transport modes displays a clear diurnal pattern, which partly may be due to the amount of data being aggregated, and partly due to the repeated COVID19 lockdowns during 2020 and 2021. In future analyses, it will be more meaningful to look at the data at smaller spatial scales or to group it by road type. Furthermore, comparisons of post-lockdown and lockdown data will provide more information on changes in diurnal trends.

The large variability within the Dublin network is further illustrated in Figure 31, which shows the range, interquartile range and median of car counts for each sensor. The boxplots show large variability between traffic sensors, which suggests that we are capturing different street environments. The boxplots also show large variability within traffic sensors, which hints at strong diurnal trends or longer term trends, e.g. consistent increases in traffic as the lockdown is eased. More detailed analysis will be required to understand the spatio-temporal trends in the data, but the initial data collected looks promising.

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Figure 30: Mean and standard deviation of traffic count by time of day

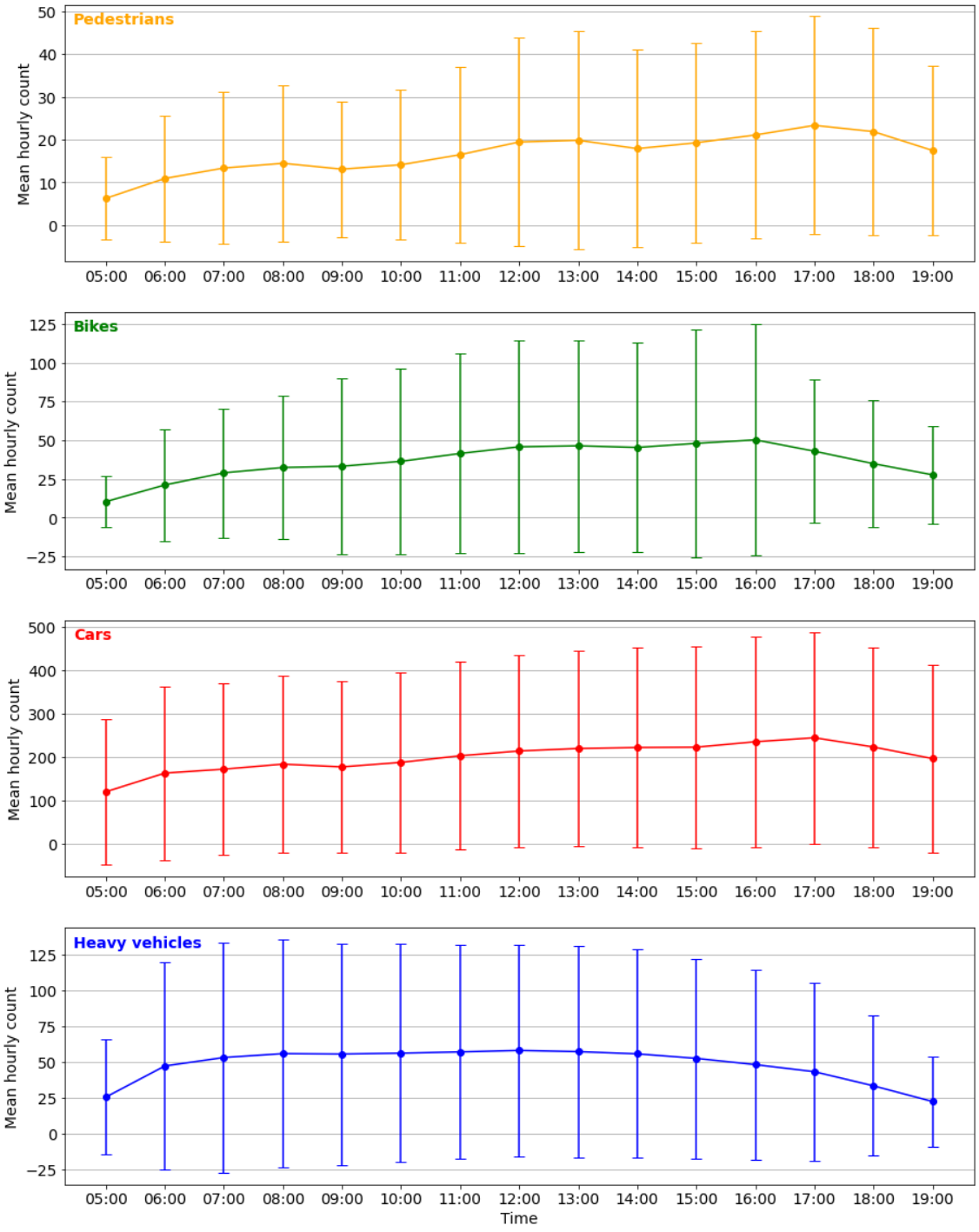

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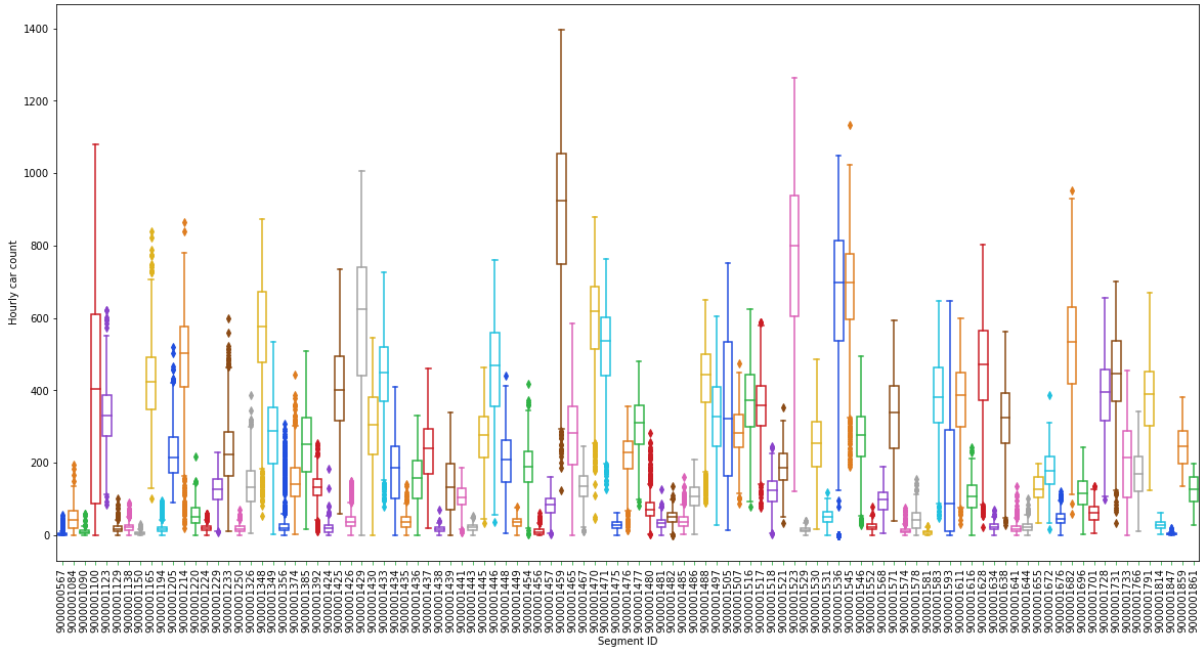
Figure 31: Boxplots of car counts collected by each sensor



In addition to traffic counts the Telraam API also provides hourly speed measurements in 10km/h intervals and the V85. The V85[4] is a common indicator used in traffic speed analysis, and it represents the speed that is not exceeded by 85% of cars measured during the particular hour. Figure 32 shows a histogram of the V85 measured by the sensors. Most streets in Dublin have a 30km/h or 50km/h speed limit (indicated as dashed red lines) and it can be seen that the majority of V85 is below 50km/h. Dublin City Council is proposing to expand the 30km/h speed limit to all streets in Dublin, and a public consultation finished in April of this year[5]. As any changes to traffic and road infrastructure tend to be controversial, the objective measurements provided by the traffic sensors could be valuable to inform the decision making on the speed limit.

[4] https://ec.europa.eu/transport/road_safety/sites/default/files/pdf/2020-10-08-road_safety_thematic_report_speed.pdf

[5] https://consultation.dublincity.ie/traffic-and-transport/30km-h-survey/#:~:text=of%20the%20city.-,The%20introduction%20of%2030km%2Fh%20speed%20limit%20in%20all%20roads,walking%20and%20cycling%20to%20school.

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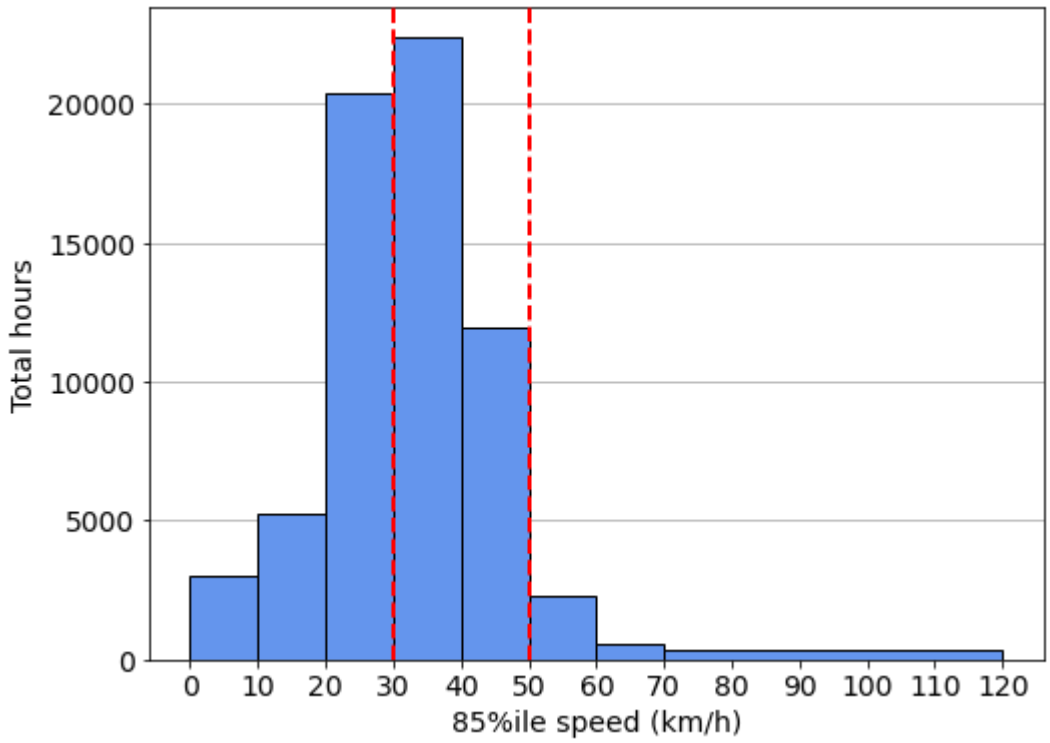
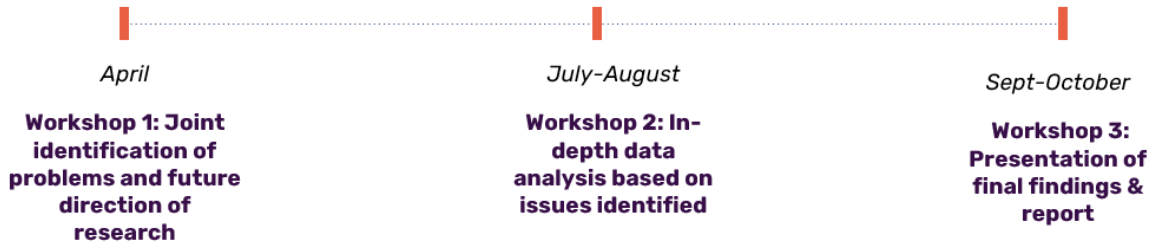
Figure 32: Frequency distribution of 85%ile speeds per hour



4.2 Participatory Data Analysis and Awareness Workshops

For the Dublin case study we decided to hold three types of workshops: (1) introductory workshops to identify area specific problems associated with traffic and to discuss the future direction of the project (see section 2.3). These workshops were held in April 2020. (2) Data analysis workshops to help participants to investigate problems identified during the first workshop. These workshops are currently planned for July/August 2021. (3) Final workshops to discuss the overall findings of the WeCount project. These workshops are planned for September/October 2021.

Figure 33: WeCount Dublin proposed workshop timetable



4.2.1 *Workshop 1 - Recruitment and Participation*

A series of five local introductory and co-design workshops were held in April. Separate workshops were organized for different areas of the city corresponding to the idea that there would be specific issues and concerns in each area which would need to be discussed separately. This followed on from initial discussions

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with some community groups in Dublin, such as one in Phibsborough, who had identified a particular local transport infrastructure project as a key concern. As such, it was thought that splitting the participants into subgroups based on geographical area could allow them to identify specific issues which could then be addressed using the Telraam data. For the purposes of organizing the workshops, participants were split into five different sub-groups corresponding to the clusters of users who had registered to participate in the project. It is important to note that these participants had generally registered independently of one another and were not already connected through, for example, a residents association or local community group. Distinct clusters of participants were identified in Castleknock-Ashtown, Phibsborough-Glasnevin, Sandymount, Dun Laoghaire-Blackrock and Harold's Cross-Dolphins Barn (see Figure 28). We initially attempted to organize local workshops in coordination with active local participants or 'champions' who had, for example, helped with the distribution of sensors. However, it quickly became apparent that these individuals typically only knew a very small number of other participants and would not be in a position to coordinate a workshop for their entire local area. This was due to the structure of the recruitment process whereby individuals typically found out about the project through Twitter or other media sources and registered independently of others in their local area. Therefore, instead of using local champions, we contacted all participants in a given area via email inviting them to attend the online workshops. In total, invitations were sent to 129 project participants in these different areas. As outlined in Table 5 below, a total of 31 people attended the workshops.

The workshops took place in the evening after normal working hours to allow those in employment to attend. Due to the timeframe of the project and the fact that these workshops took place in April, the majority of attendees had already successfully obtained and installed a Telraam sensor. This meant that there was no requirement to explain the steps of registration or installation. Out of the list of participants, those who turned up to take part in the workshops were generally people who were relatively motivated and interested in the project given they had been participating for some time rather than, for example, people who had an interest and wanted further information. Again, the majority of participants had a high level of interest, knowledge and engagement of local mobility and environmental issues. For example, in several cases they were involved in campaigning regarding local transport infrastructure projects due to perceived impacts on public space, road safety and active mobility. As such, the level of knowledge of participants of transport-related topics was generally high. Even in the case of people who were not actively engaged with local mobility, all participants had valuable experience and insights regarding transport and its impacts in their local area.

Table 5: Introductory and Co-Design Workshops

Date	**Community**	**Participants**	**Duration ca.**	**Focus**
23/3/2021	Castleknock-Ashtown	4 - 20% females	75 minutes	Problem formulation and co-design
8/4/2021	Phibsborough-Glasnevin	5 - 80% females	75 minutes	Problem formulation and co-design
15/4/2021	Sandymount	3 - 66% females	60 minutes	Problem formulation and co-design
22/4/2021	Dun Laoghaire-Blackrock	4 - 50% females	90 minutes	Problem formulation and co-design

Date	Community	Participants	Duration ca.	Focus
29/4/2021	Harold's Cross-Dolphin's Barn	15 - 60% females	90 minutes	Problem formulation and co-design

4.2.2 Workshop 1 - Structure

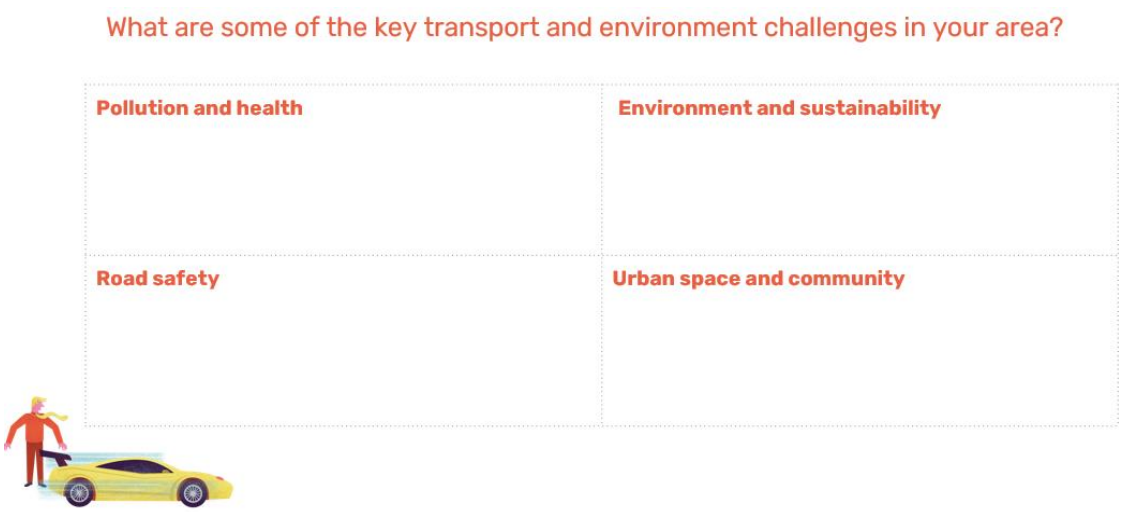
The same basic workshop structure was adopted in all cases. This did not have prior knowledge in different cases as to what the key issues might be, and because all sub-groups were located in the Greater Dublin Area and therefore had a similar policy context. The workshop were structured as follows:

1) The workshops first involved brief introductions by all attendees including a question to participants to explain why they were motivated to take part.

2) Second, there was a brief explanation of the WeCount project and its objectives, including the objective of co-designing solutions to the specific problems identified by each local group. There was an outline of the proposal timeline and structure of the project including a suggestion for subsequent in depth data analysis/co-design workshops to further develop solutions. It was noted that, depending on participation levels, these could be organized at either the local level of clusters of participants, or through one workshop for all Dublin participants.

3) There was an interactive discussion or brainstorming session to identify local issues and concerns relating to mobility, where each participant was asked about their perceptions in relation to mobility in their local area. To structure this discussion, and following on from the approach in Barcelona/Madrid, we identified four broad themes or categories which were, road safety, pollution and health, public space and community, environment and sustainability. Participants were asked to identify issues/concerns under these categories, although it was recognized that there would be significant overlap between categories.

Figure 34: Slide used during interactive discussion and brainstorming session



4) There was a second part to the interactive discussion to stimulate discussion about how the data could be used and, generally, about moving from information to action. This follows on from our understanding of the citizen science approach, specifically the need to go beyond seeing information gathering as an objective in itself and identify how data might feed into subsequent stages of policy formulation and the

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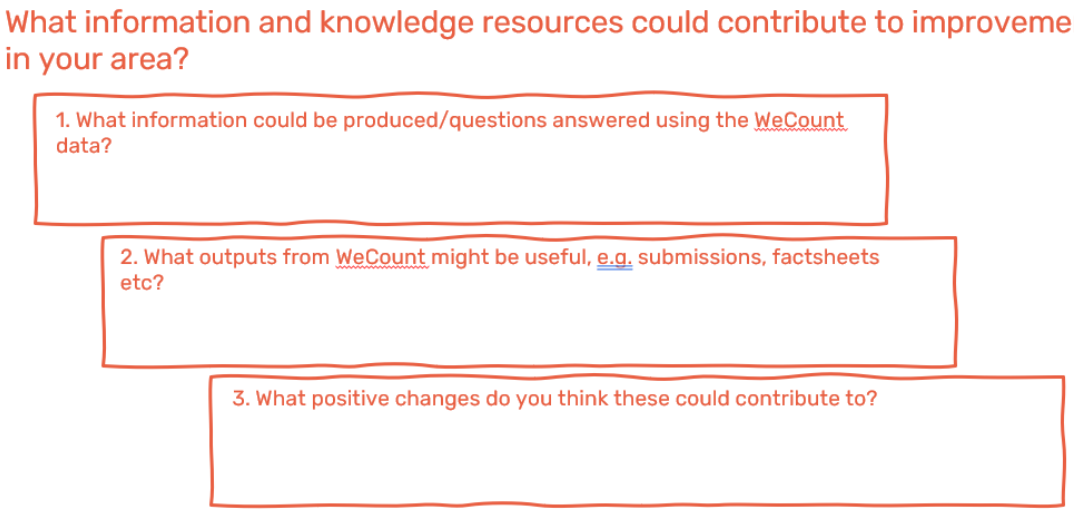
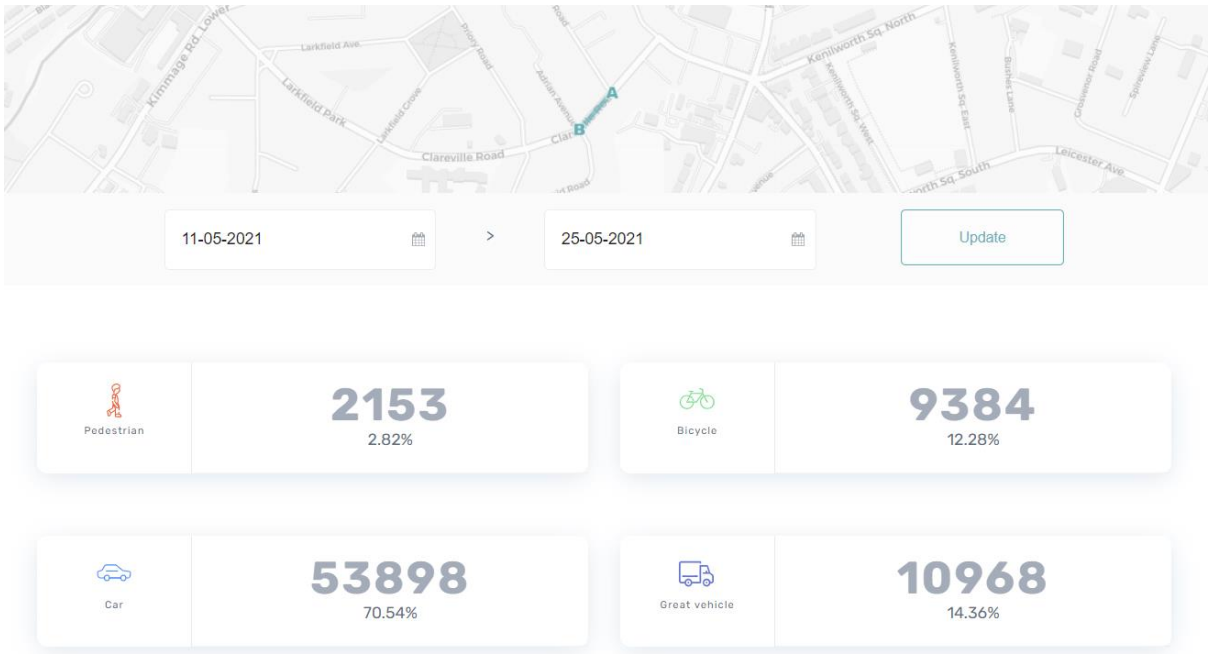
implementation of concrete projects or initiatives. This stage was also intended to allow a discussion about how data could be leveraged by addressing questions such as what support would be needed for its interpretation, what outputs it could be translated into and in what format? Correspondingly, participants were asked to set out their ideas for the stages that the project could proceed through, including what important questions relevant to local issues/concerns should be investigated, what outputs these might be translated into (e.g. factsheets or submissions to public consultations) and what changes these actions might, ideally, lead to?

Figure 35: Slide used discussion on how data can be used



5) Following these brainstorming stages, there was a discussion of possible methods of data analysis which could be used in the project. To initiate this, we first demonstrated the data summary on the Telraam website to participants to show them what was already available to them in terms of data analysis.

Figure 36: Example of initial section of data summary provided by website



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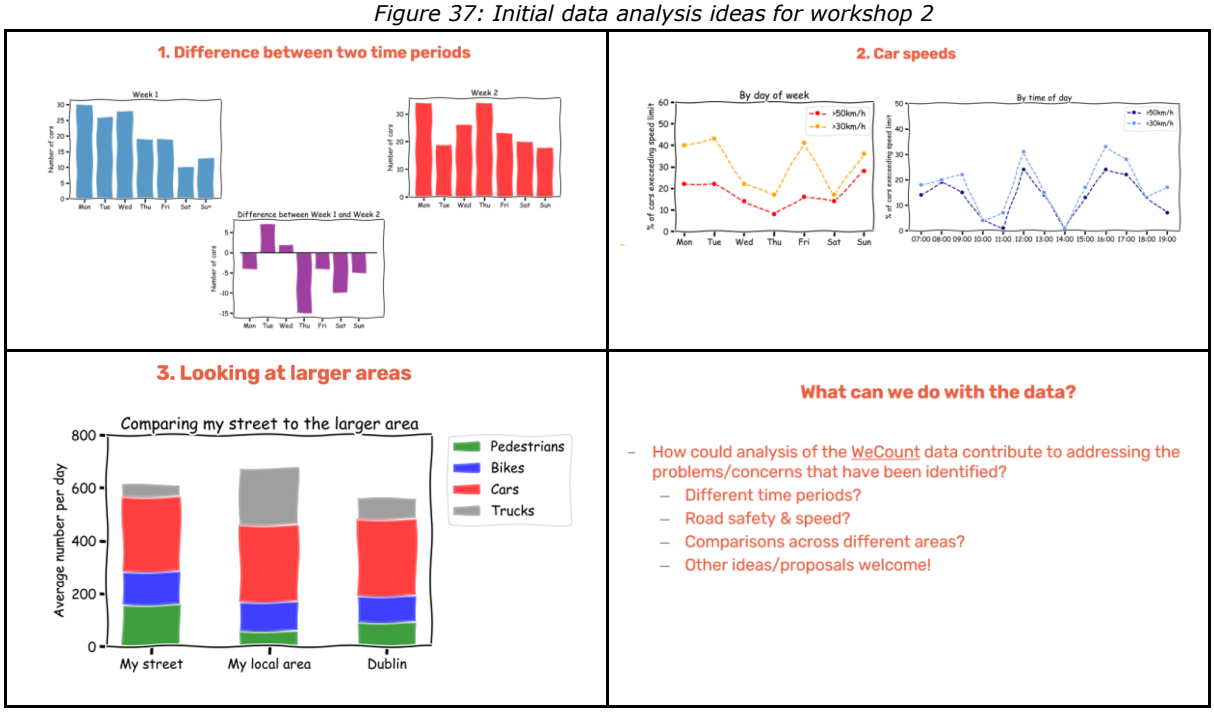
However, we also wanted to explore which other analytical outputs participants were interested in. Prior to a discussion, we showed the participants three initial ideas for analyses that could be done collectively during Workshop 2. These ideas were (1) a comparison of the traffic during two different time periods, (2) an analysis of the number of cars exceeding the regulatory speed limit on a street, (3) a comparison of the participant's street to the local area and to the Dublin network. For each of these ideas we showed a mock up graph to illustrate our suggestion (Figure 37). For the analysis of the difference between two time periods, we clarified that the time periods could be set individually. We suggested that this type of analysis could be used to compare traffic during the lockdown and after the lockdown, or traffic during term time to traffic during school holidays. For the analysis of the car speeds we clarified that the participants would specify their local speed limit and that the analysis would also show differences by time of day, weekday and potentially both. For the analysis of the larger area, we clarified that the participants could select which sensors were in their local neighbourhood.

Figure 37: Initial data analysis ideas for workshop 2



Following the presentation of these three ideas we invited the workshop participants to provide some feedback. Specifically, we asked them: Are you interested in further data analysis or is the data summary provided by Telraam sufficient? Which of the three ideas would you be interested in? Are there other analyses that you would like to do in workshop 2?

6) General feedback was collected at the end of each workshop using a Zoom poll. Notes, transcriptions, and other entries are being transferred to those responsible for the WeCount Monitoring and Evaluation (WP5) for analysis.

4.2.3 Workshop 1 - Feedback

In general, participants had a positive attitude toward the WeCount project during workshops. All workshop attendees participated when asked about key transport and environmental challenges in their local area, and most attendees commented and provided feedback on the data analysis ideas that we presented.

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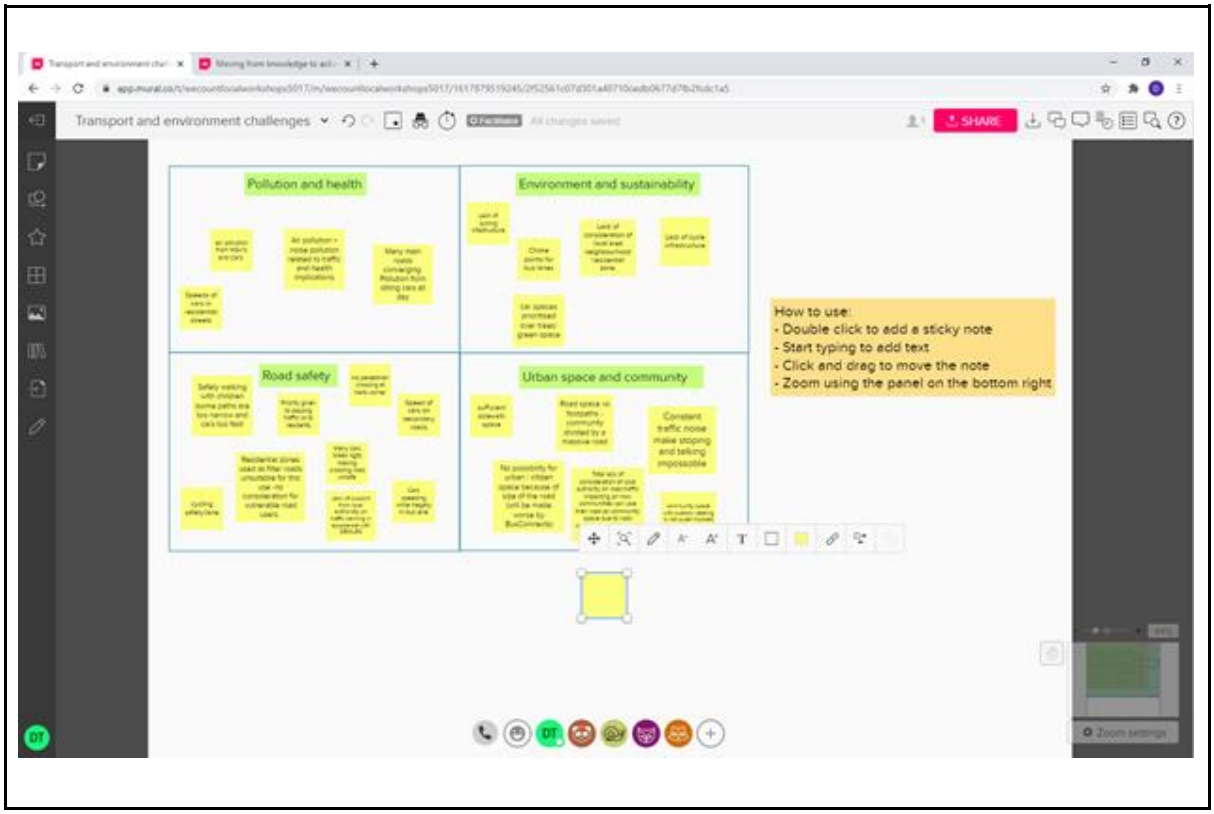
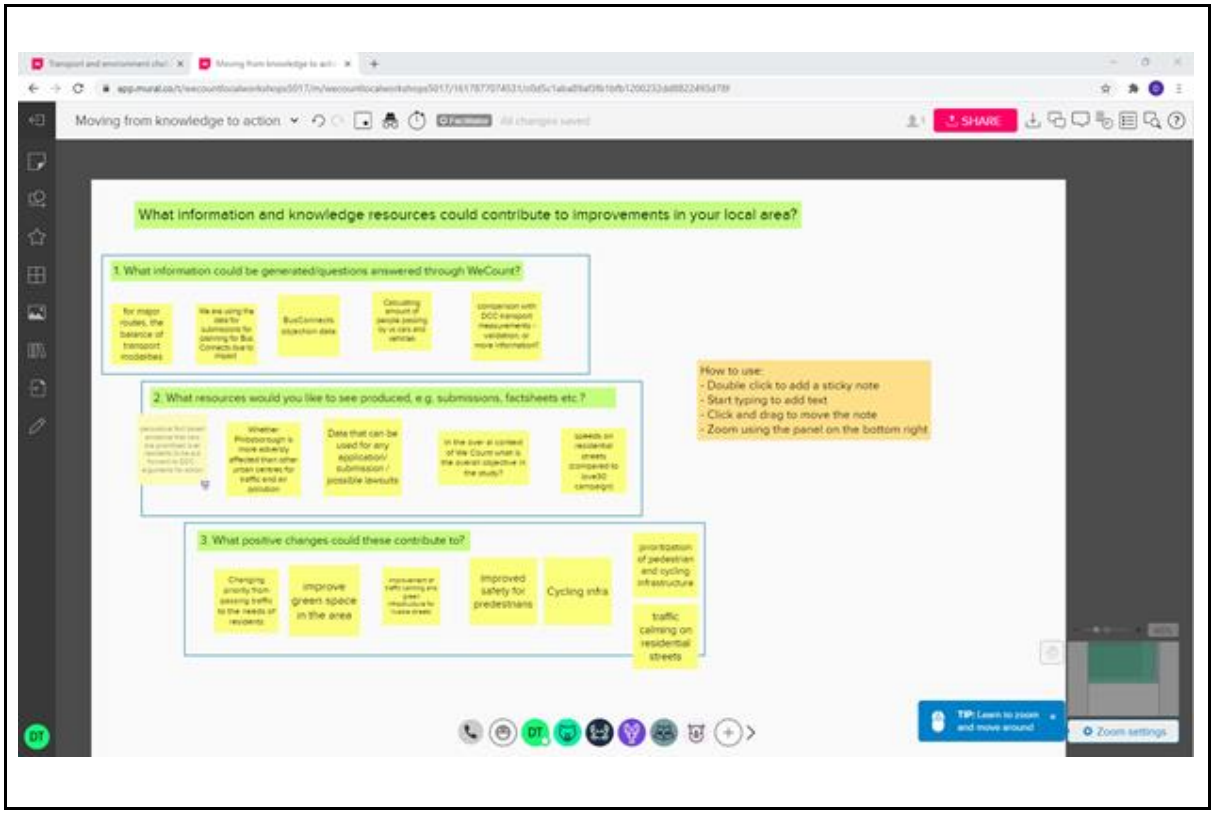
In both stages 4 and 5 of workshop 1 (see section 4.2.2), feedback from participants was collected using Mural, an online tool which allows participants to simultaneously add to an online worksheet using sticky notes (Figure 38). This allowed for a more interactive structure, and for all participants to contribute more equally, rather than a discussion being dominated by a small number of vocal attendees. Participants were able to add multiple entries, and there was time allocated for a discussion of emerging common themes. This helped to identify shared concerns which could be addressed through the WeCount data.

Figure 38: Interactive online workshop discussion using MURAL





In response to the questions posed, there was a broad range of issues and concerns raised at the workshops. In many cases these were very specific and related to the particular street or neighbourhood where the participant lived, e.g. high speed of traffic on a residential street. There were also particular ongoing projects and initiatives in different areas which were identified as key concerns. These included an expansion in bus corridors in Phibsborough-Glasnevin associated with the ongoing 'Busconnects' project, which it was feared would lead to increased volumes of traffic through the already busy town centre. In Sandymount there were also similar concerns about planned improvements in active travel infrastructure which, it was thought, would lead to increased traffic through nearby residential streets. In addition to these specific local concerns, there were other shared themes which arose across all workshops including, most notably, concern about high volumes of traffic through residential areas and neighbourhood centres. This overlapped with concerns regarding rat-running and commuting traffic passing through neighbourhood centres. It further overlaps with concerns regarding high traffic speeds and road safety. In many cases there was an interest in understanding different journey types, for example whether traffic was generated locally, e.g. by schools or was just passing through the area. In the case of busy neighbourhood centres (e.g. such as in Harold's Cross, Castleknock and Phibsborough) it was highlighted that this leads to a diminished sense of community and discourages active modes of travel. Although it is not being monitored at this stage of the project, there was a high level of concern regarding local air quality related to traffic and interest in gathering information about this. This will be followed up through the deployment of air quality sensors in schools as outlined in subsequent sections of this report.

For the data analysis ideas that we presented participants made the following additional suggestions:

- *Correlate the speed data with weather data* - if open access weather data is available, we will look into downloading this into the notebooks to run correlations. If this is not possible, we will consider doing this type of analysis on a larger scale using UCD resources.

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- *Correlate traffic volume and speed to indicate congestion* - we are currently considering ways to analyse congestion based on the available data, and this could be one method to include in the notebooks.

- *Compare hourly traffic counts on two specific street segments. This would be used to identify traffic shifting from one road to another, if infrastructure changes are made by the council* - we will add functionality for this to the area comparison notebook.

- *Make data download into Excel easier* - participants who have a traffic sensor can download annual data for their own sensor in .xls format. However, the time period covered in this download is fixed. We will add code to notebooks that will allow participants to export their formatted and cleaned data for later use in Excel or other software packages.

Furthermore, participants had the following ideas and suggestions for analyses of the Telraam data:

- *Graphs showing the mean traffic per week or per month over a longer time period (e.g. one year). This could show seasonal patterns in traffic* - We passed this on to TML as we thought these graphs could be useful additions to the summaries shown on the Telraam dashboard.
- *Congestion is a common concern in several areas. The participants know that stationary traffic will blend into the background after a certain amount of time. However, one participant asked, if an analysis could be done to show when or how often objects blend into the background, and to get the traffic counts just before objects blend into the background* - This was an interesting idea to identify congestion; however, it requires traffic counts at finer timescales than can be downloaded via the API. Therefore, we passed this idea on to TML for further evaluation.
- *Further analysis on directional traffic, i.e. amount of traffic going from A to B and from B to A. There was a concern that transport initiatives run by local authorities do not take into account that traffic at certain times of the day is predominantly flowing into one direction* - This was also an interesting idea and we are currently considering methods to formally analyse this.
- *More metadata on roads and comparisons against metadata. This was suggested during several workshops. It included comparing the traffic counts against counts, which are periodically done by the local councils using manual counters, or against data provided by the Central Statistics Office. It also included comparing traffic counts by the sensors against manual counts done on behalf of property developers to obtain planning permission for large scale housing developments. Furthermore, participants wanted to compare traffic counts on their street against the design capacity of the street* - we are currently evaluating if these types of metadata are openly accessible and could be obtained in a systematic way. If this is possible, we will consider developing it into an analysis notebook.
- *Estimate the through traffic of a local area, i.e. the total/average number of vehicles passing through* - This is an important topic in many local communities; however, it is not something that can be easily done. We will discuss the feasibility of this with transport modellers, but it may be beyond the scope of the WeCount project.
- *Estimate the number of people transported through a street segment compared to the number of people living there. The participant suggesting this is already working on this analysis individually and wanted further input on typical car/bus occupancy rates* - we will try to obtain further data for this, and may extend this type of analysis to other areas in Dublin.
- *Calculate a running baseline and relative index of the traffic counts* - the network administrator view of the Telraam dashboard has already implemented this. We will suggest to TML to also make this available for individual sensors in the participants' dashboard.
- *Correlate the traffic counts with air pollution and weather data* - air pollution is a major concern in the Dublin network and participants were very interested in the air pollution monitors. The air

pollution monitors are still in the process of being set up. Once air pollution data is available, we will develop a tool or platform that relates the traffic data to the air pollution data.

4.2.4 Workshop 1 - Reflections and Next Steps

The interactive introductory and co-design workshops contributed to the development of the project in several ways. The outcomes of the workshops and reflections on their advantages and limitations are outlined below.

1) These include generating valuable information regarding mobility and broader issues relating to the environment and public space. The workshop structure was generally open rather than prescriptive and allowed participants to identify and discuss those issues they feel most strongly about. As outlined above, key issues identified included high volumes of traffic in residential areas and neighbourhood centres, and associated issues with road safety, impacts on sense of community and the feasibility of active travel. These issues will be followed up through data analysis workshops which will be held in July/August.

2) The workshops contributed to building engaged communities. Associated with the recruitment process, the majority of participants did not know each other prior to attending a WeCount workshop and were not generally connected to existing community or transport-related groups. The workshops provided opportunities for participants to connect with other people interested in these topics in their areas and potentially to continue collectively to seek improvements in transport policy and planning. For example, In at least one case, participants agreed to share contact details and to develop a plan to act collectively outside the structure of the WeCount project.

3) There were different perspectives and expectations regarding the structure and contribution of WeCount amongst different participants. For example, some participants were happy with the idea of independently accessing the data and using it for their own purposes, primarily as individuals rather than collectively. In such cases, there was generally an interest in new data analysis tools which could be developed and accessed through the Telraam website and interface. Such participants saw the WeCount researchers as having a supporting/coordinating role in providing the technology and data analysis tools. This corresponds to a model of citizen science where data is made available to the public, but there is minimal additional support in leveraging the information and/or engaging with policy making on the part of researchers. In the case of other participants, there was a desire and expectation for greater support and intervention from the researchers and for the project to establish clear objectives in terms of how the data would be used, either at the local level or across Dublin as a whole. In such cases, participants considered that it would be up to the researchers to gather/analyse the data from all sensors in Dublin and to develop recommendations or policy proposals independently. Balancing the needs of these different types of participants is likely to be an ongoing challenge.

4.2.5 Plans for Workshop 2

Based on our interactions with the participants during workshop 1 and throughout the WeCount project, we have found that the participants have varying skill levels with technology and/or data analysis. While some participants are professionals in software engineering or similar fields, others have limited expertise, but are eager to learn more. Therefore, our aims for workshop 2 are two-fold. Our first aim is to make the workshop as interactive and applied as possible. This means the participants will work with real data from the Dublin sensors, and they will do data analysis themselves. Originally, we were planning to do this in a large face to face workshop in a public space with computer facilities, such as the Dublin Science Gallery.

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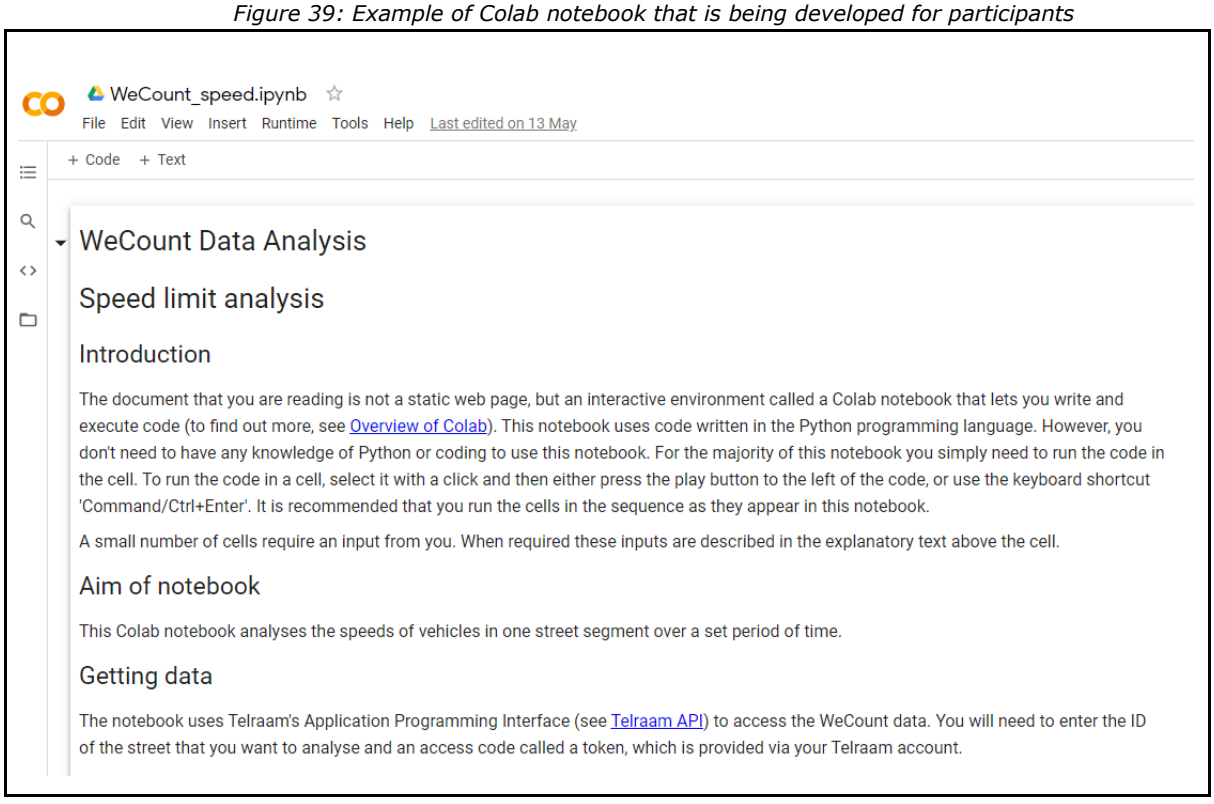
However, due to the pandemic it is uncertain whether this will be possible, and we will look into alternative arrangements.

Our second aim is to make the workshop as inclusive and accessible as possible, to ensure that citizens of all skill levels can participate. For this purpose we are currently developing analysis notebooks in Google Colab. Google Colab is a free online tool for data analysis. Participants can access it via an internet browser, and do not have to install any software on their computers. Colab uses the Python programming language and Jupyter notebooks. This means that we can provide both descriptive texts, including images and links, and analysis code to the participants (an example is shown in Figure 39). The notebook shows the participants step by step how to download data from the Telraam API, how to format and clean the data, how to calculate descriptive statistics, and how to create graphs of the data. The necessary input from the participants is minimal, they need to type in a segment ID, their API access token, and the time period that they want to analyse. For each of these there is a detailed description with pictures on how to find them and how to enter them. For example, for the time period we show the format that needs to be used and we recommend a minimum length for the time period. For the remainder of the notebook participants simply need to run the code by clicking on the run button of each code cell. There will still be descriptive text surrounding each code cell, which explains what the code does, but participants do not need to know specifics of the Python language. This ensures that the analysis is accessible to participants with no expertise in programming. However, the code is visible and can be changed, which means, participants with programming expertise can use this as a foundation for more advanced analyses.

Figure 39: Example of Colab notebook that is being developed for participants



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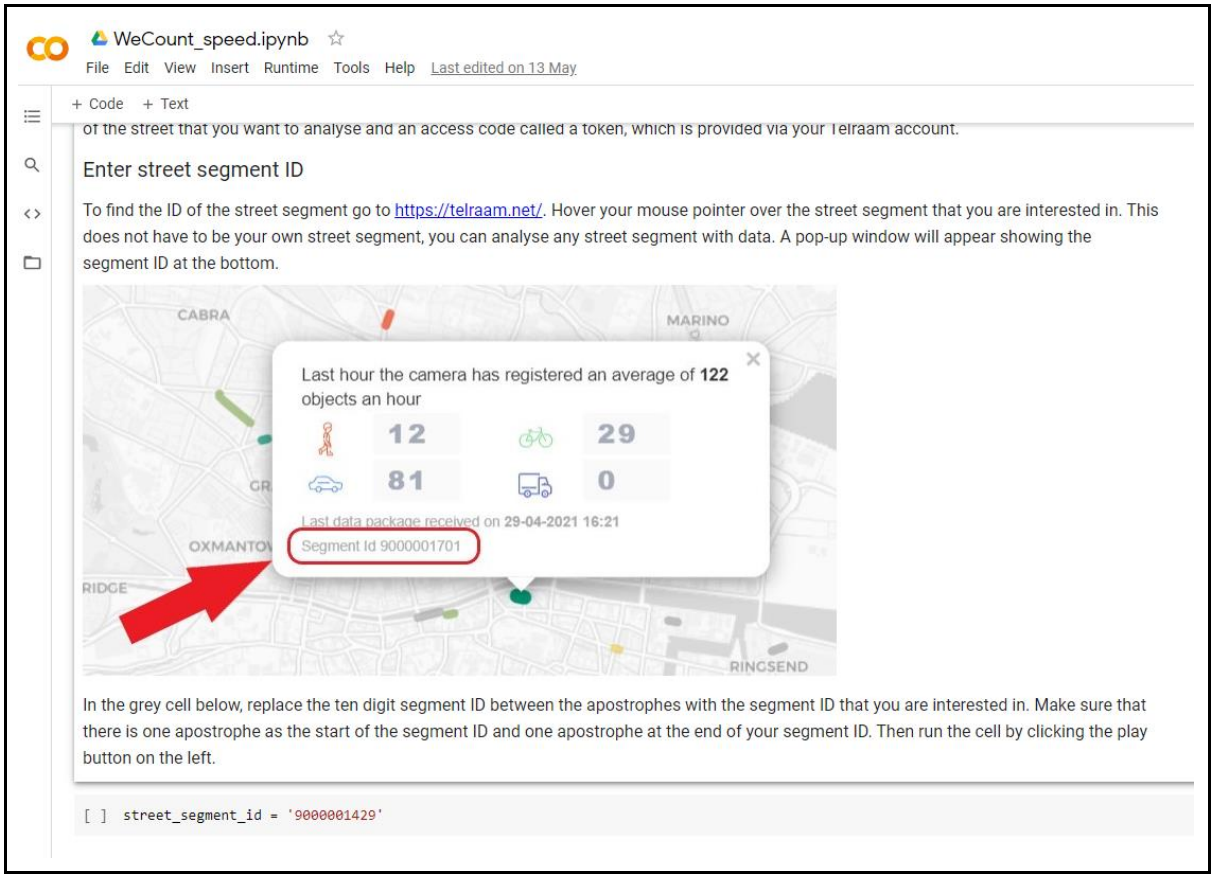

The Colab notebooks will be made open access and will be saved in a publicly available space. This will allow participants to return to the analysis and to use them again at a later date. This is important to ensure citizen science activities and knowledge exchange beyond the end of the WeCount project.

4.3 Bridge to the Policy Level

The main bridge to the Policy Level for the WeCount pilots in the Greater Dublin Area and in the rest of Ireland is linked to the activities in school.

Since we decided to go ahead with a campaign dedicated specifically to schools, we have engaged with several local and national authorities and also national institutions. This allowed us to identify a number of initiatives which we could contribute to and which would have a direct path to both infrastructural interventions to target the traffic related issues and to long term policy actions. The initiatives are:

- "*School Zones*": which is run in the Greater Dublin Area. A School Zone is an initiative designed to give priority to students at the school gate by freeing up footpaths and reducing vehicle drop-offs, pick-ups and idling. The aim is to reduce congestion and increase safety at the front of school, and prioritise active travel (walking and cycling) to and from school. School Zones aims to: Encourage traffic to slow down in the School Zone area; Prevent parking on pavements; encourage drivers to make drop-offs outside the School Zone area and not to stop in the School Zone area. A School Zone includes: Line-marking stating 'School Zone' at either end of the area; colourful circles on the road demarcating the front of school area; pencil-shaped bollards on the footpath to prevent

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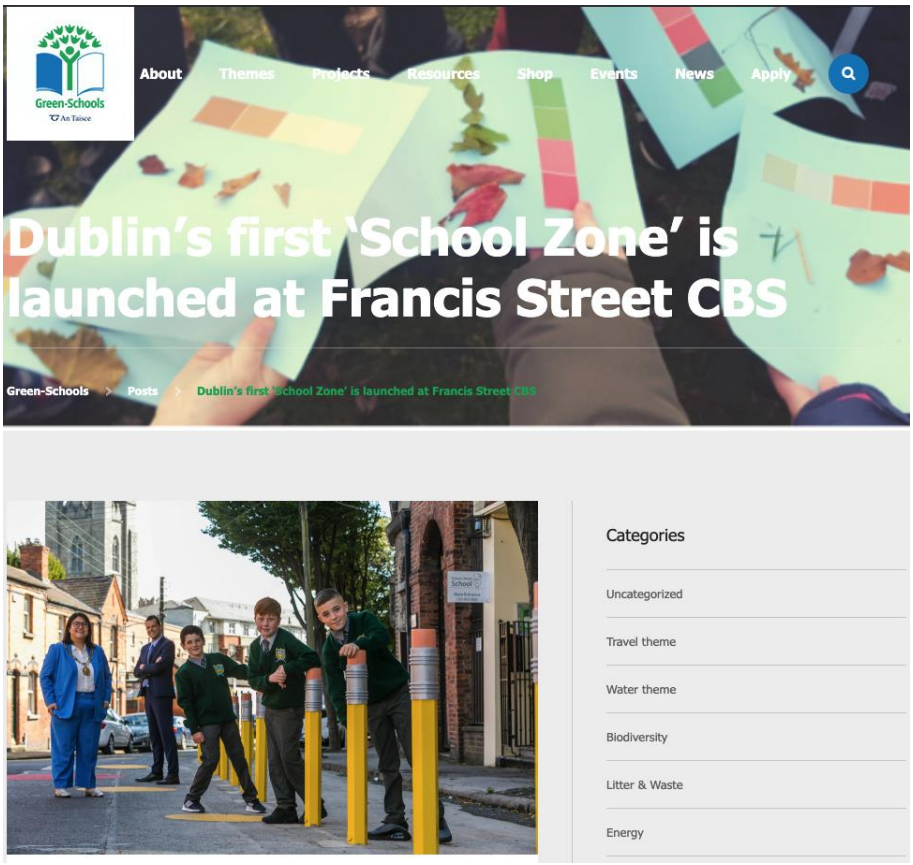
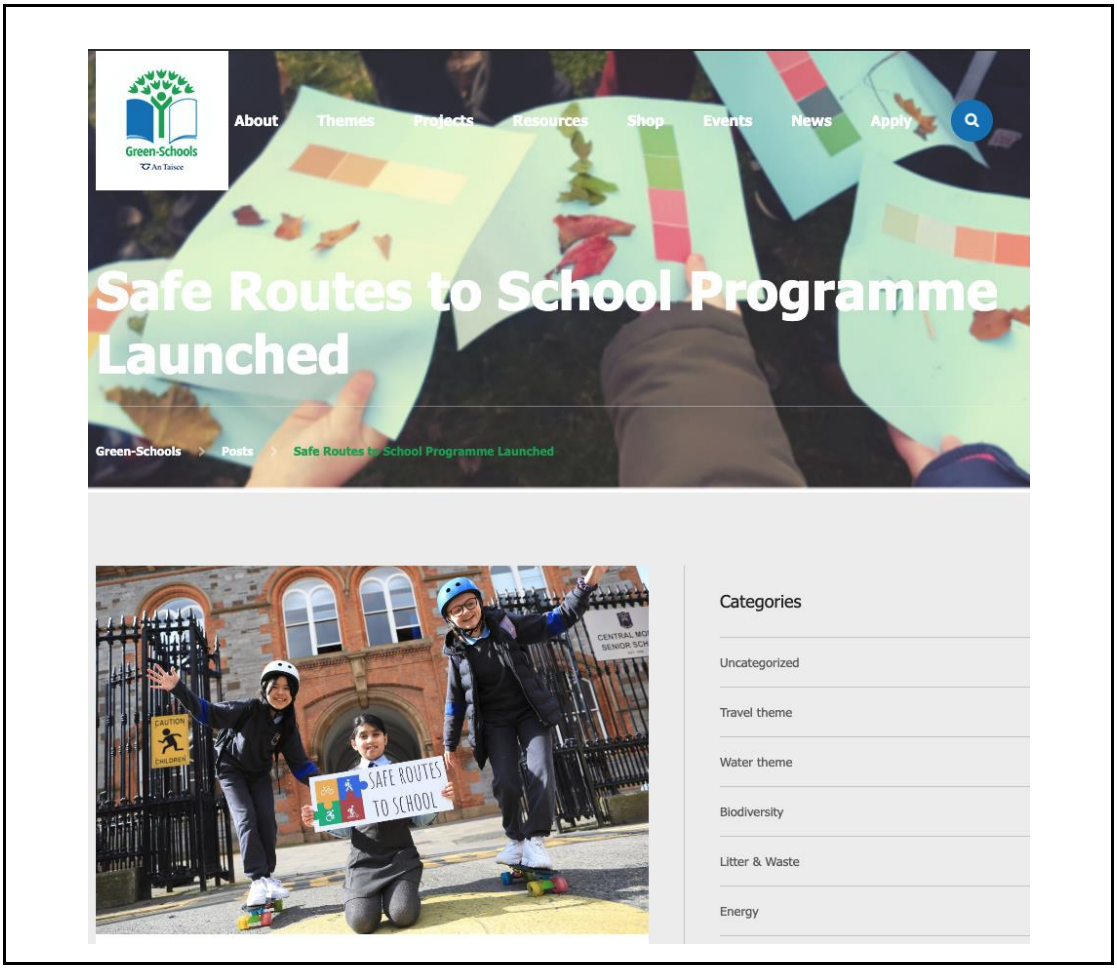
illegal parking (see Figure 10 & 40). These design features assist in creating a safer, calmer, more attractive environment at the school gate.

- "*Safe Routes to School*" which is run by the Department of Transport and supported by the Department of Education at National level. It is operated by the Green-Schools Programme in partnership with the National Transport Authority (NTA) and the local authorities. The Safe Routes to School Programme is designed to encourage as many pupils and students as possible in primary and post-primary schools to walk and cycle. It has three aims: to accelerate the delivery of walking/scooting and cycling infrastructure on key access routes to schools; to provide "front of school" treatments which will enhance access to your school grounds; to expand the amount of bike parking available at schools (Figure 40)

Figure 40: School Zone and Safe Route to School initiatives





We are also pursuing the co-development of Policy Proposals with local communities to target traffic related issues which are outside the topic of schools. We have developed a series of Data Analysis tools as detailed above which will facilitate and enable actions based on both the experience and the findings of the case study. In this way, we distinguish between three types of actions towards reaching policy makers, which are tackled separately below. These are:

- Actions and future activities co-designed together with participants at the participatory data analysis and awareness workshops.
- Actions we, as case study leaders, undertook and plan to carry out to connect with the policy domain and to transfer the knowledge and findings to relevant stakeholders.
- Actions carried out independently by WeCount communities to pursue their own interests and, sometimes, existing agendas.

More generally, from the results of the analysis conducted with participating citizens, we will compile a report including the various policy proposals prepared by the local communities we engaged as part of the project, which are willing to go ahead with this action. This will include an overview of the findings as well as a collection of ideas that citizens collectively believe to be useful in representing the current mobility situations in their streets and neighbourhoods, and that can therefore be relevant for local authorities.

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5 Reflection, Legacy, and Conclusions

The last phase of the WeCount pilots in Ireland will be about reflecting on the overall process, as well as the outputs and outcomes of the intervention, and on planning for the legacy of a number of selected case studies. The selection of the case studies will be based on the interest of the local community to maintain the sensors and use the data for policy proposals or other deliberation processes. As the overall process is not yet closed, this section of the report includes some of the lessons learned from different case studies to date, as well as reflections on what worked well and what did not across all the different phases.

Overall, each case study was carried out consistently with the latest knowledge on citizen science and following the lesson learnt from the case studies in Spain and Belgium. Participating citizens have been actively involved throughout the different phases, and it can be argued that the approach as a whole has been fully citizen centric. Citizens have guided and informed each phase of the research project, from problem formulation, through the co-design of the intervention and, in future, within the analysis, reflection and legacy phases. This ensures alignment with PE1, PE3, PE10 of the MORRI dimensions. Similarly, the main scope of our activities has not changed and thus is expected to contribute, directly or indirectly, to all the SDGs listed in the proposal.

In terms of legacy, the various pilots in Ireland have left several contributions with important impacts in terms of self-sustainability and longevity of the WeCount work. One of the main objectives of the project was to leave as a legacy a set of knowledge transfer resources as well as research and innovation tools to enable other communities to replicate the experience of the Irish case study or for other research and public bodies to undertake other similar citizen science actions in the future. The WeCount Citizen Engagement Toolkit (WP2) includes videos and printed tutorials for assembling and installing the Telraam sensor, a printed step by step installation guide as well as a spoken video tutorial for this process. We also produced a guide on how to install and run the air quality sensors. We have developed a series of data analysis tools that can be used by non-technical people to extract valuable insights from the data. These tools are described in detail in the previous sections of this report. As part of WP2, these resources will be uploaded online into existing citizen science platforms and will also be included in the local website, so it can become a one-stop place for future adopters where all information and resources needed to replicate WeCount can be found, accessed, downloaded, and adapted.

The feedback gathered from the engaged local communities helped in improve the user experience with the Telraam sensors and platform. The local communities provided a lot of useful feedback on issues related to our technology and most of the times also hands on and practical suggestions on how to improve them. The continuous dialogue with our citizen scientists allowed also to identify some limitations of the algorithms, such as the need of a 2-3 weeks calibration time to provide correct estimates of heavy vehicles, some errors in people and cyclists counts when these are moving in groups, counting errors in low traffic areas, etc. Our citizen scientists also helped in overcoming some physical limitations of the Telraam sensor related to the need of a clear view of the road, which is often not possible in schools because of the boundary walls. Our community champion in the local community of Castleknock in Dublin developed an outdoor environmental enclosure for the Telraam sensor which allowed for it to be installed on boundary walls and thus have a clear view of the road. The community champion also developed a set of instructions so schools and interested citizens could build the same enclosure for their sensor (Figure below). The instructions include also a set of files to print some parts of the enclosuree with a 3D printer, if available.

Figure 41: Outdoor enclosure developed by community champion

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Because of the high interest from local communities, we believe that the WeCount approach can be further expanded across all Irish cities, towns, and villages. The themes of more adequate cycling infrastructure and lower level of traffic around schools are common denominators for most of the local communities we engaged and we strongly believe, due to the feedback on social media, that these would be the catalysers for a further expansion of the work in Ireland. We found that the support of the national news, the activity on the social media and the engagement with climate action and sustainable mobility activism groups has been critical for the expansion of our work in Ireland, so we are planning further activities using these channels to continue the engagement of local communities and schools.

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Appendix 1: Stakeholder Engagement

1.1 Initial engagement with Greater Dublin areas

Area	Type	Interactions
Monkstown	Volunteer group	Email
Crumlin	Volunteer group	Email
Blackrock	Community champion	Email
Swords	Council	Email
Stillorgan	Community champion	Email
Balbriggan	Council	Email and video call
Dublin West	Community champion	Email
Ballymun	Council	Email
Crumlin	Community champion	Email
Phibsborough	Community arts festival	Email and video call
Smart Sandyford	Council	Email
Dun Laoghaire	Council	Email and video call
Dun Laoghaire	Community champion	Email
Phibsborough	Volunteer group	Email
Glasthule	Community champion	Email
Windy Arbour	Community champion	Email
Sandymount	Community champion	Email
Malahide	Community champion	Email
Drimnagh	Community champion	Email
Monkstown	Community champion	Email
Goatstown	Community champion	Email
Monkstown	Community champion	Email
Sallynoggin	Community champion	Email
Foxrock	Community champion	Email
Stoneybatter	Volunteer group	Email
Ludford	Volunteer group	Email
Killarney	Volunteer group	Email
Drummartin	Volunteer group	Email
Dundrum	Volunteer group	Email
Dun Laoghaire/Rathdown	Volunteer group	Email
North East Inner City	Volunteer group	Email
Harold's cross/Terenure	Volunteer group	Email

1.2 Schools

School	Council
Tallaght	South Dublin

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School	Council
Trinity Comprehensive School	Fingal
Ringsend College	Dublin City
Ringsend Youth Centre	Dublin City
Ballsbridge	Dublin City
Ranelagh Multi-Denominational School (RMDS)	Dublin City
Ballymun	Fingal
Guardian Angels National School	Dún Laoghaire-Rathdown
Swords	Fingal
Blackrock Newpark Comprehensive School	Dún Laoghaire-Rathdown
St Andrews College	Dún Laoghaire-Rathdown
Harold's Cross HCETSS	Dublin City
Synge Street CBS	Dublin City
Belmayne Educate Together National School	Fingal
Scoil an tSeachtar	Fingal
Dalkey School Project (DSPNS)	Dún Laoghaire-Rathdown
Gonzaga College SJ	Dublin City
Scoil Úna Naofa	Dublin City
Loreto College	Dublin City
Marist National School	Dublin City
Rosary College	Dublin City
Scoil Mhuire Og 1	Dublin City
Scoil Eoin	Dublin City
St Vincent de Paul Girls' School Marino	Dublin City
Rosary College Crumlin	Dublin City
St. Mary's Secondary School	Fingal
Our Lady of Good Counsel GNS	Dublin City
Griffith Avenue	Dublin City
Santa Sabina	Fingal
Muckross Park College	Dublin City
Oatlands primary school	Dún Laoghaire-Rathdown
St Joseph's national school	Dún Laoghaire-Rathdown
Gonzaga College, Sandford Road in Ranelagh	DCC
Scoil Mhuire Marino on Griffith Avenue, Dublin 9	Dublin City
Grace Park Educate Together	Dublin City
Newpark Comprehensive School	Dún Laoghaire-Rathdown
Kildare Place School	Dublin City
Synge Street CBS	Dublin City

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School	Council
St Marys School	Fingal
Santa Sabina	Fingal
Canal Way ETNS	Dublin City
Our Lady of Mercy	Dublin City
Drimnagh Castle PS	Dublin City
Christ The King Boys National School	Dublin City
St John Bosco Senior Boys School	Dublin City
Drimnagh Castle CBS	Dublin City
Belmayne Educate Together	Dublin City

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WeCount: Citizens Observing Urban Transport

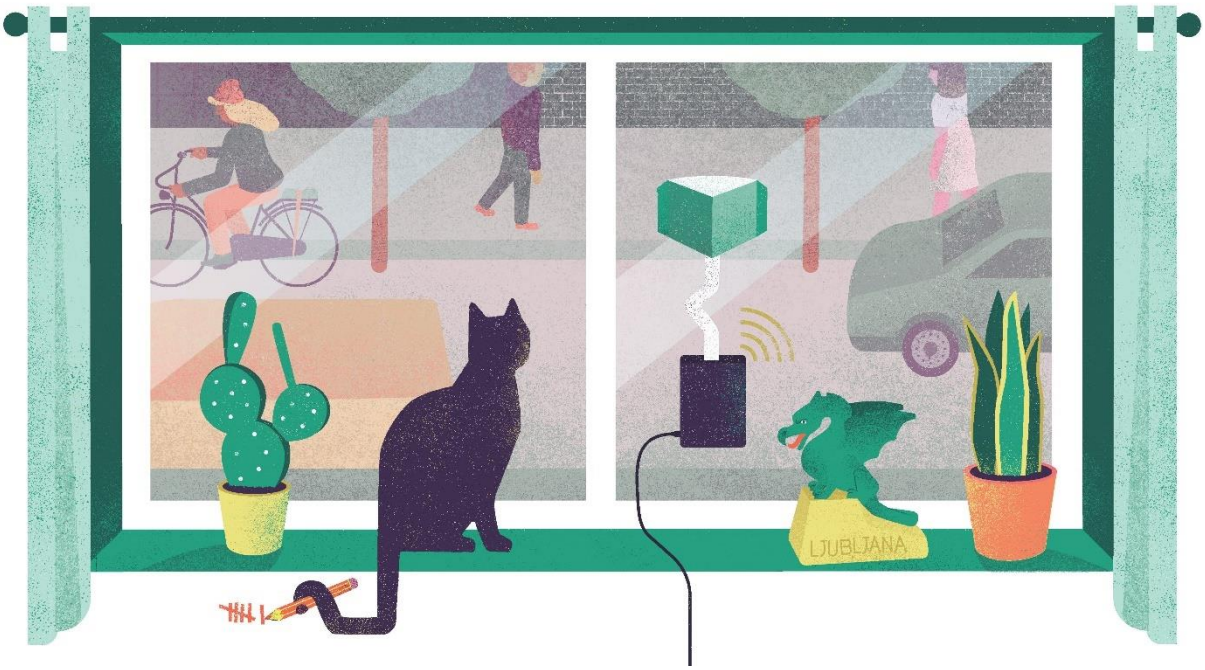
Deliverable 4.2: Summative Case Study Report – Ljubljana

PART C: Ljubljana, Slovenia

Report for:
European Commission
Research Executive Agency (**REA)**

Date: May 2021

Authors: Lucija Ažman Momirski, Tomaž Berčič, Anja Bagon, Jon Šinkovec



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Document Details

Authors	Lucija Ažman Momirski,, Tomaž Berčič, Anja Bagon, Jon Šinkovec
Contact	Lucija.azman@fa.uni-lj.si
Creation Date	March 2021
Date of Last Revision	June 2021
Description	This report provides a detailed description and reflection on all activities and outcomes from the WeCount case study in Ljubljana. The report follows the structure of the tasks within the work package, i.e. scoping and community building, co-design, data collection, data analysis and awareness, and reflection and legacy.

Version History

Version	Updated By	Date	Changes / Comments
1.0	Anja Bagon	17/3/21	Outline
1.1	Anja Bagon, Jon Šinkovec	20/4/21	1st draft
1.2	Anja Bagon, Jon Šinkovec, Tomaž Berčič	3/5/2021	2nd draft
2.0	Anja Bagon, Jon Šinkovec, Tomaž Berčič	25/5/2021	Final draft
2.1	Lucija Ažman Momirski	16/6/2021	Final version

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Contents

The WeCount Project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 872743

1 Introduction

The first Slovenian sensor started counting in December 2019 and has been active for more than a year. In line with the citizen science approach adopted from the pilot studies, participating citizens have taken a proactive role in all stages of the case study, from problem formulation and co-creation, data collection and analysis, to planning and implementing the resulting actions based on the case study findings and experiences.

After an initial study in Ljubljana, the decision was made to expand the case study outside Ljubljana area to Novo mesto and the coastal part of Slovenia. This was done for two main reasons: a strong local champion activity in Novo mesto and in the Primorska region. The second reason was an early recognition of the difficulty in finding suitable locations for Telraam sensor installation due to the "Green City" policy in Ljubljana, which was the European Green Capital in 2014, and concerns about COVID-19.

At the time of writing there are 45 users in Ljubljana who are currently counting, 16 who have already counted, 28 who have never started counting but have the device, 89 registered users and 170 memberships. In Primorska region there are 6 users who are currently counting, 7 who have never started counting, 13 registered users and 11 memberships. In Novo mesto we have 3 users who are counting now, 3 users who never started counting but have the device, 6 registered users and 11 memberships.

The case study in Ljubljana leaves important legacies, such as the knowledge of how to approach people, what strategies work best in the Slovenian environment, and a complete guide on how to extend the case study to other neighbourhoods and cities in the country.

This report provides a comprehensive description of the activities undertaken as part of the Slovenian case study. This document is therefore structured as follows. Section 2 is dedicated to the activities related to Scoping, Community Building and Co-Design throughout the case study. Sections 3 and 4 focus on data collection and analysis, respectively. In Section 5, we reflect on the legacy of the case study and planned actions for the future. In these sections, we draw lessons and reflect on expected and unexpected impacts that occurred during the case study.

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2 Scoping, co-designing and community building the local citizen science activity

This chapter provides a detailed description of the actions and interactions undertaken during the case study in relation to the scoping and co-design of the intervention, as well as the ongoing efforts in exploring, building, establishing, sustaining and utilising diverse communities of different stakeholders in WeCount in Slovenia.

Secondly, Chapter 2 is about describing the efforts that have been made to find and identify local communities, individuals and anyone who is either interested in bringing about change in local transport, who has the power to decide on transport planning, or technology enthusiasts who are interested in using new technologies in obtaining data.

Primarily in the case of the Ljubljana study, the focus was on cycling and identifying cycling corridors. Therefore, in the first phase of identifying communities, we focused on finding associations and networks that are more sustainable, have green transport policies and of course concentrate most on cyclists.

In the next phase of the project we changed our strategy and widened our search parameters, mainly due to the poor response. We focused on educational institutions that would cover the younger population, PGD's (volunteer fire services) that play a prominent role in the local communities and anyone who might be interested in the project. Because of the local champions and the architectural and social context in Slovenia, we expanded our original network in Ljubljana with two new local networks in Novo mesto and the Primorska region.

We have set up the following social networks to increase local community participation in citizen science activities. Once a new local champion emerges, tools are available to spread the news and connect new people via social media and explain the possibilities of WeCount: Facebook (WeCount Slovenija) - spreading news, sharing events and tutorials; Twitter (WeCount Ljubljana) - spreading news, sharing events and tutorials, LinkedIn (WeCount Ljubljana) - expanding the network; YouTube (WeCount Ljubljana) - sharing tutorials (in preparation). We published four articles in professional journals (non-scientific publications).

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2.1 Slovenian infrastructural and architectural context

After the great initial interest in participating in the WeCount study and adopting a Telraam sensor, it turned out that many volunteers did not have a suitable window view of the street they wanted to monitor. We thoroughly investigated the suitability of Telraam technology for the Slovenian infrastructural and architectural context, where the urban design differs significantly from that in Belgium, where the technology has been developed, tested and already deployed. It quickly became clear that the locations that meet the requirements for reliable and effective data collection are far fewer than we had expected.

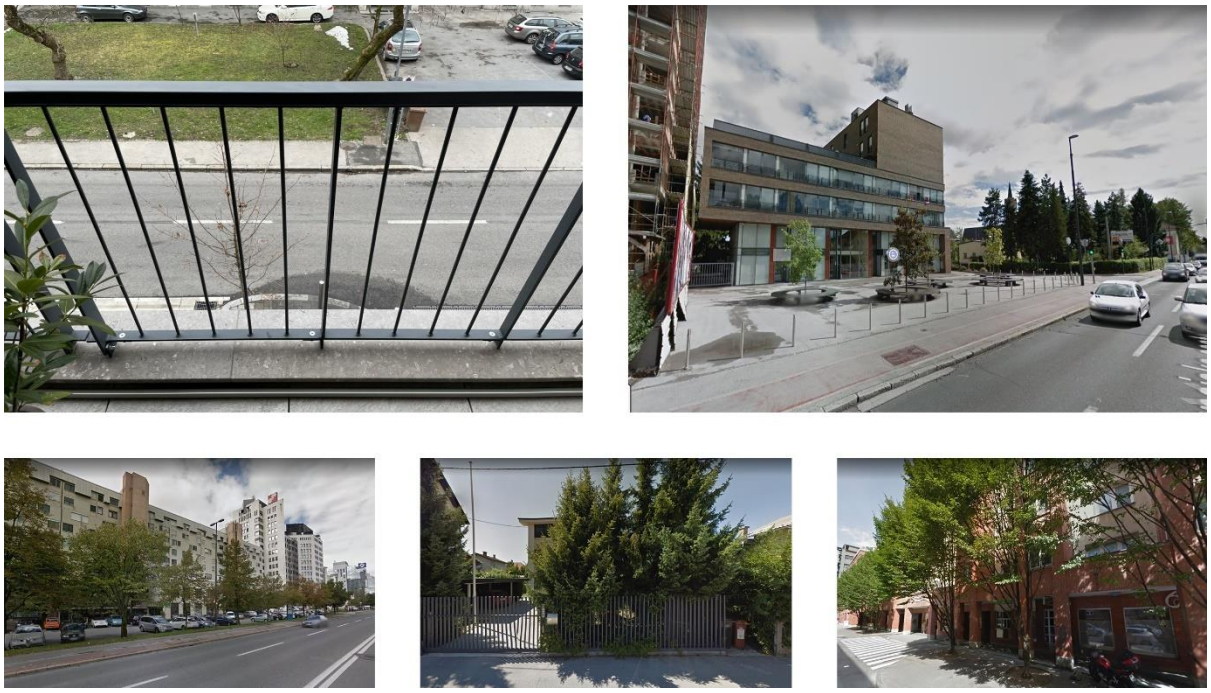

Figure 1: Urban layout of Ljubljana in most cases does not offer suitable locations for the installation of a Telraam sensor.

This is mainly due to the particular urban layout of Ljubljana, which in the vast majority of cases does not offer suitable locations for the installation of a Telraam sensor (i.e. suitable views from the windows) (Figure 1). The first obstacle was a great number of trees planted in the streets, which obstructed the view of the traffic. Ljubljana proudly holds the title of European Green Capital 2016. The second obstacle was either the distance from the selected street, which is significantly greater than 15 m, or an apartment on the upper floors, which disqualifies the selected window for positioning of the Telraam sensor.

Few of Ljubljana's (Slovenia's) hurdles to Telraam sensor placement:

- Trees or other greenery that obscures the view to the street,
- Traffic signs, urban lights or other part of electrical infrastructure,
- The distance from the selected window to the street is too great,
- Balconies or loggias,
- In general, there are few apartments directly facing the streets. Most apartments are facing inner gardens or parks. Most of the buildings directly facing the street are mostly offices, schools, office buildings, shops ect.

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2.2 Codesign effort before engaging the pre-pilot

The first sensor was installed directly after the first partner meeting in Leuven in December 2019. From the beginning, the pilot members recognised the obstacles of the sensor design and, tried to make the sensor package more subtle and less intrusive.

Proposals were sent to the core Lead partners team as early as December 6, 2019. The proposals focused on a more compact sensor design made of equal parts. The first proposal focused on making the sensor more compact and less reminiscent of a monitoring device, and adding a longer power cord, eliminating the need for extension cords.

The second proposal focused on a simpler setup, reducing the need for long camera cables and eliminating the need to apply black anti-reflective tape, thus avoiding reflections from flat camera connexion cables (Figure 2). The third benefit would be cost effective because the long flat camera cable would not need to be ordered and would make the device 5-10% cheaper or at least offset the cost of the longer power cable.

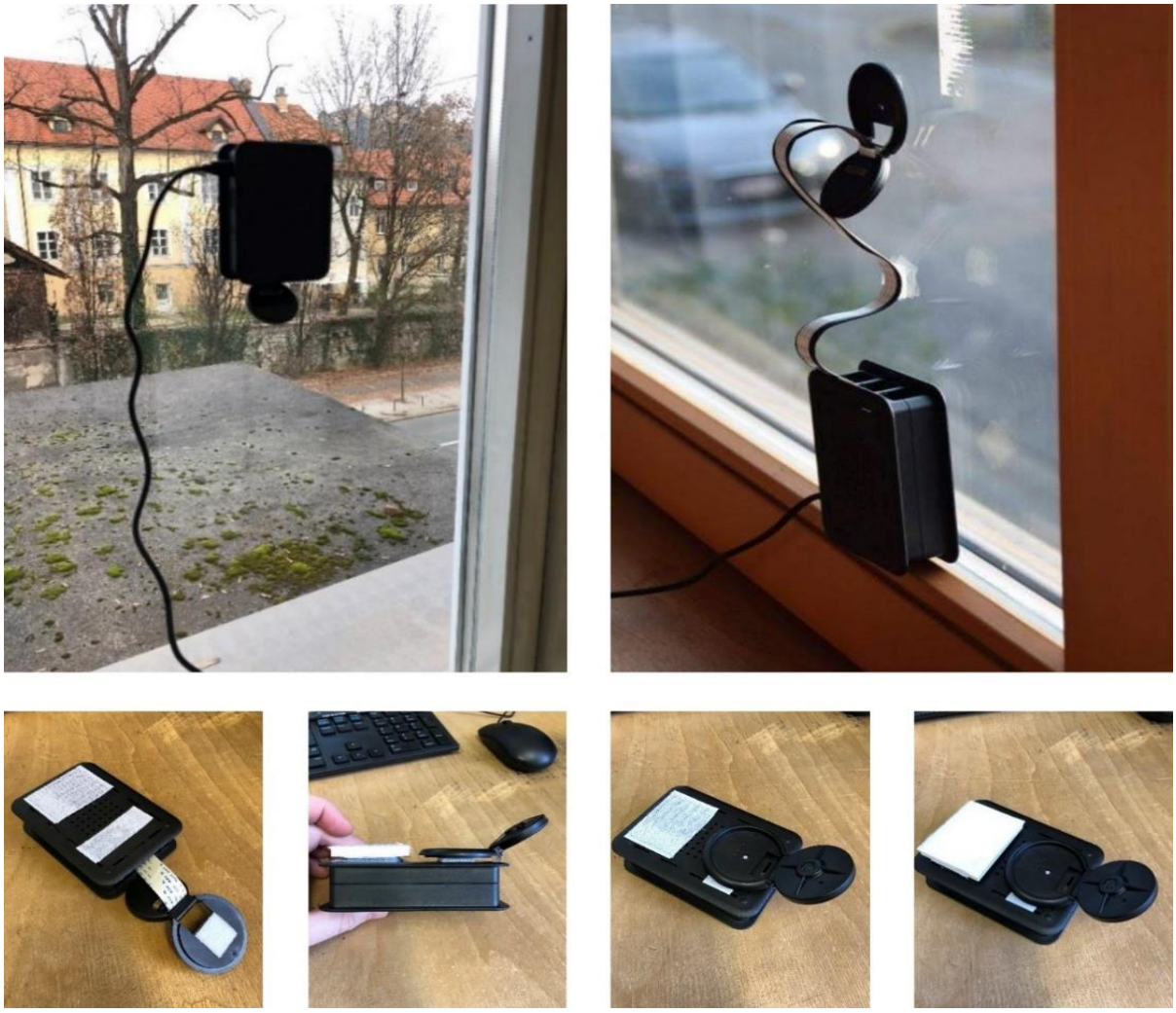

Figure 2: A simpler setup, shorter camera cables and eliminated need to apply black anti-reflective tape, thus avoiding reflections.

We also highlighted that at this early stage, the Telraam sensor has difficulty connecting to local Wi-Fi and often requires a reboot.

Discussions are currently underway with Mr. Ambrož of Nova Gorica about the possibility of involving the local school and its students in the design and manufacture of the outer case. As part of the

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engineering and technology course, the students, with the help of the professors, will attempt to design a waterproof housing for the Telraam device that would allow them to install the Telraam device at a local school.

2.3 Beta Pilot for known and unknown participants

Before investigating concerns, it is important to gain a good understanding of the local mobility context. Desk research, interviews with city officials and citizens in the different city districts gave us a deeper insight into the local situation. Desk research, interviews with city officials, facilitators, and citizens, as well as our own experience and knowledge from the participation projects carried out in Leuven and Barcelona, gave us an understanding of the local mobility context and an insight into citizens' concerns.

An interesting input to consider is the local press and social media. In relation to the latter, it was worth exploring local Facebook groups to gather concerns about mobility, general issues as well as very specific and localisable problems.

Telraam sensor installation for known participants

Consistent with the methodology adopted in this case study, a Beta-Pilot initiative was undertaken whereby the full methodology has been through the engagement of a limited amount of people in Ljubljana.

The analysis of motivations gives great insight into two aspects that shape the narrative. One part of the motivations tells us something about perceived concerns: slow traffic, speed, traffic, ... Another part tells us something about what people want to do with the data and how they might want to contribute: get insight into local mobility, contribute to local policy making.

In Ljubljana, based on an exchange of experiences from Leuven and Barcelona/Madrid in June 2020, we started the pre-pilot registrations to known participants. Each member of the research team approached potential research participant/acquaintance with a verified window to install the device.

The purpose of recruiting acquaintances was to review the registration process, identify potential issues, and review participants' experiences installing the Telraam device. By keeping communication simple and open and being present in person for all registration steps and installation, we received important feedback for the continued smooth running of the survey. As part of the beta phase of the pre-pilot, a pre-workshop was also organized at the Faculty of Architecture for known participants.

In the pre-pilot, 8 devices were installed by acquaintances, members of the research team and participants of the pre-pilot workshop.

First pre-pilot workshop

The pre-pilot workshop was organised on the 16th of June 2020 (Figure 3). There were 17 participants present, four of whom decided to count traffic with the Telraam sensor (as volunteers), 11 of whom volunteered as observers.

The workshop was as an important for defining the scope and extent of the following workshops. The participants were informed about the registration process, installation procedure of the device, what data analysis can be seen from the graphs on the Telraam website.

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Pre-registration Membership	Pre-registration Users	Pre-registration installed Telraam
10	10	8

Table 1: The table shows the number of applications and installed devices in the pre-registration process.

Figure 3:The first pre-pilot workshop was organised on the 16th of June 2020 for 17 participants.

Lessons learned

The response from the workshop participants was positive, there was a lot of interest in the research, but after the workshop there were not many applications for traffic counting. The main reason was an unsuitable window placement. After the workshop and evaluation, we decided that the workshops should be divided into two parts. The first part is an explanation of the project and the registration procedure. The participants of the first part of the workshop who have a suitable window placement will then attend the second part where we explain the installation process of the Telraam device.

2.4 WeCount Stakeholders Ecosystem Mapping and Engagement

The strategy to identify and determine the stakeholders that would form the WeCount ecosystem was summarized by adapting to the local environment with emphasizing cycling network, following the already known practices from Leuven and Madrid /Barcelona who identified stakeholders who might be interested

in the project, who work in the field of sustainable transport development or have a large social media following and would be willing to take on the role of local champion.

In the case study in Ljubljana, substantial efforts were made to understand the relevant audience, address relevant actors and engage them at different levels. These activities were crucial for building the community and engaging key actors and institutions. The first step was to conduct secondary research based on the initial engagement activities to map potential stakeholders in Ljubljana beta pilot.

Given the modest response from stakeholders and the high proportion of unsuitable sites (windows) for installation of the device, the research group changed the strategy of approaching, recruiting and identifying potential research participants. We focused on targeting stakeholders with suitable window locations for installation of the Telraam device.

Ethics Commission University of Ljubljana

Before we could conduct the research, we had to obtain ethical approval from the Ethics Committee of the University of Ljubljana. This involved a lot of work, because we had to prepare an application explaining all aspects of the research. We had to meet all the requirements of the committee. In addition to the basic data of the research description, the application also included the planned research participants, the course of the research, the research plan, the procedure, the plan for the confidentiality of the data and the evaluation of the possible risks and benefits of the collaboration.
The application received a positive decision on 15.6.2020.

Targeted approach

With the findings from the first phase of identifying potential stakeholders, the research group changed the strategy for identifying appropriate stakeholders. We started with the reverse order of stakeholder identification.

In the first step, we investigated and evaluated suitable sites that could be considered for the installation of the Telraam device. Factors that influenced further identification (mapping) of suitable stakeholders were an unobstructed view of the street, appropriate height of the window, and willingness to participate in the project. We conducted many site visits and investigated potential locations using Street View in Google Maps. Once we had selected suitable locations/street sections, we began to search for suitable stakeholders. We contacted many companies, schools, associations with premises/offices in selected locations. Many presentations of the project and invitations to the survey were made live, which contributed significantly to increasing the number of registrations and thus the installation of Telraam devices. The new strategy proved successful, but implementation was prematurely interrupted by actions related to COVID-19. Educational institutions went into lockdown, working from home was ordered, which made it impossible to present the project in person to selected stakeholders, which in our case proved to be extremely successful. We implemented the new strategy of stakeholder acquisition from the end of August to mid-October 2020.

	Educational Institutions	**Businesses**	**Local association**
No. contacted/installed devices	16/10	10/3	12/5

Table 2: Table shows how many devices were installed and how many institutions contacted.

Out of 16 educational institutions contacted, 10 opted to install the device in their building. 3 out of 10 businesses were interested in installing Telraam on their window. 12 local associations were contacted and 5 decided to install Telraam.

People had no problem with installation of the sensor on their window but were mostly not interested in maintaining and taking care of the device.

As the turnout with organising the workshop was quite disappointing, we tried different approach. We moved the campaign online to try and get in touch with larger number of people as well as targeting specific groups.

The biggest problem we approached was large number of people interested about the project but not having suitable window.

2.4.1 Citizen Communities and Civic Society

Various citizen communities and other individually interested local actors are not necessarily the citizen scientists who install a Telraam sensor, but they are important actors in communicating about WeCount project, publicizing the results of data analysis, taking the initiative for local action, and building bridges with other citizens and with policy makers.

In the spirit of the train-the-trainer approach, this stakeholder category was clearly the focus of the case study. The goal was clear: engage community champions, position WeCount within their existing interests and domains, and involve them in the case study.

2.4.2 Local and State Government connections with the WeCount project

Together with the civic communities, reaching out to relevant public agencies was one of the most important goals of the engagement for several reasons:

- A reason to ensure from the outset that WeCount was positioned within existing activities, interests, and policies.
- To make certain that the results of the project can be used and adopted in the wider scale.
- A bridge to policy level decision makers.

Municipality Ljubljana

In early September 2020, we contacted the City of Ljubljana to participate in the WeCount project survey. Due to the lack of suitable windows, a dialog was initiated with the municipality, as their offices are usually located throughout Ljubljana and have suitable windows overlooking local streets or pedestrian areas to house the Telraam sensors.

The first step was to organize a meeting with the director of the Ljubljana Municipality administration, where the WeCount project was presented in detail, the possibility of municipal participation in the project, we presented the Telraam sensor for counting traffic and the interpretation of the obtained data. The project was met with great interest, especially after the presentation of the potential benefits of traffic counting data on the Telraam platform.

Before participating in the study, it was necessary to agree on the terms of cooperation, so we prepared a comprehensive application for cooperation, which was positively approved and signed by the Mayor of the City of Ljubljana at the end of November. It was agreed that the employees of MOL would approach the study as volunteers and use the Telraam sensors installed in the offices of the administration of MOL.

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A comprehensive analysis of the buildings where the services of City Administration are located was carried out and all suitable sites were visited. We have selected 10 locations where a Telraam device can be installed. At the time of writing, dates are being co-ordinated for the installation of the devices in the buildings of MOL.

The Slovenian government is currently preparing an amendment to the Transport Act, which will also consider the increasing use of electric scooters in transport. Therefore, the hope of the city administration was that the Telraam sensor would be able to provide detailed statistics about electric scooters, but as it turned out, the sensor does not have this capability. Anyway, the reaction of the city of Ljubljana regarding participation in the WeCount project was positive.

Short timeline:

- First contact, email request to participate 7.9.2020
- Project Presentation Appointment 14.10.2020
- Meeting for the submission of applications for cooperation 19.10.2020
- Approval of cooperation by the Mayor 20.11.2020
- Visiting window locations to install Telraam devices 9.3.2020

Meeting with the Ministry of Infrastructure

In August 2020, we organized a presentation of the project at the Ministry of Infrastructure in the Platform Department for Sustainable Mobility. The purpose of the presentation was to explore the possibility of participating in the European Mobility Week and to promote the project. The response was very positive, but unfortunately no cooperation was achieved. The SPTM was an initiative to extend the research to the whole of Slovenia, but we did not decide to expand the network.

Short timeline:

- WeCount presentation meeting 18.8.2020

2.4.3 Local citizen communities and associations

Ljubljana Cycling Network (1st local champion)

Ljubljana Cycling Network (LKM) is a local association for the promotion of cycling and sustainable transport, working in the public interest in the field of prevention and safety in road traffic. In the preparatory phase of the WeCount project, Ljubljana Cycling Network signed a letter of intent to participate in the WeCount project.

In July 2020, in cooperation with Ljubljana Cycling Network, we prepared a workshop at LKM's premises for all interested association members and followers of LKM's page FB, which is followed by 3378 followers. The aim was to introduce the WeCount project and the possibility to get involved in the research, increase knowledge about citizen participation and improve their living environment.

We promoted the event through their primary information outlet - their Facebook page. 13 people were interested in attending, but in the end we did not receive any submission of registration to participate, or no one signed up. The workshop was cancelled and postponed.

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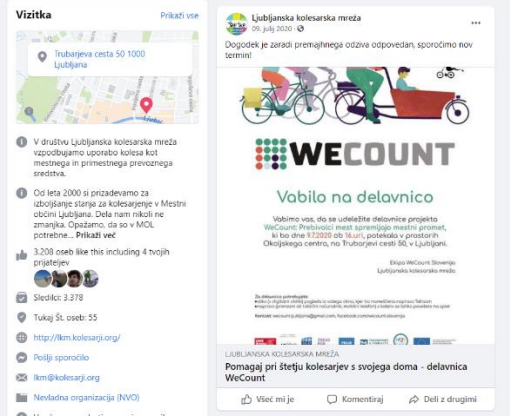

Figure 4: We promoted the event through their primary information outlet - their Facebook page.

Short timeline:

- Workshop cancellation 9.7.2020

Voluntary Fire Brigades (PGD) of The Municipality of Ljubljana

The volunteer fire brigades in Ljubljana and Slovenia operate as public fire brigades with a humanitarian character. They include volunteers of all ages, genders and professions and are integrated into the civil society of each local community. Each association has its own fire station scattered throughout the city.
In January, we conducted an analysis of the locations of the individual fire brigades in the city of Ljubljana, investigated the suitability of the sites for the installation of the device and prepared a communication plan according to the possibility of participation in the project.

The fire brigades with the optimal building locations were contacted and the WeCount project was presented. The personal contact contributed a lot to the positive response, as we were able to answer many questions live.

After individual fire departments agreed to cooperate, we supplied the Telraam sensors, assisted them with the installation and the evaluation of the data obtained.

Despite the great willingness to cooperate, the biggest obstacle during installation was the unsuitable view and configuration of the individual WIFIs.

Short timeline:

- 12.2.2021 WeCount presentation meeting and sensor installation PGD Črnuče.
- 12.2.2021 WeCount presentation meeting and sensor installation PGD Šmartno ob Savi
- 12.2.2021 WeCount presentation meeting and sensor installation PGD Barje
- 9.3.2021 WeCount presentation meeting and sensor installation PGD Vič
- 10.3.2021 WeCount presentation meeting and sensor installation PGD Ježica
- 12.4.2021 WeCount presentation meeting PGD Stanežiče

AMZS

AMZS is the National Automobile Federation and the National Sports Federation for motorsports and karting. We started working together in July 2020 when we introduced the WeCount project. The presentation of the project took place in the premises of AMZS, with Mr. Konstanjšek, Secretary-General of AMZS. Mr. Konstanjšek is also a partner and expert in a private company dealing with traffic counting.

One Telraam device was installed at the AMZS site on Dunajska Cesta in Ljubljana.

Short timeline:

- 15.7.2020 WeCount presentation meeting

2.4.4 Private sector

In terms of private companies, we first identified and then targeted companies operating either in the context of sustainable mobility or in the broader field of social innovation. The targeted approach worked well. The identified stakeholders were contacted via direct emails.

Following the change in strategy of recruiting interested participants, we contacted or made live presentations to several private sector companies. After successful presentations we delivered 3 devices along Dunajska cesta and helped with installation. The reactions to the project were very positive, but the main problem was the configuration of Wi- FI and the concern after the intrusion into the company network.

In September we contacted the company Mladinska knjiga, which sells books and school supplies. They have their branches scattered all over the city and have suitable conditions for installing equipment. We presented the project to them on the phone and started coordinating the cooperation. In October, because of the restrictive measures COVID-19 the shops for non-essential goods were closed and no cooperation took place.

2.4.5 Schools and Academia

In the integration strategy of onboarding new participants, we have placed great emphasis on cooperation with educational institutions in Ljubljana. We have developed a strategy to invite interested high school and university students to install the device, while organizing presentation workshops.

In August 2020, we conducted an analysis of the locations of surrounding schools and contacted selected schools and faculties suitable for the installation of the sensor device. We conducted live presentations of the project in educational institutions. The vast majority were willing to cooperate by either installing the device on the building, agreeing to organize a demonstration workshop for students, and including the project as a topic in various clubs.

However, in October 2020, due to the COVID-19 pandemic, the decision was made to close schools and faculties in Slovenia, so many of the already agreed presentations were cancelled.

At Ledina Gymnasium we approached the headmaster in September and presented the WeCount project in detail. We agreed to install two devices in the school building and organized two live presentation workshops as part of the computer lessons. The installed devices did not work due to inadequate configuration of School Wi-Fi Network (WPA2 Enterprise). The workshops were successfully conducted, but there was little interest in participating in the project.

We required parental permission for minors to participate in the project.
We organized two workshops at Ledina High School as part of the computer science class. However, the students were not motivated enough to participate further as the subject was not a compulsory subject for them.

LEDINA	MALE	FEMALE	TOTAL	AGE	MEMBERSHIP/USER
1.skupina	14	16	30	16-24	1
2.skupina	15	15	30	16-24	0

Table 3: Workshop statistics.

Both groups consisted of 30 students. 14 males and 16 females in the first group and 15 males and 15 females in the second. They ranged in age from 16 to 24. One student decided to become a member and install the Tleraam device on her window.

At the Jože Plečnik Gimansium School in Ljubljana and the Ljubljana Secondary School Centre we organized a presentation of the WeCount project with the school principals and teachers of computer education in August and September 2020. Due to the positive response and interest in monitoring traffic around schools, we reached an agreement for the installation of four devices.

In August and September 2020, the presentation of the project was organised by the headmasters of Šentvid Grammar School, Bežigrad Grammar School, Prule Elementary School, Prežihov Voranc Primary School and the Faculty of Theology in the Department of Mathematics. Due to the measures related to COVID-19 and the subsequent closure of schools in October 2020, it was not possible to organize demonstration workshops for students.

At the Electrical and Computer College and Gymnasium Ljubljana we presented the project to the headmaster in September 2020. Due to the very high interest especially in the technical aspect of using the Telraam device, we organized an online demonstration workshop for computer science teachers and the computer club in September 2020. The computer club planned to present the project and the device and to involve the students in the project. Students would learn more about how the device works, assemble it, start counting traffic, and come up with ideas to improve the software code. As a result, the project was included in the computer club's annual program. The realization failed due to restrictions related to COVID -19 and the closure of schools.

For students of the faculty Social Sciences in the 2nd level of the course Social Informatics an online presentation of the Project Telraam was carried out in November in the subject New Technology in Social Research. In the case of the WeCount project and the use of the Telraam device, automatic measurements using new technologies for the needs of social science research were presented, which coincided with the annual syllabus of the course. The presentation was given in English and was well attended.

The University of Ljubljana and ALOU also came to participate in the study (Figure 5). Three devices are installed at the university and one at ALOU. None of the devices work because of the wifi configuration.

Lessons learned

Following input from other project consortium members, schools, and academic institutions (primary, secondary, university) were an important target for the case study. In general, two types of stakeholders in this cluster were approached and, some, eventually engaged:

- Academics with technical knowledge to seek support for hardware adaptation to the infrastructural context.

- Schools and students to be part of the overall case study and/or to set up independent pilots.

Regarding the involvement of schools, they were considered as strategic partnerships as they could act as gatekeepers for younger generations to engage in participatory transport mapping activities and Citizen Science processes in general.

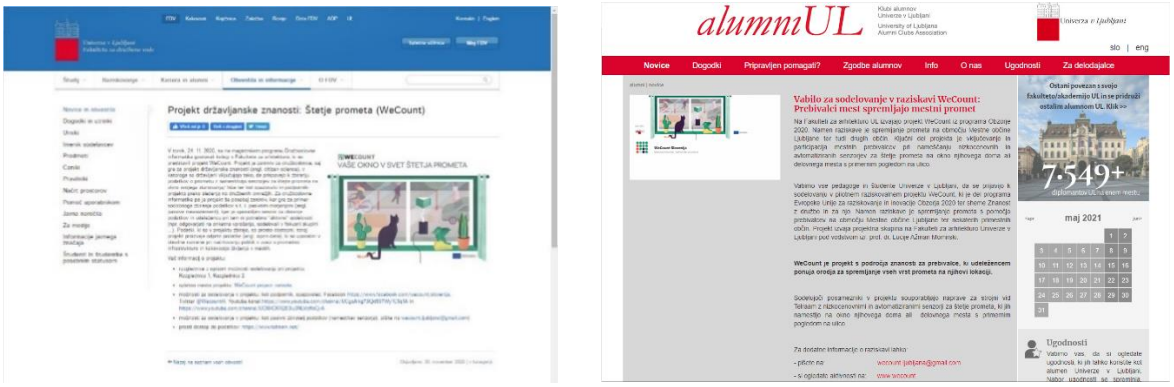

Figure 5: The University of Ljubljana also came to participate in the study and published an article on their website.

University e-mail

As part of the Mobility Week, which took place between 16 and 22 September 2020, an invitation to participate in the WeCount project was sent to UL employees and an article inviting them to participate was posted on the UL website. UL has over 6,000 employees of all ages and professions, so the invitation covered as wide a range of potential participants as possible. The response was very positive and registrations for the project skyrocketed. Mr. Luka Mali from the faculty Electrical Engineering, who later became the local champion for the Novo mesto area, was also introduced to the project for the first time.

University website

As part of the communication infrastructure, a web page was created with all relevant information about the WeCount project. The page is part of the homepage of the Faculty of Architecture in Ljubljana, which contains all basic information about the WeCount project, a short description of the project content, logos and links to the homepages of the participating partners.[1]

Figure 6: The homepage of the Faculty of Architecture in Ljubljana, which contains all basic information about the WeCount project.

[1] http://www.fa.uni-lj.si/default.asp?id=3126

2.5 Communication and Dissemination

In the case study of Ljubljana, a considerable amount of effort was put into communication and dissemination activities.

The first step was to define a strategy to promote the project in the most effective way. The tools we used were:

- Press release in various magazines,
- Social media (Facebook, Twitter, LinkedIn, Instagram, Youtube),
- Email communication with active citizens (local champions),
- Email communication with organizations such as SPTM, MOL, KMLj, fire departments, schools, libraries, university, etc.,
- Targeted public relations (businesses, shops, etc.).,
- Word of mouth (students, acquaintances, neighbors, etc.),
- Information sessions (Gimn. Ledina, Gimn. Šentvid, Gimn. Bežigrad, Vegova, FDV, OŠ Prežihov Voranc, etc.),
- Posters at various strategic locations in Ljubljana.

After the COVID-19 lockdown, strategies had to be adjusted. All efforts to attract and inform people were shifted to the internet. The use of social networks for advertising increased significantly. Communication via telephone or online meetings became the only form of communication.

2.5.1 Press

In September 2020, we explored media interest in the WeCount project and the possibilities of publishing an article about the WeCount project that would appeal to a wider range of potential participants. We conducted numerous interviews with journalists and in October 2020 articles were published on various media portals and in the print edition of Finance newspaper.

The article titled *Faculty of Architecture with Innovative Project to Improve Traffic* was published on 1 October 2020 on the website of the Slovenian News Agency STA, which is summarized by all Slovenian media houses. The summarized article was published by several other web portals.

Article titled *Do you have a nice view of traffic from your window? How to use it to your advantage* was published on 9 October 2020 on Finace.si website, in the category Transport & Logistics. An article with the same title was published in the printed edition of Finance newspaper with a circulation of 5,000 copies per day on 15/10/2020.

To reach the car enthusiast population, an article with the title *Measurement of traffic starts, become part of the project for more safety* (in Slovene: Merjenje prometa se začenja, postanite del projekta za večjo varnost) was published in the online edition of Avto magazine on 5 October 2020.

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Figure 7: Articles were published in various magazines.

Website article	https://avto-magazin.metropolitan.si/	22.1.2020
Website article	www.revija-tranzit.si	January 2020
Website article	www.novice.press	23.1.2020
Website article	https://www.racunalniske-novice.com/	22.1.2020
Website article	www.mojaobcina.si	19.9.2020
Website article	https://www.uni-lj.si/	17.9.2020
Website article	http://znanost.sta.si/	1.10.2020
Website article	https://avto-magazin.metropolitan.si/	5.10.2020
Website article	https://www.fdv.uni-lj.si/	30.11.2020
Radio broadcast	https://radiostudent.si/kultura/	23.2.2021
Website article/Press article	https://tl.finance.si/	9.10.2020

Table 4: Timeline of published articles.

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2.5.2 Radio interview

On 23 January 2021, the research team gave a radio interview about the WeCount project. It was broadcasted on Radio Študent in the Urbi et Orbi program slot. The program focuses on urban issues, current events in planning, design and, most importantly, the understanding of cities and urban units. In a 30-minute interview we explained in more detail the project, the participation in the traffic counting, and the Telraam device.

Link to the recording [2]

2.5.3 Face to Face Engagement: Other Physical Interactions

In addition to the presentations of the project to the interested public, approaching people and personal contacts, we have tried to arrange cooperation in the framework of the annual Mobility Week, following the example of the partners from Leuven and Barcelona / Madrid and the experience so far that it is a more inappropriate approach to approach new participants and promote the project of personal commitment. At one of the stands of the outdoor event we wanted to promote the project and engage interested visitors. Due to actions related to COVID-19 the event was cancelled. At the time of writing, the COVID-19 restriction ban on people gathering in small groups is still in place, so a face-to-face engagement cannot be held.

2.5.4 Individual posters

We put up posters with QR code in various places in Ljubljana (Figure 8). The aim was to address targeted passers-by. Due to the COVID-19 pandemic, many places were closed (schools, faculties, libraries), so the posters were no longer visible to the local public.

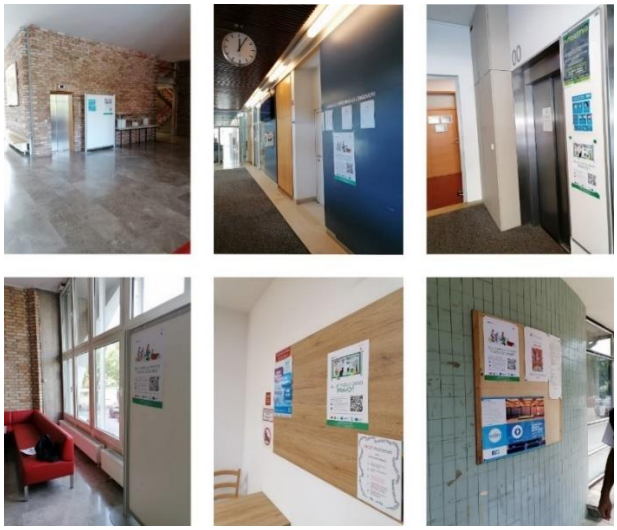

Figure 8: Posters with QR code in various places in Ljubljana.
Figure 9: Poster aiming to address targeted passers-by.

[2] https://radiostudent.si/kultura/urbi-et-orbi/%C5%A1tejemo-promet-pod-na%C5%A1imi-okni

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2.5.5 Facebook campaign

Due to COVID-19 lockdown, the campaign was moved online. Facebook campaign started with setting up the WeCount Facebook (WeCount Slovenija) page. News and articles about Telraam were frequently posted (*Figure 11*). The page was used to post about events and workshop and to keep track of the people that signed up for those events. Telraam was advertised in different targeted groups, where the turnout was quite good. As of the beginning of May, there are 65 posts on the WeCount Facebook page (5.5.2021), 79 people liked the page and 83 people followed. First post was posted on the 12 March 2020. [3]

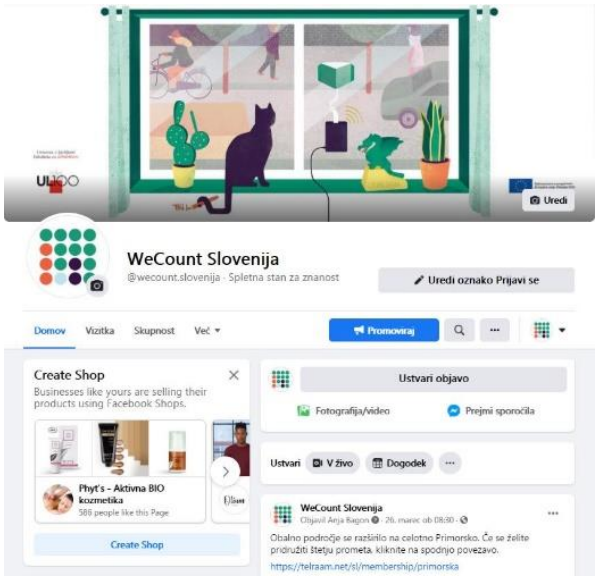

Figure 10: Facebook campaign started with setting up the WeCount Facebook (WeCount Slovenija) page.

[3] https://www.facebook.com/wecount.slovenija

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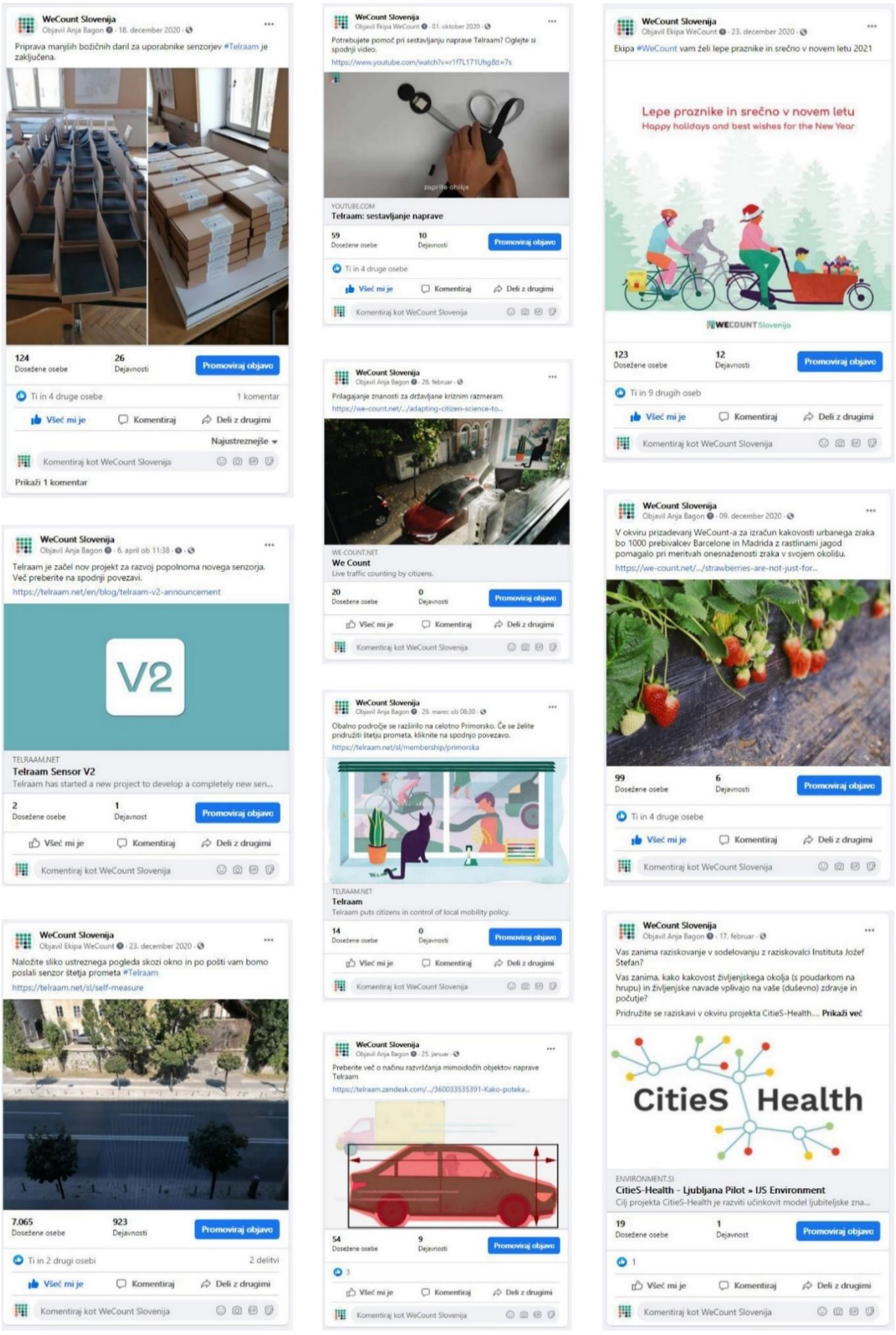

Figure 11: News and articles about Telraam were frequently posted.

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2.5.6 LinkedIn and Twitter

Additional accounts on LinkedIn (WeCount Ljubljana) and Twitter (WeCount Ljubljana) were created. They were used to inform about events and news and to target specific groups of people (students of electrical engineering, technology enthusiasts, people working with traffic, etc.).

The LinkedIn profile was set up on 2 July 2020, as of early May 2021 (5/5/2021) we have 47 connections.

Twitter profile was set up in August 2020, as of early May 2021 (5/5/2021) we have 9 followers and 27 tweets. [4] [5]

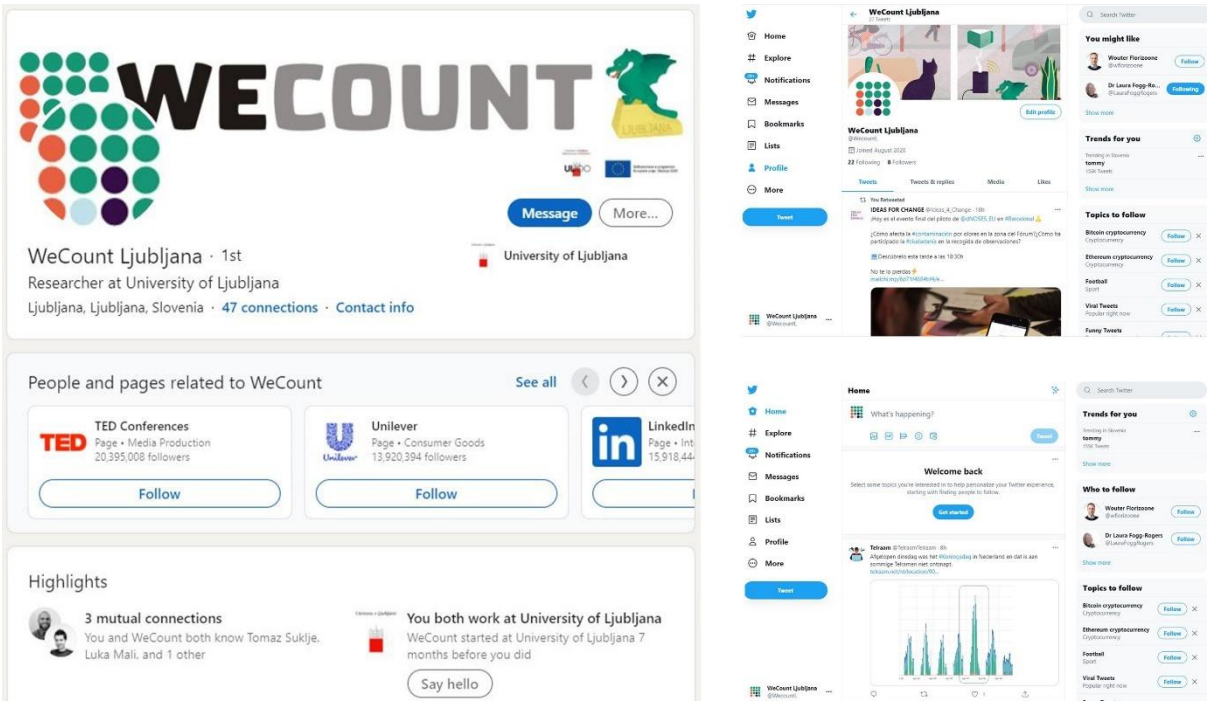

Figure 12: Accounts on LinkedIn (WeCount Ljubljana) and Twitter (WeCount Ljubljana) were created.

2.5.7 Youtube

The YouTube account was created to share useful videos on assembling and setting up the Telraam device (Figure 13). There are three videos published (5.5.2021). [6]

Final registration was published on the 30 September 2020 and has 65 views and 1 like. [7]

Registration procedure was published on the 30 September 2020 and has 36 views. [8]

Telraam assembling video was published on the 30 September 2020 and has 42 views. [9]

[4] https://twitter.com/WecountL
[5] https://www.linkedin.com/in/wecount-ljubljana-5b2b181aa/
[6] https://www.youtube.com/channel/UC6HCKR253Iu3NLVqflbCj-A
[7] https://www.youtube.com/watch?v=1CeSvHA24bM
[8] https://www.youtube.com/watch?v=QgIklh2ykUU&t=11s
[9] https://www.youtube.com/watch?v=r1f7L171Uhg&t=1s

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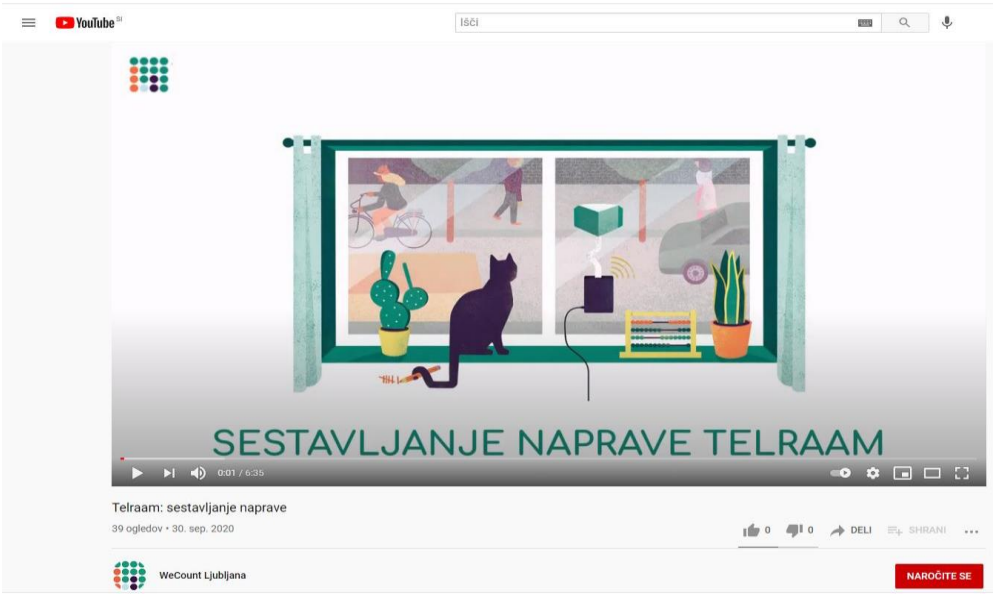

Figure 13: The YouTube account was created to share useful videos on assembling and setting up the Telraam device.

2.5.8 Instagram

The goal of creating an Instagram account was to get in touch with younger participants. As of beginning of May (5.5.2021) we have 16 followers and 6 posts. [10]

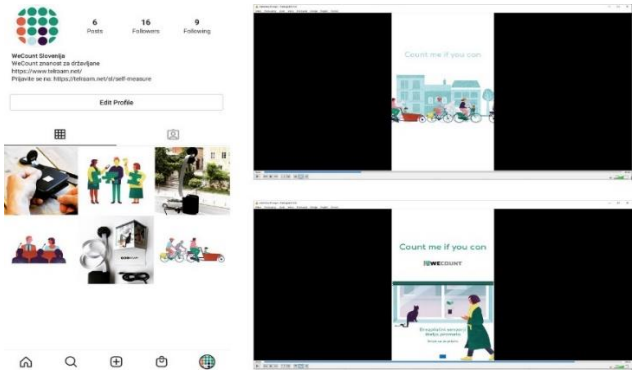

Figure 14: The goal of creating an Instagram account was to get in touch with younger participants.

2.6 The impact of COVID-19 on community building and citizen engagement

The actions related to COVID-19 and the full closure of activities in Slovenia for several months required a complete change of strategy in the implementation, recruitment and development of the traffic counting network. The previous experiences from Leuven and Madrid / Barcelona served as a basis for an easier transition to online implementation of the set objectives.

In the period before the closure, community building and recruitment of interested people mainly took place live, through demonstration workshops and demonstration meetings. In the short period of

[10] https://www.instagram.com/wecountslovenija/

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implementing the initial strategy, we introduced the project to many stakeholders and the responses were very positive, which is reflected in the growth of the number of participants in the project.

In October 2020, the measures related to COVID-19 in Slovenia were sharply tightened. It was necessary to quickly adapt and establish a new strategy. The biggest problem was to promote the project and inform people about the possibility of participating in the traffic census. For this purpose, we tried to familiarize people with the WeCount project through social networks (FB campaign) and approach potentially interested people. Once interest was known and people had signed up for the survey, we ran online workshops, but these were poorly attended. Telraam devices were delivered contactless to pre-confirmed participants. We also provided volunteers with all the support and assistance they needed to install the device. To this end, we also created video tutorials that were available to everyone via the YouTube channel.

It should be emphasized that despite our quick adaptation to the situation, COVID-19 had a significant impact on the realization of the set goals in building the WeCount community and recruiting new participants. It turned out that personal contact is still the most important factor in promoting the project and recruiting new participants.

2.7 Expanding the network

The need to extend the research to other areas in Slovenia and to create new networks for traffic counting was evident from the very beginning. The main reason was the difficulty in attracting new participants in the Ljubljana area, due to measures related to COVID-19 and at the same time the interest of residents from other municipalities.

Primorska

The expansion of Obala came about because of traffic data used by an architecture student who also became our local champion. The village in question is congested with traffic because of the nearby port, and the Telraam data is used to justify the proposal for the area she created in her master's thesis.

The Obala region was later extended to Primorska, as there were some interested parties in the northern parts and the city Nova Gorica.

Currently there are 15 users registered, 7 users counting, 8 users never started counting.

Through the local champion for Novo mesto, we contacted Mr. Robert Ambrož in March 2020, who is one of the founding members of The Things Network Nova Gorica community and the Xiris Institute. We had a long conversation about our WeCount project and the possibility of involving the broader population in Nova Gorica.

Mr. Ambrož's wish is to install many devices in Nova Gorica and connect the devices to the LoReWan network. Mr. Ambrož has joined the volunteers for traffic counting, we have supplied him with 2 devices.

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Novo mesto

In September 2020, we established contact with Tomaž Šuklje and Luka Mali from the Faculty of Electrical Engineering. They are working with the start-up company Sensedge, which developed from the initiative www.microclimate.network, within which they set up an open platform for capturing and displaying data. They are focused on development projects that focus on loT and sustainability. They produce sensors from recycled materials for measuring air quality in indoor and outdoor environment. They are also an active partner in the European project Varcities within the H2020.

At the beginning of October 2020, we organized an online meeting where we presented the project, exchanged experiences, and agreed to cooperate. At the initiative of Luka Mali, which is actively working in the field of sustainable mobility in the municipality of Novo Mesto, we agreed to expand the network for counting traffic to the area of Novo mesto. Luka Mali was recognized as a local champion, who was actively involved in recruiting volunteers and promoting the project. The aim was to install the devices on municipal buildings and adapt the devices to connect to the LoRaWAN network, which Telraam devices do not currently support.

Figure 15: The expansion of Obala came about because of traffic data used by an architecture student.

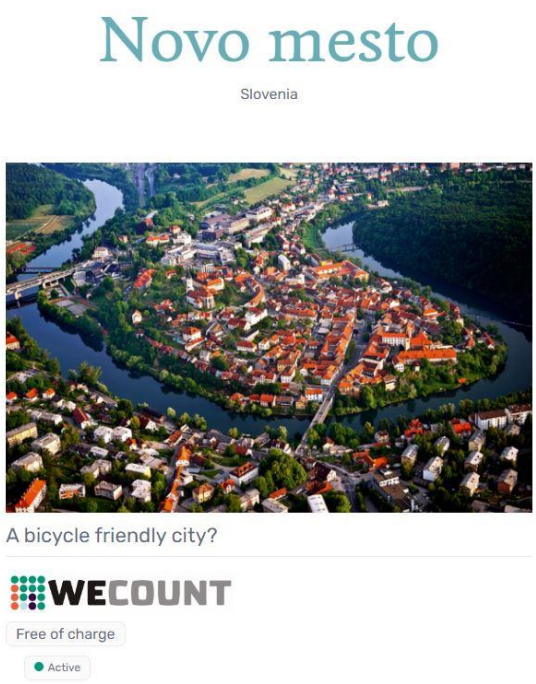

Figure 16: At the initiative of Luka Mali, which is actively working in the field of sustainable mobility in the municipality of Novo Mesto, we agreed to expand the network for counting traffic to the area of Novo mesto.

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3 Data Collection

This chapter provides a detailed description of activities conducted as part of task 4.3. The chapter covers how the procurement, distribution, installation and maintenance of the Telraam sensors were tackled to support data collection as well as how the project was adapted to the exceptional circumstances of the COVID-19 related restrictions.

3.1 The Procurement, Assembly, Preparation, and Distribution of Sensor Hardware

At the end of March 2020 we ordered 200 sets of unassembled Telraam equipment from Gotron. The original thought was that the participants of the WeCount survey would assemble the devices themselves. The plan was to organize special workshops where the devices would be presented and assembled. Due to COVID-19 limitations and the possibility of device failures and delays in detecting problems in the operation of the devices, we decided to assemble and test the devices ourselves. We assembled about 150 Telraam devices, loaded them with programs and updates, and left the rest disassembled for participants to assemble themselves. To that end, we recorded a video of the process of assembling the devices, along with other video tutorials. We have created a Youtube profile WeCount Ljubljana, which is accessible to all.

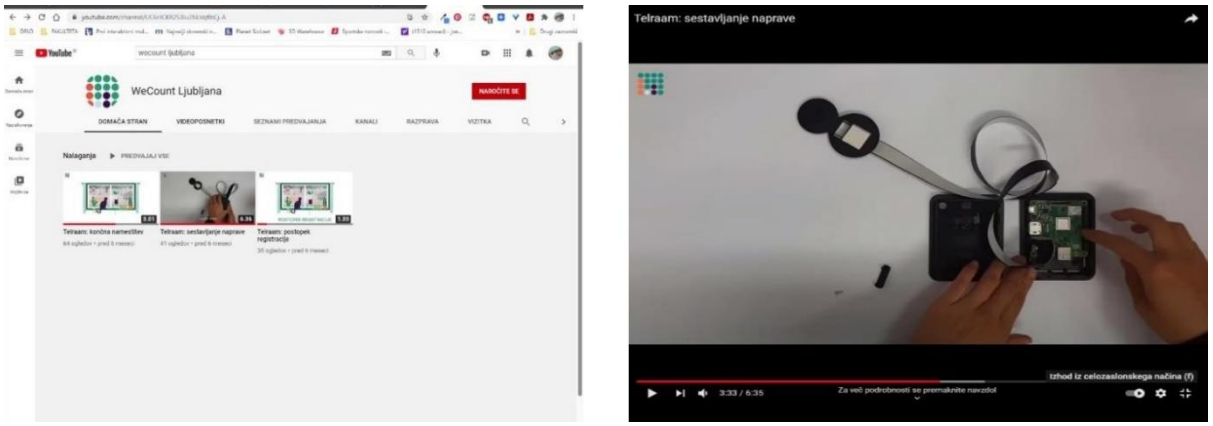

Figure 17: Video of the process of assembling the devices on our Youtube channel WeCount Ljubljana, which is accessible to all.

The strategy for obtaining the device was initially for subjects to receive the Telraam device after prior registration and approval of a suitable view through the window in the workshop. Due to limitations associated with COVID-19, we decided to ship the assembled device free of charge to certified volunteers. For this purpose, we designed the shipping package in which the device remained undamaged during shipping. We included the notified consent in the package, and after receiving the device, participants emailed it to us. Most of the devices were shipped by Pošta Slovenije, and some were delivered by us.

In order to distribute the Telraam sensor to interested residents, we have put together packages that can be sent by post or delivered in person. The package contains an assembled device with a description and instructions for use, a consent form, an information sheet, an anti-reflection sheet and a business card.

The package contains a Telraam compound device, the corresponding power supply unit, information material about the WeCount project, material about the Telraam device and installation, a flyer, a reflection foil, a self-adhesive hedgehog and a consent form.

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Figure 18: To distribute the Telraam sensor to interested residents, we have put together packages that can be sent by post or delivered in person.

Handing over or distributing the devices in person at the originally scheduled workshops proved to be a much more appropriate way to acquire Telraam.

In face-to-face contact, study participants asked us a number of questions, all of which they received answers to in person rather than by email or by reading the (FAQ or Zendesk) Frequently Asked Questions and Answers section.

Many of the study participants conatacted us after the postal delivery of the sensor and we worked together to resolve any installation difficulties. In conclusion, therefore, we would like to suggest that face-to-face adoption of Telraam is much more appropriate, and in the context of COVID-19, postal delivery with greater support and communication with participants proved to be appropriate.

The first Telraam device was installed at the faculty window on 6 December 2019. The purpose of the installation was to understand the operation of the device in detail, to mount the device and to learn about the registration process. We tried to anticipate problems that might arise during the registration of the participants and the installation of the devices.

We have found that the device should be taped to the window in such a way that it can be removed and reattached in the same place. However, due to summer sun and high temperatures and low temperatures after winter, the adhesive must be resistant to temperature changes and allow reliable gripping. We tested several products and decided on a wide self-adhesive hook and loop tape that allows use in a wide range of temperatures. A piece of self-adhesive tape was included in the package for shipping to participants.

During assembly, we came to the realization that the sensor needed improvements, which we later included in the shipping package. The housing was attached to the windowsill or glass with self-adhesive hedgehogs, which had to be temperature resistant, or the adjustment would not be successful.
Due to the reflection of the AWM flat cable connecting the housing to the camera in the glass, we used black self-adhesive tape.

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The AWM flat tape in white that connects the computer and sensor caused glare in the sensor image and consequently displayed incorrect traffic data. The problem was solved by gluing a full-length self-adhesive machine-cut black nalle to the AWM tape.

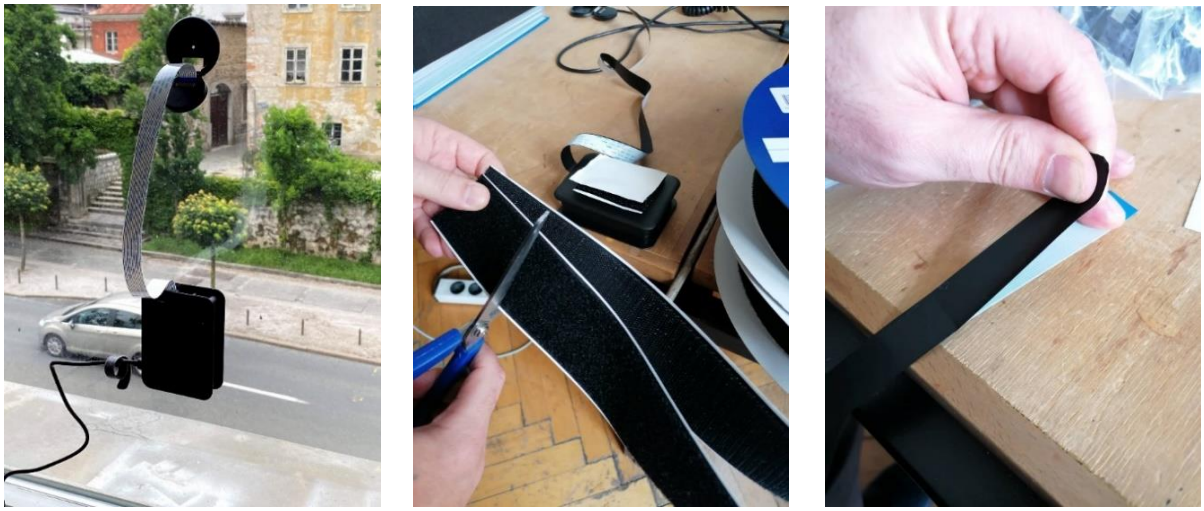

Figure 19: first Telraam device installed, self-adhesive tape and self-adhesive anti-glare tape.

3.2 Sensor Installation

Before describing the sensor installation in detail, we briefly described the technical onboarding steps of users in the platform.

To apply for a device, users were required to complete a two-step online registration form in which candidates provided location details, socioeconomic information (later used in the evaluation), and, most importantly, uploaded an image of the street view to assess whether the location itself was suitable for the installation of a sensor device.

Once the project team had assessed suitability, candidates were invited via the Telraam management platform to register and receive the Telraam device.

The process of procuring and installing the Telraam device was initially planned in two steps. Traffic counting participants would register on the website (1st application form), and if they expressed interest in traffic counting, they would attach a picture of the view from the window where the device would be installed via the 2nd online application form. After confirming the appropriate view, applicants would be invited to attend a workshop on the WeCount project, how to install and handle the device, and how to interpret the data obtained. During the workshop they would personally take delivery of the Telraam device and sign the consent provided.

The first and only conducted workshop with personal takeover was organized on June 16, 2020 at the Faculty of Architecture. The workshop (PRE -WORKSHOP) served as a preparation for the following workshops. In the workshops, the WeCount project, registration process, installation and operation of the Telraam device were presented in detail. The table below shows the participants and the application structure.

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INVITATION SENT	PARTICIPANTS male	PARTICIPANTS female	PARTICIPANTS total/response
27	5 (30%)	12 (70%)	17 (62%)

PARTICIPANTS pre-workshop	Sign-up observers	Sign-up users	Device installed
17	5	10	6

Table 5: Pre workshop statistics.

Due to the situation related to COVID-19, we changed the strategy. After confirming the appropriate view for the installation of the device, we sent an email to the participants with an invitation to the online workshop and all the information about the project and the process of installing the device. For this purpose, we also recorded a video tutorial on how to install the device correctly. After receiving the shipping address of the Telraam device, the device was shipped and we organized an online workshop. The online workshops were poorly attended.

INVITATION SENT	PARTICIPANTS male	PARTICIPANTS female	PARTICIPANTS total/response
11	5 (83,4%)	1 (16,6%)	6 (54%)

Table 6: Online workshop 22.10.2020 - Zoom

INVITATION SENT	PARTICIPANTS male	PARTICIPANTS female	PARTICIPANTS total/response
21	1 (100%)	0 (0%)	1 (5%)

Table 7: Online workshop 3.12.2020 - Zoom

INVITATION SENT	PARTICIPANTS male	PARTICIPANTS female	PARTICIPANTS total/response
37	6 (100%)	0 (0%)	6 (16%)

Table 8: Online workshop 20.1.2021 – Zoom

Despite low participation in the online workshops, most participants successfully installed the Telraam device. Where problems arose, we resolved them through site visits, phone and video, and email. We installed the devices at companies and interested schools.

Most problems occurred with incomplete online installation and connection to WIFI. There were surprisingly few issues with the physical installation of the device on the window, they were mostly related to the mounting of the angle of the sensor as it does not stay in the same position after installation even with light touches. Below is feedback from participant Johanna, a researcher on the project European Cities Health and a volunteer on the traffic count.

In some cases it turned out that the power supply (socket) was not close enough, so we asked Gotron to replace the power supplies that would have a longer power cable. Since this was not possible, we purchased electrical extensions and delivered them to the participants.

To receive a Telraam device, pre-registration was required via the 1st online form. We sent an invitation to all potential volunteers to attend an online workshop where we introduced the project and presented how to use the device. We asked them to fill in the 2nd online form and attach a picture of the view. All those who registered and had a suitable view were selected to install the Telraam device. We asked them for their address for free delivery of the device. We have attached all the important information to install the device (YouTube, Info, Zendesk, etc.).

Most of the participants installed the devices without any problem, with the others we communicated directly and guided them through the installation of the device. They were provided with all the technical help.

3.2.1 Co-Designed Installation process with specific Participants

Specific user feedback:

Johanna Robinson

Another important note. Apparently when I installed the anti-reflective shield, the cable that connects to the camera compressed tighter, changing the camera angle towards the window. It took me a few days to figure this out. So maybe also a note to new volunteers, to pay attention when installing the anti-reflective shield. There might even be a better hole for the cable in the bottom corner, so it does not pull and change the camera angle.

My camera is not perfectly straight either, which is a bit difficult with a round object. And when it is attached with the strong straps, there's not much you can do. There might also be solutions on how to get it straight before attaching it to the window. If it is technically important at all.

Klemen Bartol – IT technician at University of Ljubljana

After looking at the basic configuration of the Telraam device on the https://github.com/Telraam/Telraam-RPi/blob/master/Misc/general-configuration-HOWTO.txt site, I noticed a -few things. Already the .iso image itself is configured in a way that I think can cause problems (in enterprise environments).

1. On the Raspberry pi, the localization defaults to the Belgian settings - this can be seen here: https://www.raspberrypi.org/forums/viewtopic.php?t=214717 I fixed it myself by setting it to SI in the country line.

Figure 20: Code improvements.

Developer's suggestion: Depending on which country Telraam is in, the localization settings would be adjusted accordingly.

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2. The hostname is obviously always set to TELRAAM (source [11]).

   However, this means that if there are multiple Telraam devices on the same network, they will all have the same name, and this can cause a lot of problems (source [12]).

```
48
49  # ==============================
50  # DISABLE ETH0 & CHANGE HOSTNAME
51  # ==============================
52  sudo nano /etc/rc.local
53  *** sudo ifconfig eth0 down
54  sudo nano /etc/hostname
55  *** change raspberrypi: telraam
56  sudo nano /etc/hosts
57  *** change raspberrypi: telraam
58
```

Figure 21: Code improvements.

Developer's suggestion: just as the serial number for Rpi is automatically generated, a hostname should be created with a fixed part Telraam and a variable part% serial_number%. Example: telraam-2021-2341-2341-88RR IPv6 is disabled, which is great - at first, I thought it was problematic, but it turned out to be ok.

Kelemen's conclusion:

In short, there doesn't seem to be anything with our infrastructure, and the device itself (as I have looked through the documentation) has (in my opinion) a few such bugs that could really affect the operation of a larger network. I have only highlighted the settings that I think are most likely to be responsible for the non-functioning, but surely the developers know if there are other settings that relate to localisation that could affect the non-functioning. The Telraam app itself running on the Raspberry should have some other settings that could affect it.

Lessons learned

General Findings about the sensor installation

- Installing the sensor at the top of the window was difficult. It was suggested that longer power cords be used to avoid the use of impractical extension cords.
- The camera is constantly moving, which was especially critical when the windows have curtains.

[11] https://github.com/Telraam/Telraam-RPi/blob/master/Misc/general-configuration-HOWTO.txt)-
[12] https://security.stackexchange.com/questions/69198/can-2-devices-have-same-host-name-on-same%20-network

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Figure 22: The camera is constantly moving, resulting in recording the wrong view and unreliable data.

- The sensor will not work if Wi-Fi networks are encrypted or require additional credentials. This prevents schools, other public or private institutions, and those that rely on public Wi-Fi from hosting the sensor.
- The installation process seemed simple for the most part for those with some English and technical knowledge. The steps requiring the sensor to be connected to the WLAN via the participants' smartphones were found to be difficult.

Experiences in terms of strategy

- In contrast to Leuven, there seems to have been collaboration on issues in Ljubljana.
- "One strategy for all" is probably not appropriate. This was especially important in terms of time. For example, some participants are working with schools and have shown interest to start measuring in this area from September / October 2020.
- Given some issues with the quality of the data, we found it extremely important to manage the expectations of participating citizens.

Process-related experiences

- Conducting an online sensor installation workshop with participants seemed most effective for self-installation of the sensor.
- Related to the previous point, we found that some participants had problems installing the sensors.

Technical and User Experience related lesson learned

- Telraam sensors often fall off windows, especially when placed on the window facing south. To remedy this problem, participants were subsequently given two additional double-sided tapes.
- Placement of the sensor at the top of the window (e.g., to overcome obstacles such as a balcony or outdoor air conditioning unit - as shown in the figure below) proved problematic. It was suggested to use longer power cables to avoid impractical extensions, but the problems with the power supply needed for the sensor to function properly occurred. The second problem encountered with the installation of the sensor is the mounting of the housing, as it cannot stand on the windowsill, but must be attached directly to the window glass with double-sided tape, which loosens over time. Another solution that has worked better is to use Velcro to attach the sensor housing.
- The camera housing is constantly moving, which has proven to be especially critical when the windows have curtains. It usually then falls off or changes the view, resulting in incorrect and

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erratic data. TML has solved this problem for future subscribers by adding a new feature to the platform that allows them to check the positioning of their cameras daily.

- The sensor does not work when Wi-Fi networks are encrypted or require additional credentials. This hinders schools, other public or private institutions, and those that rely on public Wi-Fi to host a sensor.
- It could take several weeks for the sensor to begin counting heavy vehicles.
- Participants expressed interest in also distinguishing between bicycles, scooters, and motorcycles.
- Strategy-related outcomes.
- Engagement by topic and engagement by neighbourhood or geographic area were both equally unsuccessful.

3.3 Data Collection Process

In Ljubljana, Novo mesto and Primorska, a total of 188 participants registered for the WeCount project by the time of writing the report. The structure of interest in participating in the project is shown in the table below. According to the interviews with the participants, most of those who registered as observers intentionally registered as observers because the view was unsuitable for the installation of the device.

	LJUBLJANA	NOVO MESTO	PRIMORSKA	TOTAL
OBSERVERS	39 (23%)	0 (0%)	0 (0%)	**39 (21%)**
COUNTERS	79 (47%)	6 (55%)	4 (44%)	**89 (47%)**
OBSERVERS AND COUNTERS	50 (30%)	5 (45%)	5 (56%)	**60 (32%)**
TOTAL	**168**	**11**	**9**	**188**

Table 9: Ljubljana, Novo mesto and Primorska sensor statistics

Of the total number of applicants who showed interest in the traffic count (149), they completed the 2nd online form and attached an image of view 94. This is shown in the table below. Despite repeated requests to complete the 2nd online form and attach a picture, 37% of potential registered volunteers did not attach a picture. We suspect a rather high percentage of non-responsive participants is due to emails going directly to spam or ambiguities when filling in the 1st registration form - ticking both options to participate in the project (observer/volunteer).

	LJUBLJANA	NOVO MESTO	PRIMORSKA	TOTAL
TOTAL COUNTERS	**129**	**11**	**9**	**149**
ATTACHED IMAGE	81 (63%)	7 (64%)	6 (67%)	**94 (63%)**
DID NOT ATTACH IMAGE	48 (37%)	4 (36%)	3 (33%)	**55 (37%)**

Table 10: Attached/not attached image.

Of the participants who attached the image, 85 were selected for the traffic count. All participants who were selected for the traffic count received the devices. 9 participants who attached the picture were not selected. The reasons were varied and ranged from physical barriers to inappropriate viewing angle to location of residence (traffic count network is not available at their location).

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	LJUBLJANA	NOVO MESTO	PRIMORSKA	TOTAL
TOTAL ATTACHED IMAGE	**81**	**7**	**6**	**94**
SUITABLE WINDOW	73 (90%)	6 (86%)	6 (100%)	**85 (90%)**
UNSUITABLE WINDOW	8 (10%)	1 (14%)	0	**9 (10%)**

Table 11: Suitable/unsuitable window.

In Ljubljana, about 46 devices are operating stably, out of the 73 sent. 14 devices counted traffic in the past, 12 never. All participants who had problems with device stability were contacted individually and attempts were made to determine the cause of the problems. The most common cause of failure was the inability to connect to WiFi, due to different WiFi network settings / encryption (major network systems, WPA2 Enterprise, etc.).

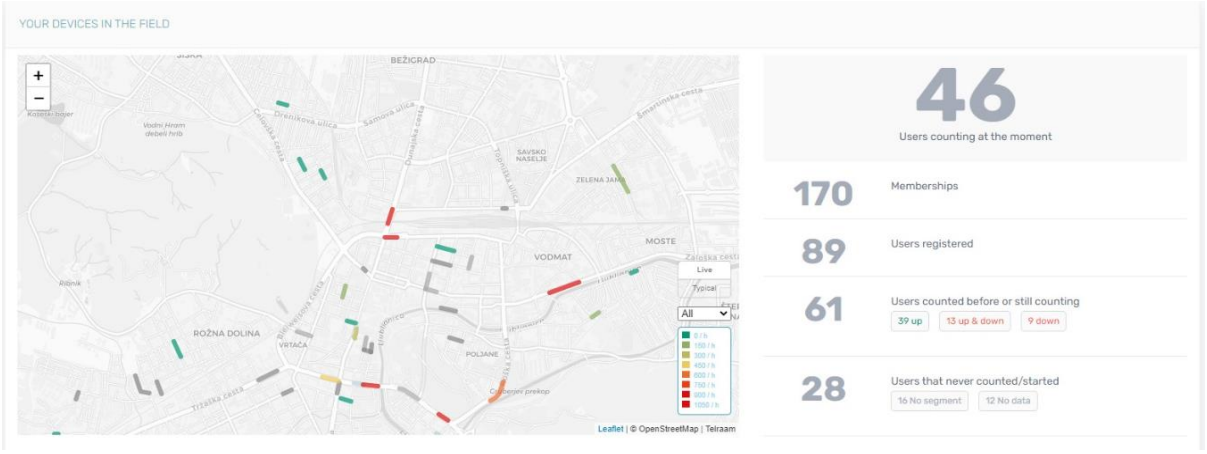

Figure 23: devices installed in Ljubljana

In the main administration building of the University of Ljubljana in the centre of Ljubljana, we tried to install 3 devices, but they never worked. A computer expert tried to solve the problem, but without success. He mentioned below possible reasons for the non-functioning of the devices.

A similar problem occurred in some institutions (Ledina Gymnasium, ALUO, Ethnographic Museum).

We also found some problems with the operation of the supplied power supply. The devices were very unstable, each time the device had to be manually reset when it did not work. We replaced the power supplies of four subscribers with new ones exclusively for the Rasberry Pi 3+, which we also ordered from local vendors. This solved the problem with the stability of the device. We replaced the unit on one subscriber, but the unit still does not work.

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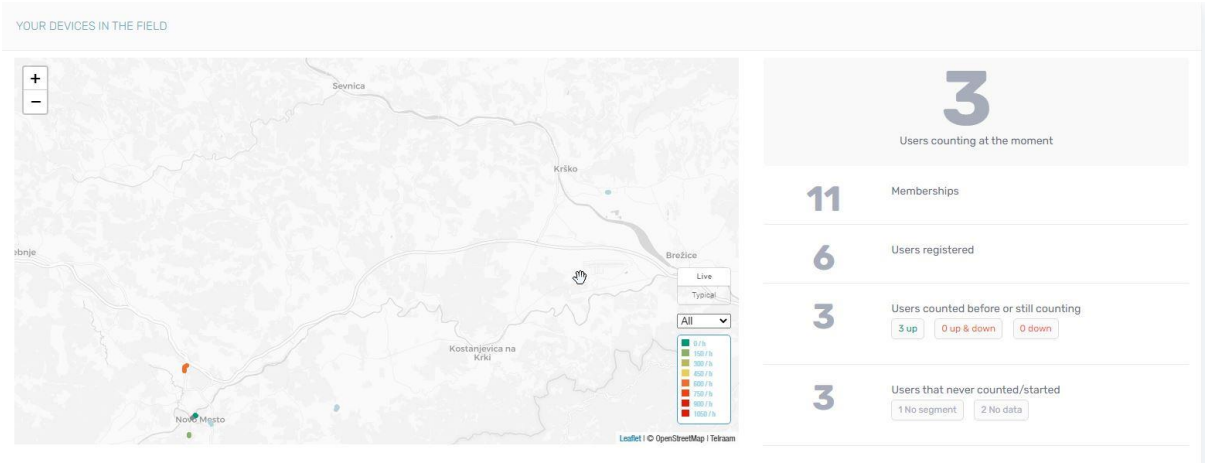

Figure 24: Novo mesto network.

The traffic counting network Novo mesto was created on the initiative of the local champion Mr. Luka Mali. The case study was also joined by technology enthusiasts from Novo mesto area who installed their own devices.

There are 7 devices installed in Novo mesto, 5 are working, 1 device has worked in the past, 1 never. We sent devices to five participants from Novo mesto, the other three provided the devices themselves.

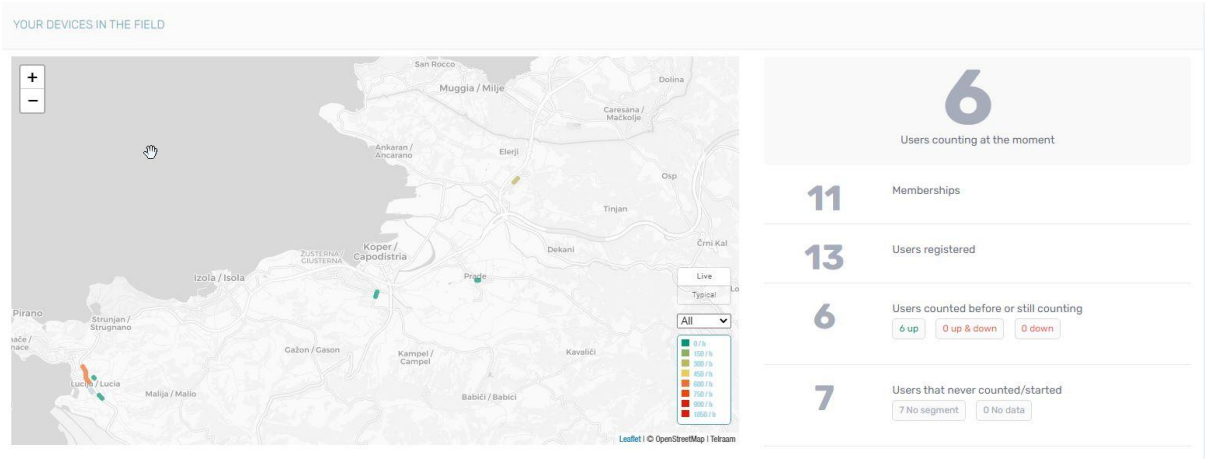

Figure 25: Primorska network

Due to the interest of the residents of the coastal city in participating in the WeCount project, the Obala traffic count network was initially created. Based on the demonstrated interest in traffic monitoring in the municipality of Nova Gorica, we expanded the network to the entire Primorska region. At the time of writing the report, we have also dispatched 3 additional devices.

In Primorska region all 6 installed devices are stable, but there are 13 registered users. Five out of 7 registered users who have not yet purchased the device are fictitious. The reasons for the registration of the fictitious users are unknown. At the time of writing, one subscriber has registered with two matching windows, the devices have been shipped, and the installation is not yet complete.

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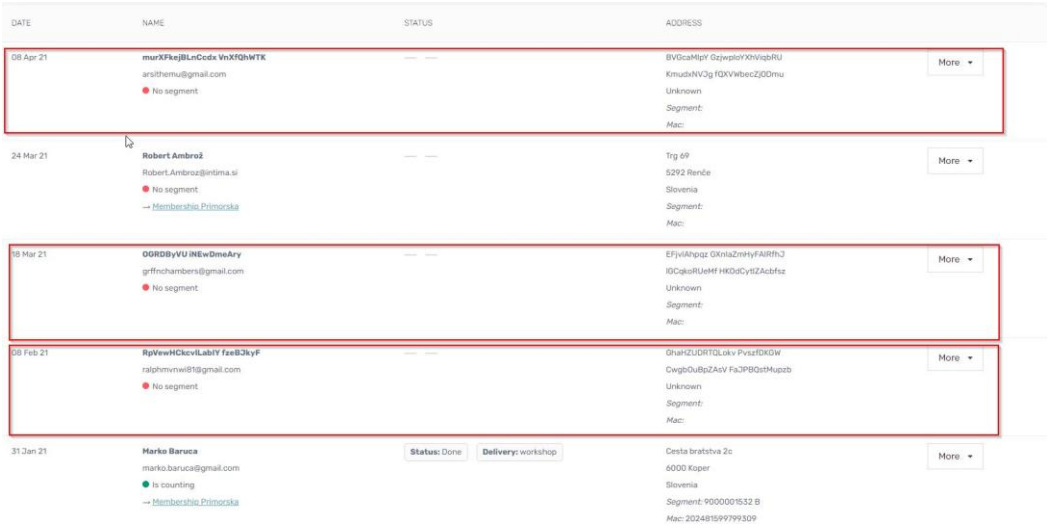

Figure 26: Five out of seven registered users who have not yet purchased the device are fictitious.

Display of the operation of all distributed Telaraam sensors.

	LJUBLJANA	NOVO MESTO	PRIMORSKA	TOTAL
TOTAL SELECTED COUNTERS	**73**	**6**	**6**	**85**
STABLE – ALWAYS COUNTING	45 (62%)	5 (72%)	6 (100%)	**56 (66%)**
UNSTABLE - SOMETIMES COUNTING	13 (18%)	1 (14%)	0	**14 (17%)**
DEVICE NEVER WORKED	12 (17%)	1 (14%)	0	**13 (15%)**
DID NOT RECEIVE THE DEVICE	2 (3%)	0	0	**2 (2%)**

Table 12: Total device statistics.

The following graph shows the number of all registered participants in the survey and the percentage of registered volunteers in the 14-day interval from the installation of the first device.

Movement in the number of registrants coincides with events related to project promotions, restrictions and releases associated with COVID-19 and the annual leave period. The turning points are described below:

- 1st event; pre-workshop (16.6.2020).
- 2nd event; publication on Facebook - invitation to the workshop of the Ljubljana Cycle Network (cancelled).
- 3rd event; summer holidays.
- 4th event; extensive promotion of the WeCount project (schools, personal visits, press, posters, workshops, University e-mail, workshops).
- 5th event; October lockdown.
- 6th event; moving the campaign online (online workshops, exercises and lectures for students, promotion on Facebook and other social media).

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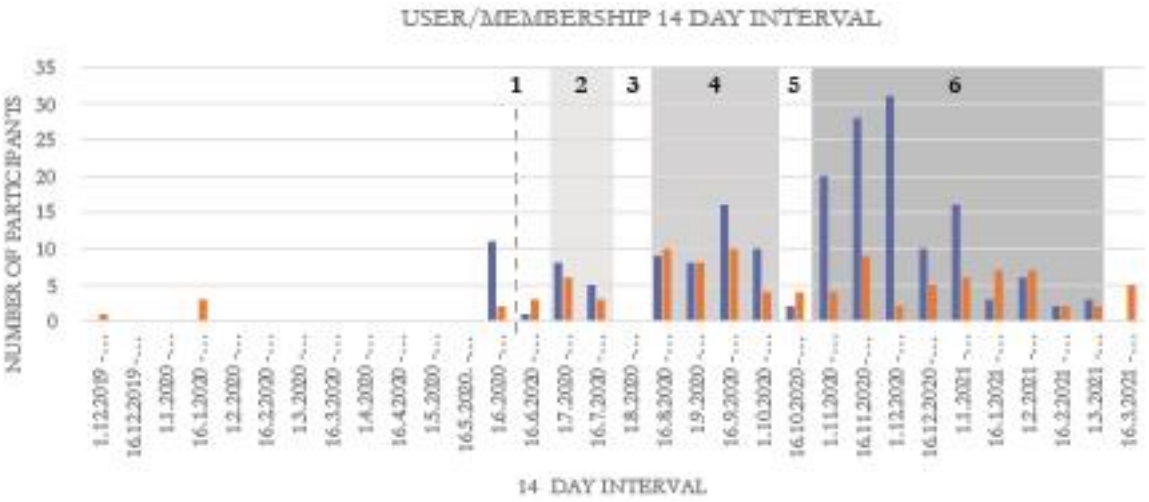

Figure 27: User/membership 14 day interval.

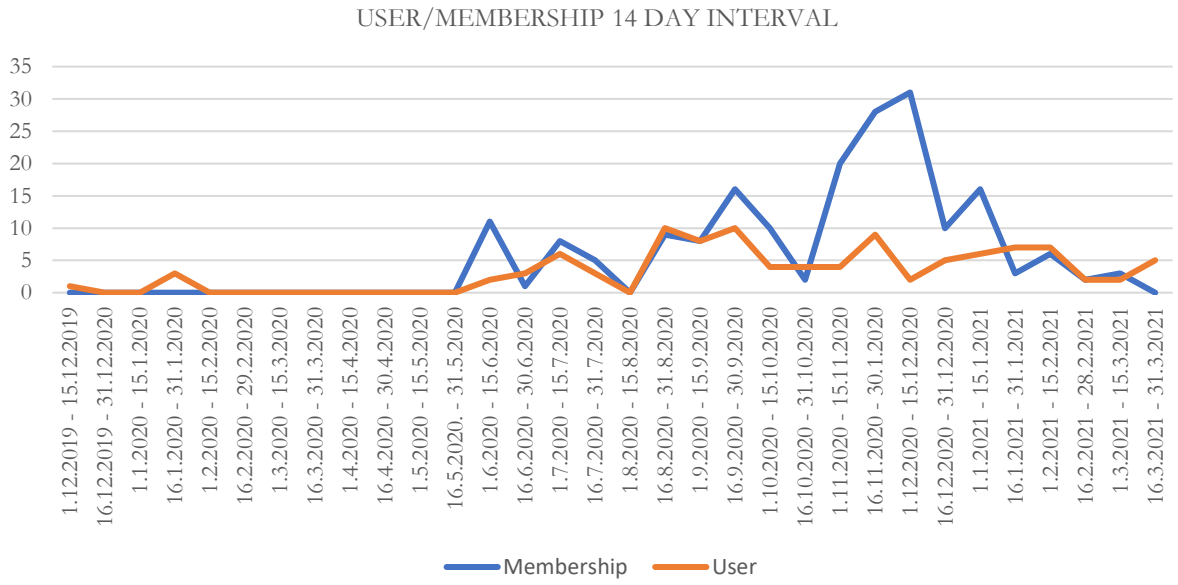

Figure 28: User/membership 14 day interval.

3.3.1 User onboarding before COVID-19

Telraam device, pre-registration was required using the 1st online form. We sent an invitation to all potential volunteers to attend an online workshop where we introduced the project and presented how to use the device. We asked them to fill out the 2nd online form and attach a picture of the view. All those who registered and had a suitable view were selected to install the Telraam device. We asked them for their address for free delivery of the device. We have attached all the important information to install the device (YouTube, info, Zendesk, etc.).

Most of the participants installed the devices without any problem, with the others we communicated directly and guided them through the installation of the device. They were provided with all the technical help.

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3.3.2 Onboarding participants via Social Media (during COVID-19)

Due to the low response of participants in the thematic workshops, mostly following unsuitable window locations due to distance, various obstacles, or the angle of view on the street, and due to the COVID-19 constraints, we decided to shift part of the communication about the Wecount project, to attract participants, to social media. To this end, two advertising campaigns were conducted.

The first campaign was a series of Facebook posts for specific Facebook groups that might have an interest in the Telaraam sensor technology. Therefore, we promoted the project to various groups as individuals or as Wecount Slovenija and created a conversation within these groups about the device and the project. The groups we joined to promote the project are Slovenian developers (Slovenski developerji) with more than 12,000 members, Engineers of Slovenia (Inženirji slovenije) with more than 3,800 members, Young Architects of Slovenia (Mladi arhitekti Slovenije) with 1,500 members, Traffic cameras at Ig and nearby (Radar na Igu in okolici) with 2,900 members, Events at FRI (Dogodki na Fri) group dedicated to computer science students with 1,700 members.

Figure 29: Facebook campaign on sensor adoption in the group of Slovenian Developers with lively discussion and comments.

The second campaign, which took place over 36 days between 12/28/2020 and 2/2/2021 on Facebook and Instagram, targeted individual groups of people with certain common characteristics, interests, education, and hobbies. The campaign reached up to 31,960 people, 820 of whom engaged with the post, which includes all the actions people take with the ads as they run. Post engagements can include actions such as responding to or sharing the ad, claiming an offer, viewing a photo or video, or clicking on a link. Of these, 774 clicks on the ad itself is an indication that your ads are relevant to your target audience, which helps your ads perform better. When people respond to a post, they automatically follow up with further responses and comments, which can engage them in an ongoing conversation on your business page. Nine of them shared the ad and 8 were direct comments.

The highest number of people involved in the campaign were men between 25 and 54 years old. The vast majority saw the ad on their mobile device or cell phone, 23,976, and 11,352 people (7160 + 4192) saw the ad on a desktop computer. Other ad placements were negligible. Of these, 23,176 visitors were from the Central Slovenian region, 4,432 from the Coastal and Karst region, and 3,783 from the south-eastern part of Slovenia. These areas were also the focus of the campaign.

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Figure 30: Basic information about the Facebook campaign.

Figure 31: Demographics of campaign participants.

During this period, we gained 21 users of the device in Ljubljana, 3 users in the Coastal and Karst region and one user in the south-eastern part of Slovenia. In total, 25% of all users (15.4.2021) have been added in the time of the campaign. The number of applications continued to increase after the end of the campaign, but the intensity of applications has decreased significantly since the end of the campaign.

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4 Data Analysis and Awareness

4.1 Generic analysis

After the initial interest in participating in the WeCount study and adopting a Telraam sensor, it became apparent that many volunteers did not have a suitable window view of the street they wanted to monitor. It quickly became clear that the locations that met the requirements for reliable and effective data collection were far fewer than we had anticipated. This meant that, with explicit interest and local support, we expanded to two new local networks in Novo mesto in the Primorska region. The general analysis shows the overall numbers and traffic count results for each local network. The smaller networks such as Primorska and Novo mesto have small numbers of sensors at the time of the report, so the results are not as meaningful on a global scale, but for any properly operating sensor, the data is valuable and can be of great use. The deployment of sensors and networks themselves is still increasing due to the delay caused by the COVID-19 epidemic.

4.1.1 Telraam public data

Ljubljana

Ljubljana was the starting point for the case study, which focused on cycling and the cycling network. In cooperation with the local champion Ljubljana Cycling Network, we wanted to inventory, assess, and improve the space for cyclists in Ljubljana.

Due to Slovenia's urban characteristics, we quickly discovered that despite the high level of interest in sensor deployment, there were no suitable windows for sensor installation. Nevertheless, during the analysis period (between November 2020 and April 2021), the number of sensors almost doubled from 28 installed sensors in November 2020 to 50 installed sensors in April 2021 and is currently still growing.

In total, the sensor network detected 22,542,012 objects, of which 532,848 were pedestrians, 2,518,885 were cyclists, 16,156,151 were cars, and 3,334,128 were large motor vehicles (buses and trucks). We can see that the sensors mainly detect motor vehicles, which account for 72% of the counted traffic, followed by heavy motor vehicles, which account for 15% of the counted traffic. The sensors also detected 2% of pedestrians and a surprisingly large number of cyclists 11%.

	Pedestrians	Bikes	Cars	Lorries	No. of sensors	Count All
November	38,432	136,101	1,283,569	304,014	28	**1,762,116**
December	49,774	105,405	1,539,297	338,937	30	**2,033,413**
January	78,060	135,542	1,813,530	333,354	39	**2,360,486**
February	98,168	396,891	3,162,557	527,091	48	**4,184,706**
March	141,513	793,100	4,435,998	917,830	53	**6,288,441**
April	126,901	951,846	3,921,200	912,902	50	**5,912,850**
TOTAL	**532,848**	**2,518,885**	**16,156,151**	**3,334,128**		**22,542,012**

Table 13: No. of counted objects (categorized) per month.

The total number of all traffic categories listed from November 2020 to March 2021 grows proportionally with the number of Telraam devices in operation. A large jump in all counts was observed in March when the measures regarding COVID-19 were gradually relaxed, resulting in a higher number of road users. However, this result may be questionable as a road with a larger number of road users may have been

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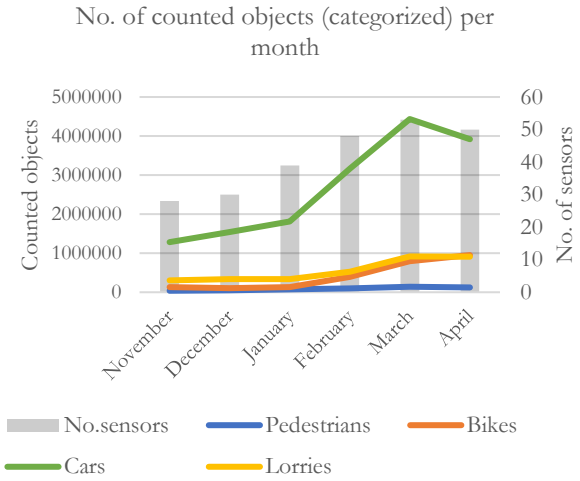
added, which can be further analysed in the next section of this document based on the locations of the individual sensors.



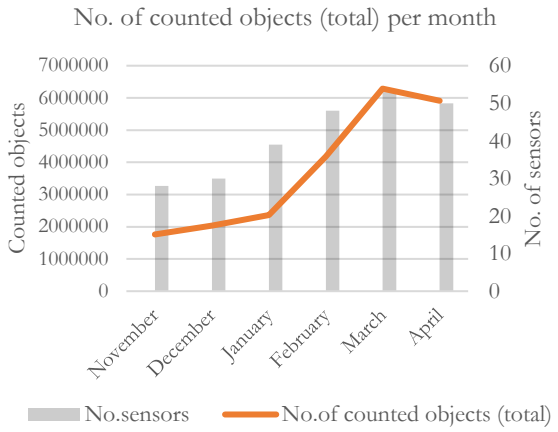


Figure 32: No. of counted objects (categorized) per month.
Figure 33: No. of counted objects (total) per month.

The cumulative analysis of the speed of motor vehicles (only cars) does not tell us much. In general, we can say that Slovenians are very slow drivers, or the sensors were placed on the roads with a speed limit of 30.

Another finding could be that we as drivers spend most of our time in traffic jams, which would contribute to a significant number of motor vehicles. In the first category, the overall network results show that 15% of cars are driving within the speed range from 0-9 km/h, 19% drive in the 10-19 km/h range, and 25% of cars drive in the 20-29 km/h. Another 22% of cars travel in the 30-39 km/h range. All higher speeds 40-49km/h, 50-59km/h, 60-69km/h and 70+km/h are 12%, 4%, 1% and 2% respectively.

	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70+
November	13.0	19.4	25.8	22.6	12.5	3.9	1.2	1.5
December	10.2	19.0	27.1	22.5	13.4	4.9	1.4	1.5
January	12.5	18.8	25.4	23.1	13.0	4.4	1.3	1.6
February	16.9	17.2	25.1	23.0	11.2	3.6	1.2	1.7
March	19.0	21.6	23.1	19.4	10.2	3.5	1.3	1.9
April	19.3	19.7	21.6	20.2	11.6	4.1	1.4	2.1
TOTAL	**15.2 %**	**19.3 %**	**24.7 %**	**21.8 %**	**12.0 %**	**4.1 %**	**1.3 %**	**1.7 %**

Table 14: Average speed (per month).

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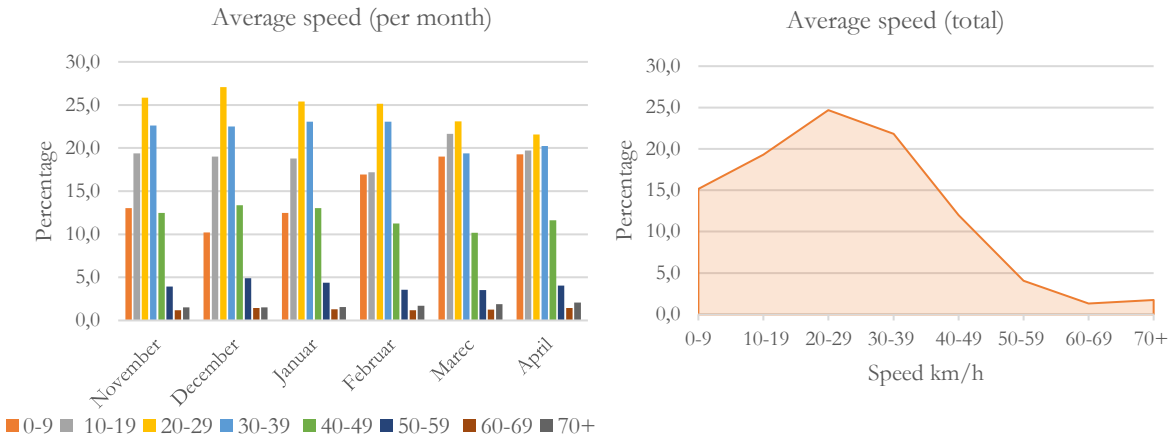

Figure 34: Average speed (per month).
Figure 35: Average speed (total).

The graph (Figure 34) shows that the speeds in Ljubljana are consistent with the speed limits. The growth of the counted objects is due to the growth of the working sensors. Figure 35 shows the movement of average speeds for the considered months. The slowdown of the overall traffic is seen in the months of March and April, which is due to the higher congestion and number of road users due to the relaxation of the restrictions associated with COVID-19 and the resulting higher road load.

Novo mesto

The traffic counting network in Novo mesto was also joined by technology enthusiasts from the Novo mesto area, who installed their own devices. Together with the local champion we are still waiting for a wider sensor installation on the initiative of the municipality.

There are 7 devices installed in Novo mesto, 5 working, one additional device has worked in the past, one sensor never worked. We sent devices to five participants from Novo mesto, the other two provided the devices themselves. We negotiated with the municipality to install a larger number of sensors throughout the city.

The data in Table 16 are inconclusive and show sensor activity for the last 6 months, from November 2020 to April 2021. The first working sensor in Novo mesto's network was installed in November 2020, the second in December 2020, and the third sensor in February 2021. In addition, two more sensors were installed, but they did not work.

The installed sensors counted a total of 862,616 road users (detected objects), including 22,723 from the single sensor in November 2020. Two sensors counted 13,312 objects in December 2020, 8,677 objects in January 2021. 3 sensors reliably detected 142,011 events in February 2021 and in March and April 2021 the devices detected 371,585 and 317,620 objects, respectively.

Due to the small number of reliable sensors, the data is inconclusive. However, the data shows that there is a decrease in traffic during the COVID-19 closure between December 2020 and January 2021. And there is a significant increase from 3 sensors from February to a steady level in March and April 2021.

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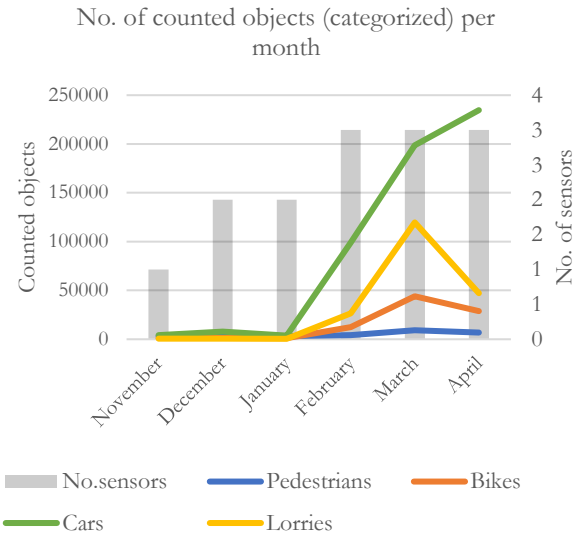
	Pedestrians	Bikes	Cars	Lorries	No. of sensors	Count All
November	3,370	1,386	4,119	536	1	**9,412**
December	3,614	1,312	7,889	497	2	**13,314**
January	3,264	1,174	3,764	475	2	**8,679**
February	4,152	12,373	98,939	26,547	3	**142,014**
March	9,254	44,019	198,610	119,702	3	**371,588**
April	6,863	28,806	234,666	47,285	3	**317,623**
TOTAL	**30,517**	**89,069**	**547,987**	**195,042**		**862,630**

Table 15: No. of counted objects (categorized) per month.



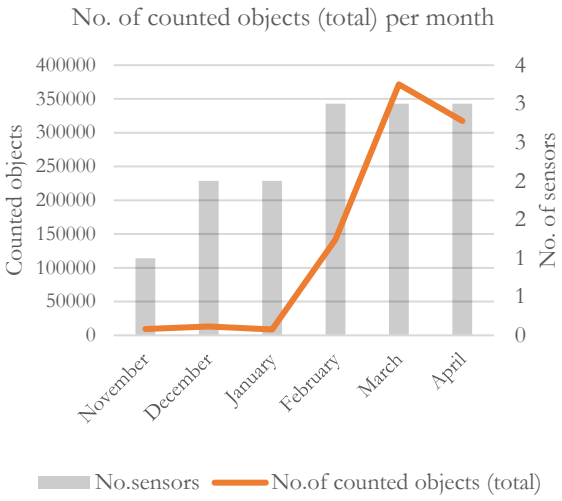


Figure 36: No. of counted objects (categorized) per month.
Figure 37: No. of counted objects (total) per month.

	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70+
November	12.2	52.2	32.6	2.2	0.5	0,1	0.0	0.1
December	7.3	30.6	36.3	19.4	5.3	0.8	0.2	0.2
January	5.4	30.6	44.9	16.6	2.2	0.4	0.0	0.1
February	11.8	28.8	30.4	16.3	8.3	2.4	0.5	1.5
March	8.0	28.2	30.1	15.9	11.6	3.8	0.9	1.5
April	4.7	21.9	32.9	18.6	15.2	5.2	0.9	0.5
TOTAL	**8.3 %**	**32.0 %**	**34.5 %**	**14.8 %**	**7.2 %**	**2.1 %**	**0.4 %**	**0.7 %**

Table 16: Average speed (per month).

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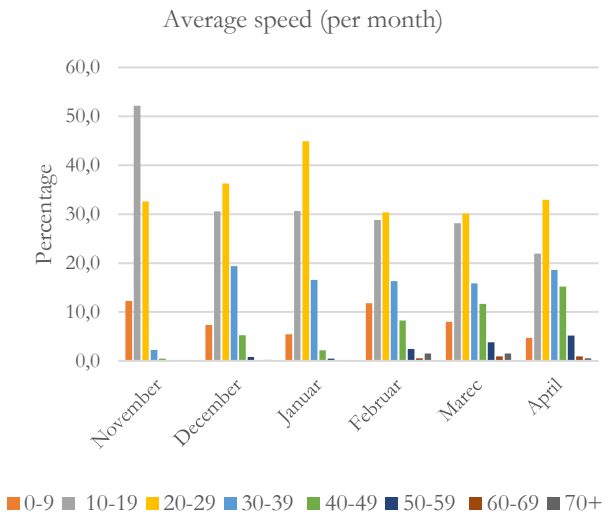

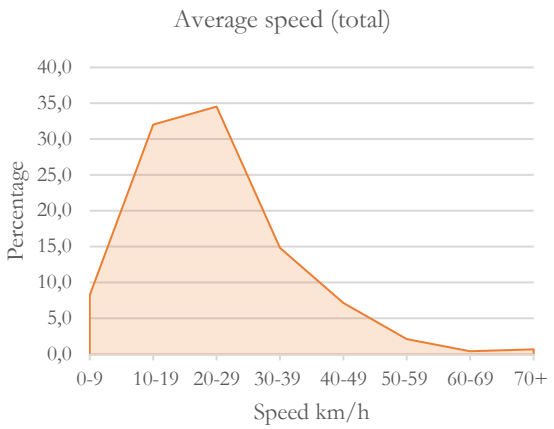

Figure 38: Average speed (per month).
Figure 39: Average speed (total).

Primorska

In the Primorska region, the most vocal support for the project came from a student, Ms. Melissa Bartol Misson, who has a connection to the local municipality and is working on her master thesis. She will use the data from the installed Telraam sensor in her work. In general, installed sensors increased by an average of one per month. In total, the sensors counted 18,012 pedestrians, 208,716 bicycles, 1,616,923 cars and 252,143 large motor vehicles during the six-month period. All told, 2,095,794 street objects were counted.

	Pedestrians	Bikes	Cars	Lorries	No. sensors	Count All
November	1,441	25,843	181,665	27,004	3	**235,956**
December	1,236	20,590	174,374	23,527	4	**219,731**
January	1,840	16,458	183,362	25,171	5	**226,836**
February	4,511	37,876	358,557	45,405	6	**446,355**
March	5,639	54,021	410,745	85,679	6	**556,090**
April	3,344	53,928	308,220	45,357	7	**410,856**
TOTAL	**18,012**	**208,716**	**1,616,923**	**252,143**		**2,095,794**

Table 17: No. of counted objects (categorized) per month.

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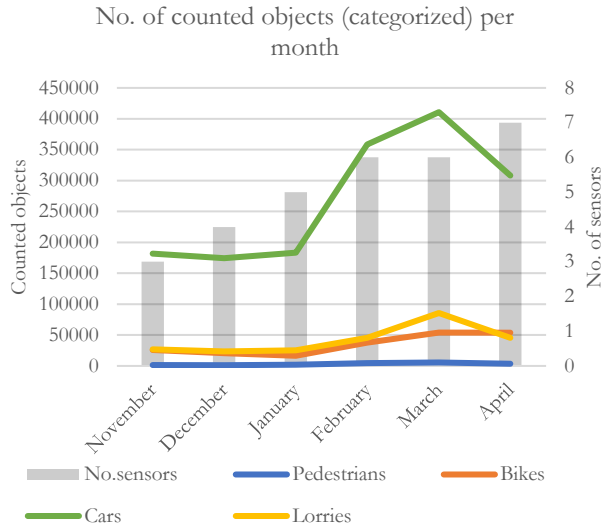

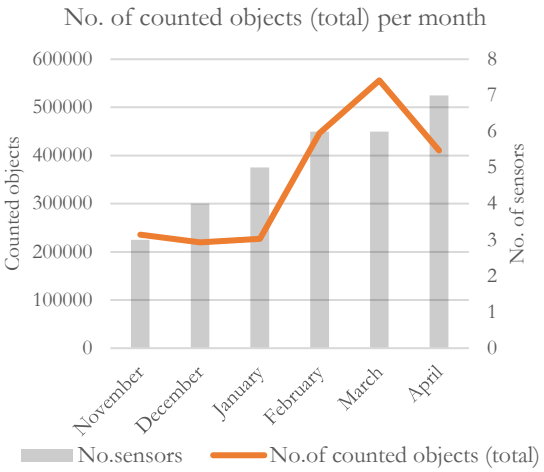

Figure 40: No. of counted objects (categorized) per month.
Figure 41: No. of counted objects (total) per month.

Average values for the speed of cars in the Primorska region 20% drive in the range of 0-9 km/h, 26% drive in the range of 10-19 km/h and 15% in the range of 20-29 km/h. As in all other networks, higher speeds are represented by lower numbers: 12% of trips are in the 30-39 km/h speed range, 9% in the 40-49 km/h range, 8% in the 50-59 km/h range and 6% in the 60+ km/h range.

The results show that roads are extremely congested even with COVID-19 closures.

	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70+
November	20.6	31.3	141	7.9	4.8	6.7	6.8	7.8
December	13.4	29.7	12.2	10.7	11.5	10.8	7.0	4.8
January	13.9	33.9	16.0	9.2	8.9	7.8	5.7	4.7
February	24.2	24.4	14.4	12.6	9.3	6.9	4.6	3.7
March	17.2	19.4	16.9	15.4	10.6	7.8	5.4	7.3
April	32.7	14.5	139	13.5	9.6	6.3	4.5	5.0
TOTAL	**20.3 %**	**25.5 %**	**14.6 %**	**11.5 %**	**9.1 %**	**7.7 %**	**5.7 %**	**5.5 %**

Table 18: Average speed (per month).

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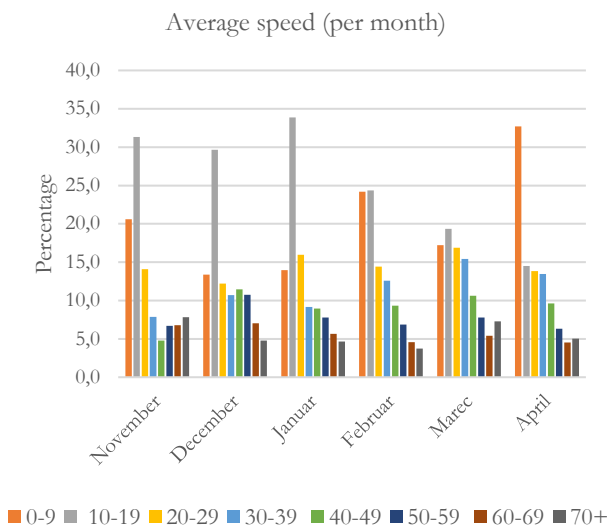

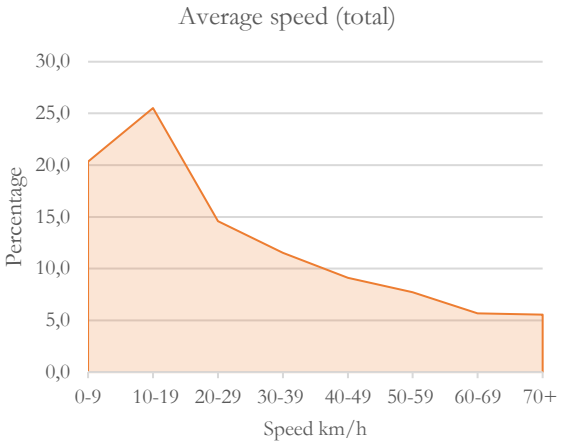

Figure 42: Average speed (per month).
Figure 43: Average speed (total).

Comparison with existing data

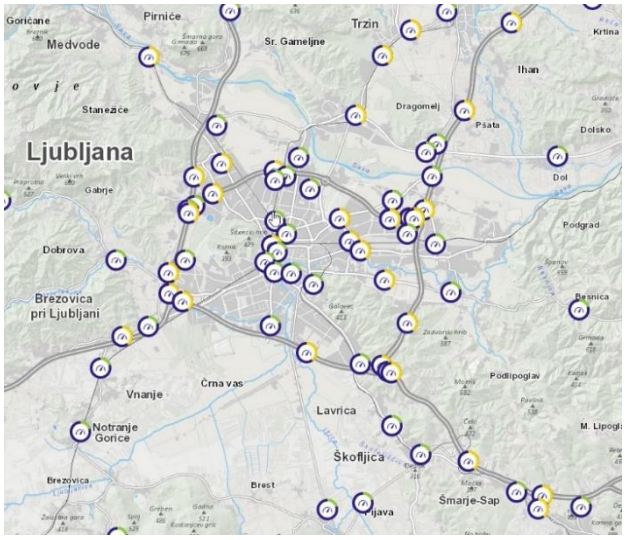

Figure 45: MOL network

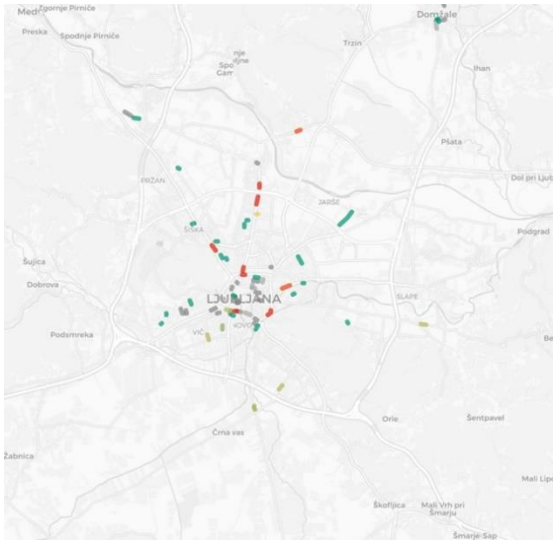

Figure 44: Telraam network

A system of official traffic counting with stationary counters has been established in Ljubljana [13]. Most of the traffic counters are installed on the bypasses and main access roads. After checking the locations of the official traffic counters and the locations of the installed Telraam sensors, the locations of the Telraam sensors do not match the locations of the official traffic counters. In the research group, we tried to compare some locations that either partially match or are in a common section or area. The data provided by the official traffic counters from MOL are the average speed of vehicles and the density of traffic on the lane and passing lane. Therefore, for comparison with the official count, we took the data from the Telraam sensors and adjusted them for the analysis. For the comparison of traffic density we considered the average sum of the number of cars and trucks, and for the comparison of average speed we took the speed data

[13] https://prominfo.projekti.si/web/

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v85 from the graph on the Telraam site. The following comparisons are made for a specific day of the year and a specific time period.

Dunajska street 24.5. (time period 10:00 – 12:00)

Figure 46: MOL and Telraam on Dunajska street segment

Segment	A-B Traffic density Vehicles/h	B-A Traffic density Vehicles/h	Average speed (total)
Dunajska MOL	396	348	52 km/h

Table 19: MOL data for Dunajska street.

Segment	A-B Traffic density Vehicles/h	B-A Traffic density Vehicles/h	Speed v85
Dunajska Telraam	436	402	49.5 km/h

Table 20: Telraam data for Dunajska street.

Telraam data for roaming traffic on the Dunajska cesta section differs from the official MOL data by about 10%. The v85 data for the Telraam sensor differs from the average speed for the MOL meter by about 5%.

Litijska street 24.5. (time period 10:00 – 14:00)

Figure 47: MOL and Telraam on Litijska street.

Segment	A-B Traffic density Vehicles/h	B-A Traffic density Vehicles/h	Average speed (total)
Litijska MOL	312	348	43.5 km/h

Table 21: MOL data for Litijska street.

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Segment	A-B Traffic density Vehicles/h	B-A Traffic density Vehicles/h	Speed v85
Litijska Telraam	227	250	43.75 km/h

Table 22: Telraam data for Litijska street.

Telraam data for roaming traffic on the Litijska cesta section differs from the official MOL data by about 27%. The v85 data for the Telraam sensor does not differ from the average speed for the MOL meter.

4.1.2 User only data

As described earlier in this report, we encountered several problems in selecting locations for the sensors. Challenges included the peculiarities of urban structures, visibility from the windows of the street body, which in Slovenia is often separated by greenery, COVID-19 Lockdown, Wi-Fi problems with the operation of the sensors due to the sensitivity of the devices, and other circumstances. Relatively few devices worked reliably during the whole period of traffic monitoring and counting.

For the detailed analysis we selected five road sections, namely Zoisova cesta, which is part of the inner ring of Ljubljana and is highly congested. Dunajska cesta, which is one of the main access roads to Ljubljana, but the location of the sensor is outside the Ljubljana motorway bypass. The location of the sensor on Litijska cesta is also outside the Ljubljana motorway bypass. Pokopališka cesta is a less busy street connected to another main access road to Ljubljana - Šmartinska cesta - but the neighbourhood itself is exclusively residential in character and finally Ulica Ob Ljubljanici, the least busy street along Ljubljanica River, where cyclists and heavy traffic predominate.

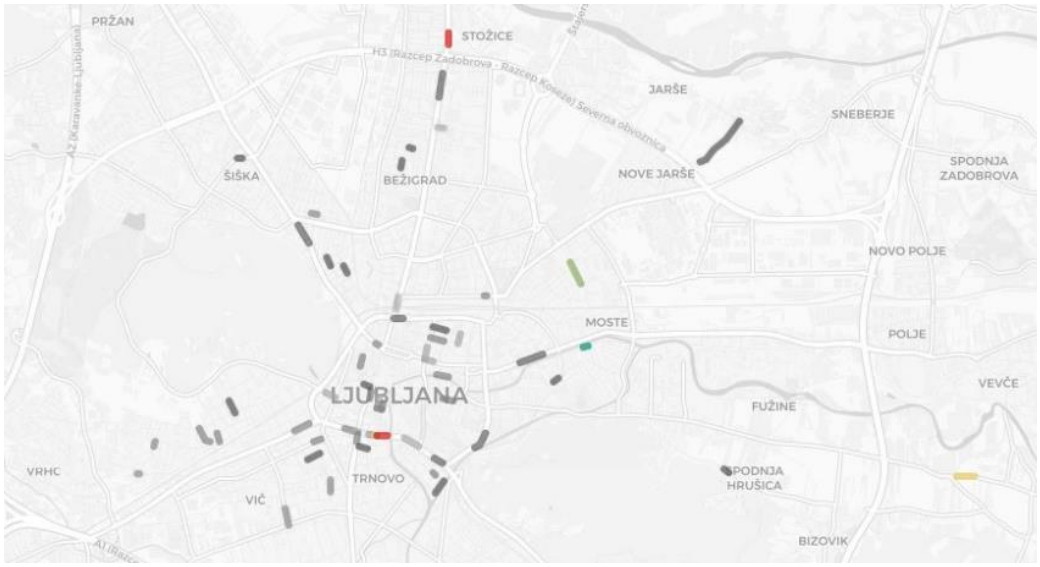

Figure 48: Analysed Telraam devices

Zoisova street

Zoisova street, is a busy road that is part of the inner ring Ljubljana Road. At the location of the sensor, the road has two lanes westbound to the city centre and only one lane eastbound in the other direction. The speed limit is 50 km/h and most cars travel 30 - 40 km/h, there are some (about 5%) that exceed the speed limit. From November to April the total number of cars continued to increase, this could be because the COVID-19 restrictions were lifted.

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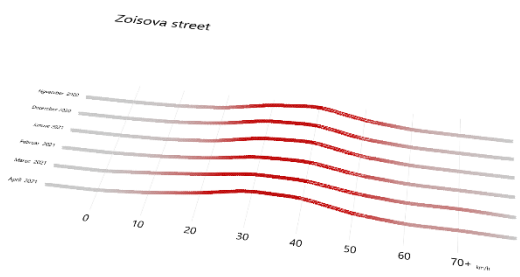


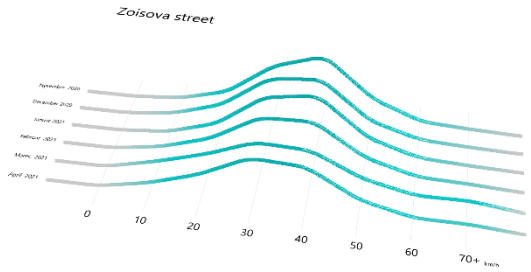


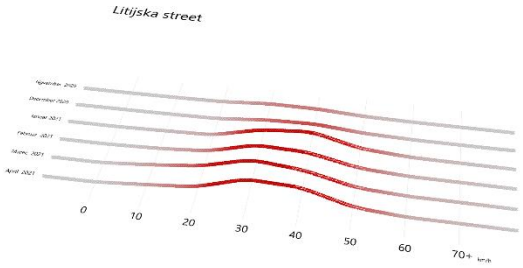
Figure 49: Absolute numbers of cars for Zoisova street.
Figure 50: Percentage for Zoisova street.

Zoisova street	Speed 0		Speed 10		Speed 20		Speed 30		Speed 40		Speed 50		Speed 60		Speed 70+	
November	743	3%	612	2%	2754	10%	8318	29%	10831	38%	4115	14%	816	3%	311	1%
December	828	3%	957	3%	3537	12%	9235	32%	10042	35%	3355	12%	751	3%	295	1%
January	787	3%	761	3%	3407	11%	9456	32%	10697	36%	3753	13%	825	3%	313	1%
February	1038	3%	1406	5%	4139	14%	9216	30%	9518	31%	3568	12%	874	3%	541	2%
March	2059	5%	2714	7%	6012	16%	10447	27%	9943	26%	4241	11%	1465	4%	1618	4%
April	1775	4%	2552	6%	6587	15%	12781	30%	12037	28%	4515	11%	1191	3%	1162	3%

Table 23: Zoisova street statistics

Litijska street

Litijska Street is the city entrance from Litija (from the east). It is an arterial road connecting settlements east of Ljubljana with Ljubljana. The speed limit is 60 km/h, it has two lanes. The section where the sensor is installed is without sidewalks in the bike lanes. There are two bus stops (one on each side) and a pedestrian crossing that can reduce the speed detected by the sensor. Most cars have a speed of 30 to 40 km/h, a small percentage (1%) has exceeded the speed limit. In November and December, there were less cars due to COVID-19 restrictions. After the restrictions were lifted, the travel speed became lower (more congestion).



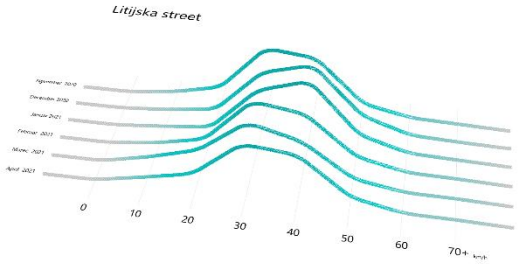


Figure 51: Absolut numbers for Litijska street.
Figure 52: Percentage for Litijska street.

Litijska street	Speed 0		Speed 10		Speed 20		Speed 30		Speed 40		Speed 50		Speed 60		Speed 70+	
November	258	4%	244	3%	704	10%	2750	38%	2518	35%	600	8%	149	2%	76	1%
December	286	3%	236	2%	624	6%	3450	33%	4233	41%	1254	12%	227	2%	91	1%
January	766	3%	719	3%	1549	6%	9174	33%	11626	42%	3114	11%	580	2%	272	1%
February	1483	5%	1064	3%	2991	10%	11534	37%	10138	33%	2692	9%	549	2%	348	1%
March	1958	5%	2586	6%	5994	15%	14607	36%	11270	28%	2795	7%	611	2%	478	1%
April	1827	4%	2435	6%	5151	12%	15106	35%	13668	32%	3493	8%	590	1%	430	1%

Table 24: Litijska street statistics.

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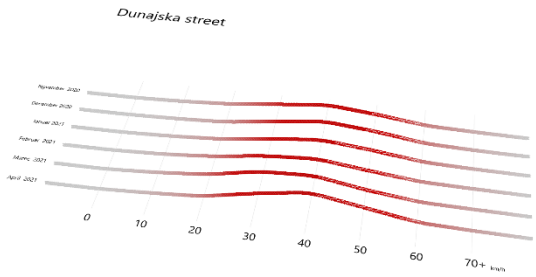
Dunajska street

Dunajska cesta is the main entrance to the city of Ljubljana from the northern part. The speed limit is 60 km/h. Where the sensor is installed, there are two lanes on each side, a bicycle lane, a sidewalk and a bus stop. Traffic increases with the removal of the restrictions.



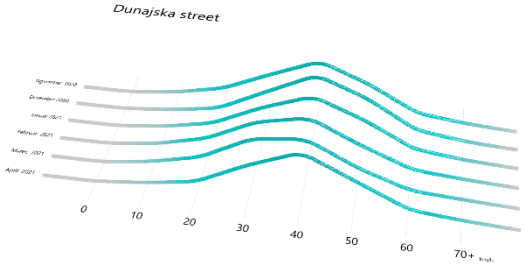


Figure 53: Absolut numbers for Dunajska street.
Figure 54: Percentage for Dunajska street.

Dunajska street	Speed 0		Speed 10		Speed 20		Speed 30		Speed 40		Speed 50		Speed 60		Speed 70+	
November	1590	6%	883	3%	2520	9%	5894	21%	9073	32%	5879	21%	1583	6%	579	2%
December	1060	4%	710	2%	1996	7%	6033	21%	9947	35%	6677	23%	1812	6%	566	2%
January	1476	5%	921	3%	2662	9%	6745	22%	9916	33%	6384	21%	1713	6%	583	2%
February	1980	6%	1162	4%	3438	11%	7913	25%	9815	31%	5329	17%	1447	5%	617	2%
March	3049	8%	1641	4%	4438	11%	10744	27%	12161	30%	6000	15%	1627	4%	740	2%
April	2445	6%	1318	3%	3368	8%	9804	22%	14975	34%	8592	20%	2232	5%	867	2%

Table 25: Statistics for Dunajska street.

Pokopališka street

Pokopališka street is a smaller street in the sleeping area, with a graphic high school nearby. The speed limit is 30 km / h. It connects the area of Zelena jama with Šmartinska cesta (which is the main entrance from the northeast). On the section where the sensor is, there are two lanes towards Šmartinska cesta, on the opposite side there is one lane. There is no bike lane, the sidewalk is on both sides. The number of cars is constant, their speeds increase over time (from November 2020 to April 2021). A large percentage of cars exceed the speed limit, this can be attributed to the proximity of traffic lights.

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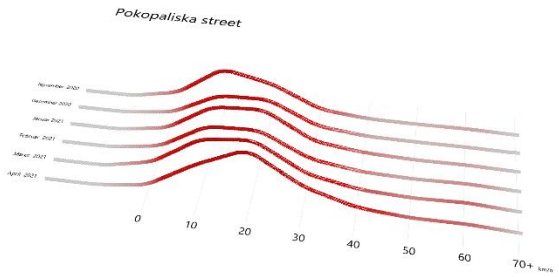


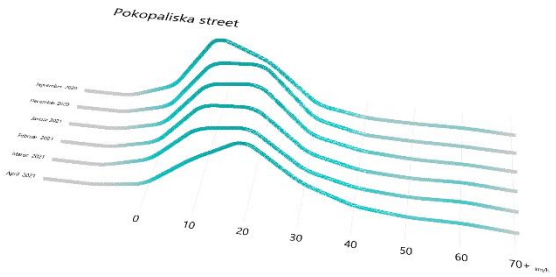


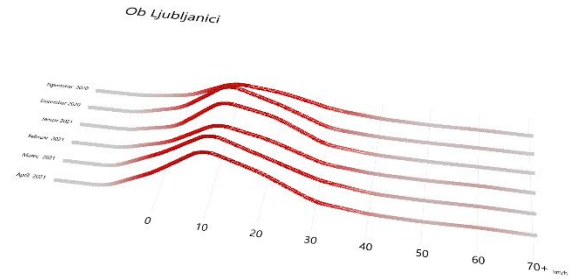
Figure 55: Absolut numbers for Pokopališka street.
Figure 56: Percentage for Pokopališka street.

Pokopališka street	Speed 0		Speed 10		Speed 20		Speed 30		Speed 40		Speed 50		Speed 60		Speed 70+	
November	1241	5%	2756	10%	12033	44%	8700	32%	1843	7%	347	1%	211	1%	369	1%
December	514	2%	1705	7%	8875	38%	9257	40%	2077	9%	371	2%	185	1%	216	1%
January	837	3%	2151	7%	10897	36%	11769	39%	3023	10%	910	3%	294	1%	420	1%
February	1889	6%	2169	7%	10532	34%	11110	36%	3221	10%	815	3%	310	1%	653	2%
March	1807	5%	3114	8%	12586	32%	14121	36%	4812	12%	1519	4%	648	2%	1094	3%
April	1278	3%	1859	4%	10664	25%	17397	40%	7407	17%	2387	6%	963	2%	1044	2%

Table 26: Pokopališka street statistics.

Ob Ljubljanici

Ob Ljubljanici is a one-way street on the edge of the residential area with a longitudinal parking regime and represents an important bicycle connection between Štepanjsko naselje and the city center. The speed limit is 30 km/h, a small percentage of cars exceed this speed (about 3%). The diagrams show that fewer cars appeared when there were COVID-19 restrictions, but the speeds were higher.



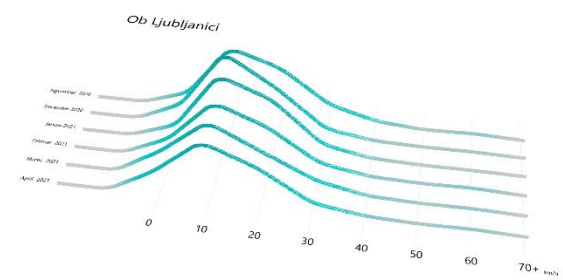


Figure 57: Absolut numbers for Ob Ljubljanici.
Figure 58: Percentage for Ob Ljubljanici.

Ob Ljubljanici	Speed 0		Speed 10		Speed 20		Speed 30		Speed 40		Speed 50		Speed 60		Speed 70+	
November	701	4%	1678	9%	7418	41%	5690	31%	1962	11%	478	3%	65	0%	208	1%
December	608	2%	3278	13%	12452	48%	7642	29%	1506	6%	300	1%	128	0%	187	1%
January	941	3%	2865	10%	12834	45%	9512	33%	2087	7%	361	1%	81	0%	119	0%
February	2873	10%	3767	13%	11574	39%	8058	27%	2092	7%	488	2%	216	1%	431	1%
March	3504	9%	6343	17%	14561	39%	8757	23%	3101	8%	612	2%	240	1%	383	1%
April	3715	9%	6611	16%	15903	39%	10624	26%	2709	7%	727	2%	229	1%	480	1%

Table 27: Ob Ljubljanici statistics.

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4.2 Participatory Data Analysis by citizens

4.2.1 "Unguided" citizen analysis

Sabina Potočki

Ljubljana / Zaloška cesta / street segment no. 9000001501B

For the first few weeks the Telraam camera correctly monitored the relationship between vehicles and cyclists, at least in my opinion, in a week it "learned" to detect heavy vehicles, and a few days ago I lost my internet connection for a short time, which I did not find out until a day and a half later. Following the instructions, I then turned the camera off and back on, checked the view, and resumed operation. The fact that it does not reconnect on its own is probably not such a central problem, as I lose connection extremely rarely. However, in the last few days the counting results are surprising, as the camera is "recording" an extremely high number of cyclists, certainly a number that is many times the volume of cycling traffic in the last few days. Since the point of Telraam is to record the ratio between different vehicles as accurately as possible, I do not see the point of the count if the results (especially in the last 4 days) show say a cycling flow between 200 and 600 per hour, which is completely unrealistic. Based on the graph below, it seems to me that the camera was counting relatively correctly up to Feb 11th 2021, and the results for the last few days and the ratio of cars to cyclists are completely wrong ... I have no idea what the reason is, do you think maybe the camera has "illusions" because from morning until about 1:00 or. 2:00 pm the sun is shining directly on the recording window? Because until 2.00 pm, the results of this excessive number of cyclists appear here, and in the afternoon, when the sun is not shining on the window, the results appear more normal. Today, for example, the camera measured 3,877 cyclists and 2,634 cars, which looks to me like a cyclist revolution is being prepared in Ljubljana. Of course, the number of cyclists today, for example, is not significantly different from February 1st, 2nd, or 3rd. Maybe there are a few more because of the nice weather, but there cannot be a few hundred more ... Any advice? Unfortunately, this "sun" window is the only one that lends itself to counting, so let me know if counting makes any sense at all, because if the sun is to blame, the results on sunny days will probably be completely wrong, which is probably not the point of counting.

A link to the UV protection film I used on the outside window where the camera is located is in the description. I am also attaching photos of the view of the camera and the street from the apartment, the view of the window with the film from outside the apartment, and another photo of the window from the street side where you can see the film, which is reflective, meaning you cannot see it through the windows into the apartment.

I think the film helped a bit because now the window is tinted, the glass does not heat up, and it kind of protects the camera from direct sunlight and hot glass. But I am not sure that this film prevents the camera from counting cyclists perfectly correctly during the hours when the sun shines directly on the window, because there still seem to be far fewer cyclists on cloudy days than on sunny mornings. [14]

For comparison, let us look at the data from 3 to 6 May 2021 (Mon-Thu) on my Telraam, when it was mostly cloudy and occasionally rainy, and compare it to the results from, say, from 10 to 11 May 2021,

14 https://www.amazon.de/Sonnenschutz-Spiegelfolie-hochglanzverspiegelt-selbstklebend-Innenmontage/dp/B0716P68K7/ref=sr_1_10?currency=EUR&dchild=1&ie=UTF8&keywords=Window%20UV%20film&language=en_GB&qid=1614329865&sr=8-10

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when it was sunny... Of course, there is always the possibility that there are more cyclists on sunny days than usual, but I still think the variances are too large, but they are now that the slide on the window can be a bit smaller...

Let us say on it was cloudy on Monday, May 3 and the camera recorded 1,166 cyclists; yesterday, which was also Monday and it was sunny, it recorded 2,725 cyclists. So, like I said, I don't know exactly how and what, but somehow, I don't think there were 1,600 more cyclists on the road yesterday just because the weather was nice.

Figure 59: The view of the camera and the street from the apartment, the view of the window with the film from outside the apartment, and another photo of the window from the street side where you can see the film.

Tilen Košak

Primorska / Ulica Istrskega odreda / street segment no. 9000000794B

Figure 60: Ulica Istrskega odreda, shown on map in red.

The analyses made by the owner of the meter on Ulica Istrskega odreda in Lucija in the Primorska region are shown. The diagrams show that the number of traffic increases with time. This is due to the release of measures related to COVID-19 and the approach of the summer tourist season.

	Bike (A > B / lft)	Bike (B > A / rgt)
January	8,388	2,543
February	9,470	6,545
March	10,790	12,113
April	21,060	16,949

Table 28: Ulica Istrskega odreda, bikes.

The table shows the number of bikes that passed his window from January to April 2021. The numbers are higher on the left side of the road (from point A to point B), which means that more bicycles go from Lucija to Valeta than vice versa. It is strange that more bikes go uphill than downhill. Clearly the number of bikes is increasing with time.

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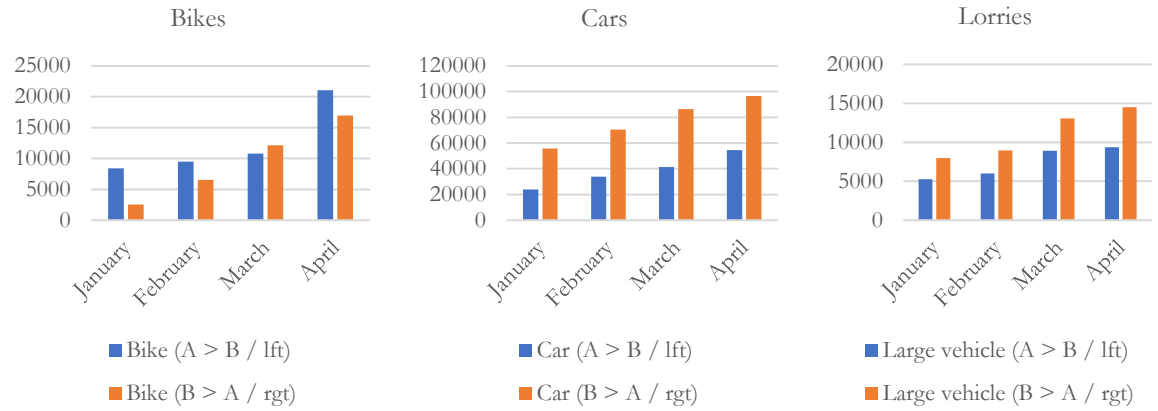

Table 29: Bikes, cars, and lorries statistics.

The graphs show that the number of passing objects increases with time. Suspiciously, many more cars travel from point B to point A, that is, from Valeta to Lucija.

	Car (A > B / lft)	Car (B > A / rgt)
January	24,015	55,888
February	33,820	70,505
March	41,223	86,504
April	54,442	96,720

Table 30: Ulica Istrskega odreda, cars.

	Large vehicle (A > B / lft)	Large vehicle (B > A / rgt)
January	5,243	7,961
February	6,013	8,945
March	8,923	13,073
April	9,365	14,515

Table 31: Ulica Istrskega odreda, large vehicles.

4.2.2 "Guided" data analysis

In Ljubljana, we wanted to test the usefulness of data obtained from Telraam devices in a specific case in a targeted analysis. For this purpose, we invited students from the Faculty of Architecture to participate and contribute their knowledge to the understanding and interpretation of the obtained data.

SNP exercise

As part of the SNP course at the Faculty of Architecture, an exercise was conducted for urban design students. The exercise was carried out with the aim of presenting the WeCount project, which focuses on public participation in the planning of a better living environment, learning new technologies, the registration of traffic flows and obtaining user data in concrete cases. 29 students participated in the course and completed the exercise. The process of the exercise was designed in 3 steps, which are described below.

To introduce the exercise, an online workshop was organized on November 25, 2020 to introduce the WeCount project and explain how to interpret the data obtained on the Telraam site.

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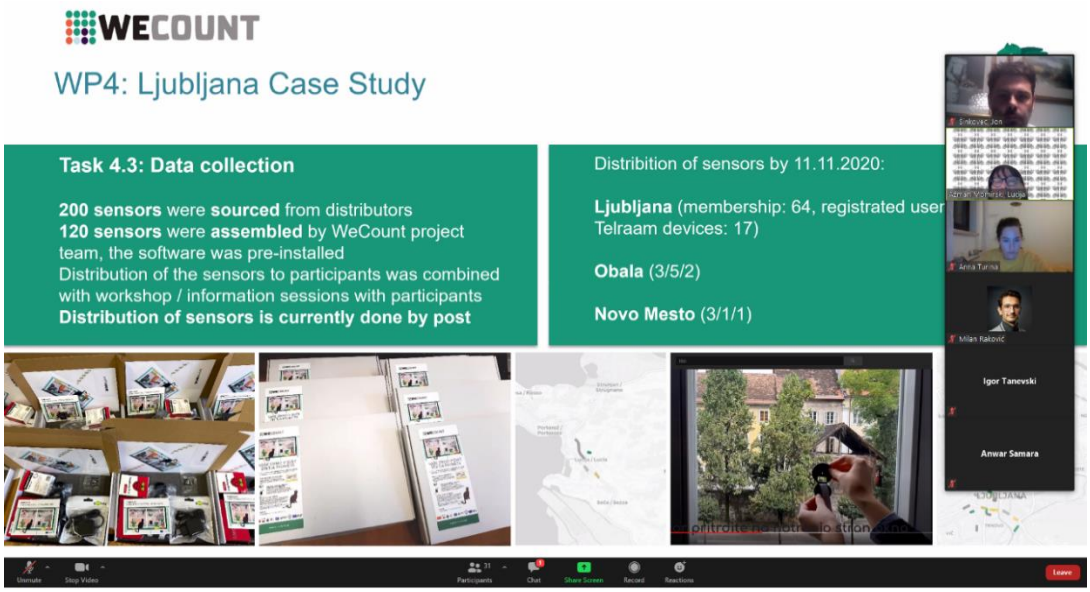

Figure 61: For all students who wanted to do an exercise for SNP course, two more workshops were organized.

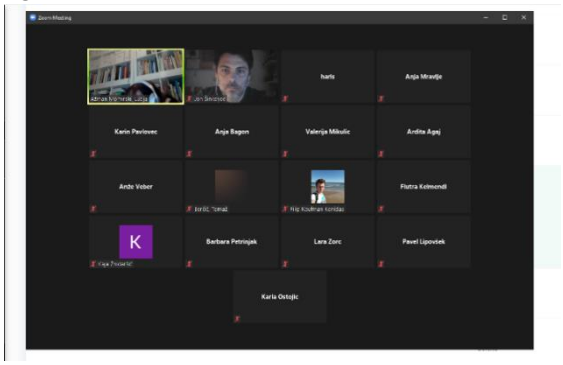

Figure 62: The workshop was attended by 14 students.

For all students who wanted to do an exercise for SNP course, two more workshops were organized (**Napaka! Vira sklicevanja ni bilo mogoče najti.**) to explain the procedure of the exercise in more detail. The workshop was attended by 14 1st semester students on 6/1/2021 (**Napaka! Vira sklicevanja ni bilo mogoče najti.**) and 11 2nd semester students on 13/1/2021.

TOTAL PARTICIPANTS	PARTICIPANTS female	PARTICIPANTS male	SIGN – UP observer	SIGN – UP counter
28	20 (72%)	8 (28%)	26(92%)	2(8%)

Table 32: Workshop participants.

The SNP exercise was divided into three parts.

First step - GDPR

The first step was to introduce students to the process of participation in the research, taking into account the Data Protection Act and their rights and responsibilities as participants in the WeCount project. All students who participated in the survey were required to complete and sign an informed consent form and complete an online survey confirming their consent to use their exercise results for scientific purposes in the WeCount project.

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TOTAL PARTICIPANTS	PARTICIPANTS female	PARTICIPANTS male	AGE 20-24	AGE 25-30	Place of residence suitable for Telraam device	Place of residence unsuitable for Telraam device
29	19 (71%)	10 (29%)	22 (75%)	7 (25%)	17 (58%)	12 (42%)

Table 33: Workshop participants.

Second step - public participation

In the second step, we put the students in the role of a local champion who has to present the project to any three residents of the city and ask them about participating in the WeCount survey and about their possible willingness to count traffic with the Telraam device. The student had to present the WeCount project, the enrolment process, the data analysis, and at the end prepare a report in the form of a completed online survey. We prepared two online surveys, for candidates who have a suitable window to install a Telraam device and for candidates who do not have a suitable window (Figure). The graphs below show the results of the surveys.

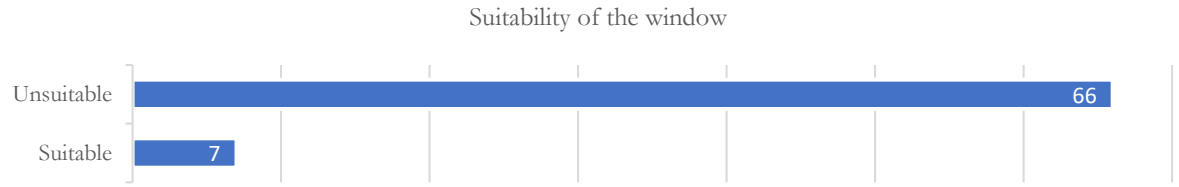
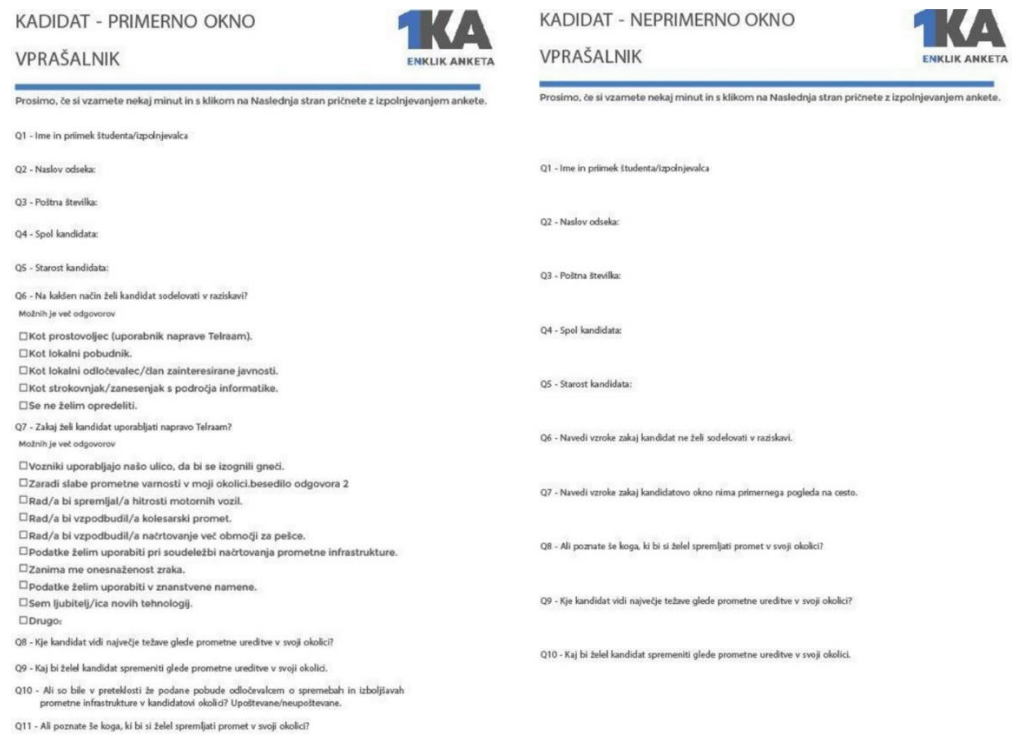


Table 34: Suitability of the window.


KADIDAT - PRIMERNO OKNO

VPRAŠALNIK

ENKLIK ANKETA

Prosimo, če si vzamete nekaj minut in s klikom na Naslednja stran pričnete z izpolnjevanjem ankete.

Q1 - Ime in priimek študenta/izpolnjevalca

Q2 - Naslov odseka:

Q3 - Poštna številka:

Q4 - Spol kandidata:

Q5 - Starost kandidata:

Q6 - Na kakšen način želi kandidat sodelovati v raziskavi?

Možnih je več odgovorov

- ☐ Kot prostovoljec (uporabnik naprave Telraam).
- ☐ Kot lokalni pobudnik.
- ☐ Kot lokalni odločevalec/član zainteresirane javnosti.
- ☐ Kot strokovnjak/zanesenjak s področja informatike.
- ☐ Se ne želim opredeliti.

Q7 - Zakaj želi kandidat uporabljati napravo Telraam?

Možnih je več odgovorov

- ☐ Vozniki uporabljajo našo ulico, da bi se izognili gneči.
- ☐ Zaradi slabe prometne varnosti v moji okolici.besedilo odgovora 2
- ☐ Rad/a bi spremljal/a hitrosti motornih vozil.
- ☐ Rad/a bi vzpodbudil/a kolesarski promet.
- ☐ Rad/a bi vzpodbudil/a načrtovanje več območji za pešce.
- ☐ Podatke želim uporabiti pri soudeležbi načrtovanja prometne infrastrukture.
- ☐ Zanima me onesnaženost zraka.
- ☐ Podatke želim uporabiti v znanstvene namene.
- ☐ Sem ljubitelj/ica novih tehnologij.
- ☐ Drugo:

Q8 - Kje kandidat vidi največje težave glede prometne ureditve v svoji okolici?

Q9 - Kaj bi želel kandidat spremeniti glede prometne ureditve v svoji okolici.

Q10 - Ali so bile v preteklosti že podane pobude odločevalcem o spremembah in izboljšavah prometne infrastrukture v kandidatovi okolici? Upoštevane/neupoštevane.

Q11 - Ali poznate še koga, ki bi si želel spremljati promet v svoji okolici?

KADIDAT - NEPRIMERNO OKNO

VPRAŠALNIK

ENKLIK ANKETA

Prosimo, če si vzamete nekaj minut in s klikom na Naslednja stran pričnete z izpolnjevanjem ankete.

Q1 - Ime in priimek študenta/izpolnjevalca

Q2 - Naslov odseka:

Q3 - Poštna številka:

Q4 - Spol kandidata:

Q5 - Starost kandidata:

Q6 - Navedi vzroke zakaj kandidat ne želi sodelovati v raziskavi.

Q7 - Navedi vzroke zakaj kandidatovo okno nima primernega pogleda na cesto.

Q8 - Ali poznate še koga, ki bi si želel spremljati promet v svoji okolici?

Q9 - Kje kandidat vidi največje težave glede prometne ureditve v svoji okolici?

Q10 - Kaj bi želel kandidat spremeniti glede prometne ureditve v svoji okolici.

Figure 35: We prepared two online surveys, for candidates who have a suitable window to install a Telraam device and for candidates who do not have a suitable window.

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Suitable window

Number of respondents: 7

There were 7 participants with suitable windows. Most of them were 24 and 29. Most project participants were volunteers. Reason for participating was mostly driven by love for new technologies. Others who joined the project were also interested in academic benefits of the project, however none of the participants wanted to use the data for scientific purpose.

Gender	Female	Male
No. of participants with suitable window	3	4

Table 35: No. of participants with suitable window.

Age	23	24	28	29	38
No. of participants with suitable window	1	2	1	2	1

Table 36: No. of participants with suitable window.

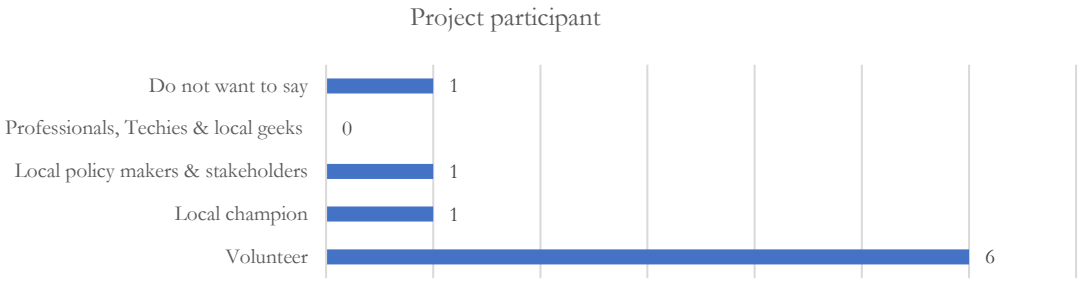

Table 37: Project participant.

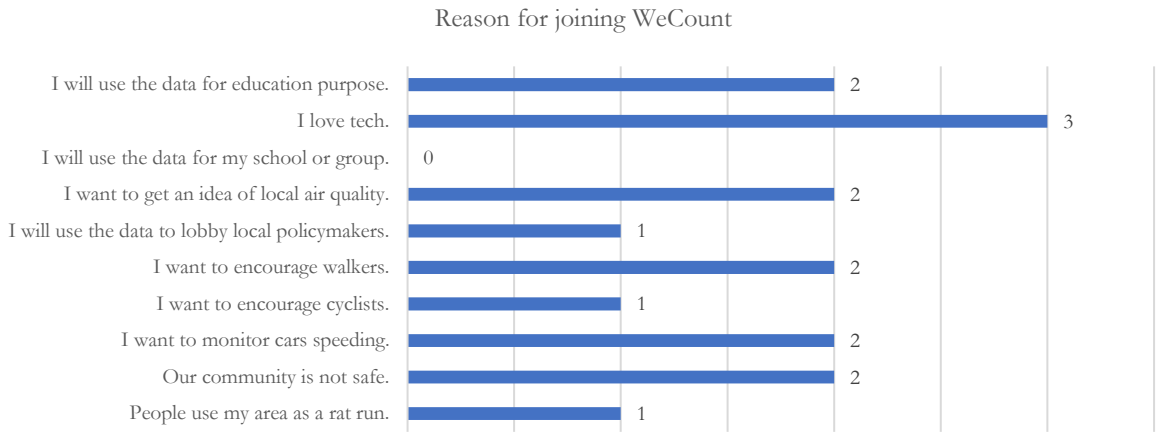

Table 38: Reason for joining WeCount

Unsuitable window

Number of respondents: 66

There were 66 participants with inappropriate windows. Most of them were between 20 and 29 years old. The most common reason for unsuitable windows was that none of their windows faced the street. Some also stated that there were many obstructions blocking the view from their window, such as trees and fences. For some, their building is too far from the street, and some do not live in the selected areas.

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Gender	Female	Male
No. of participants with unsuitable window	42	24

Table 39: No. of participants with unsuitable window.

Age	15-19	20-29	30-39	40-49	50-59	60-69	70-79
No. of participants with unsuitable window	1(1%)	50(76%)	4(6%)	4(6%)	3(5%)	3(5%)	1(1%)

Table 40: No. of participants with unsuitable window.

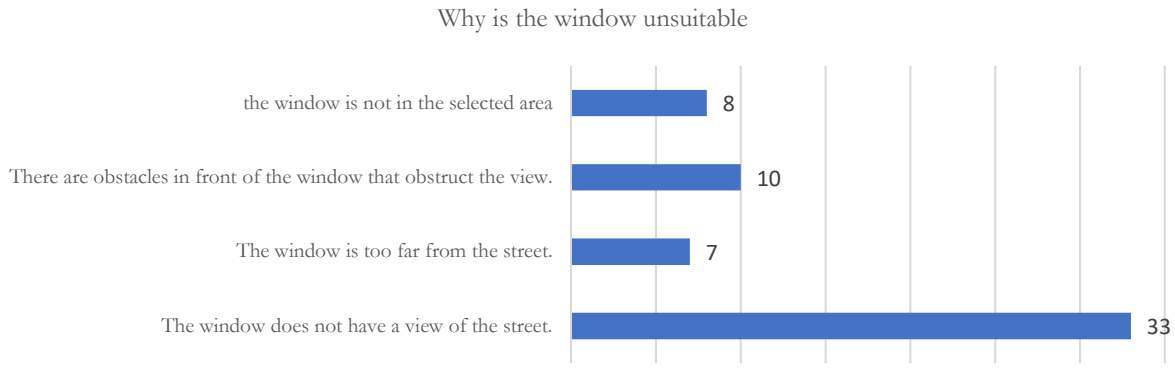

Table 41: Why is the window unsuitable.

Third step – Exercise; graphic work

In the third step, we presented the students with the Telraam data obtained and its application to a specific case. Each student had to choose their own road section where the Telraam device is already installed. The first task was to outline the existing situation without Telraam data, with an analysis of the traffic structure on the selected section and an analysis of the width of the road profile in relation to the users - road users. The second task was to sketch the situation on the selected section with Telraam data. The third task was to compare the situation without and with Telraam data and to suggest improvements in traffic regulation based on the Telraam data obtained.

The graphs below shows the students' results and solutions. They selected street sections and analysed the actual situation there in terms of traffic density and structure. Lack of bike lanes, high bike traffic, high speeds in residential areas are just some of the problems identified by the students. Their solutions largely follow the Telraam data obtained, resulting in high quality solutions for redesigning road profiles.

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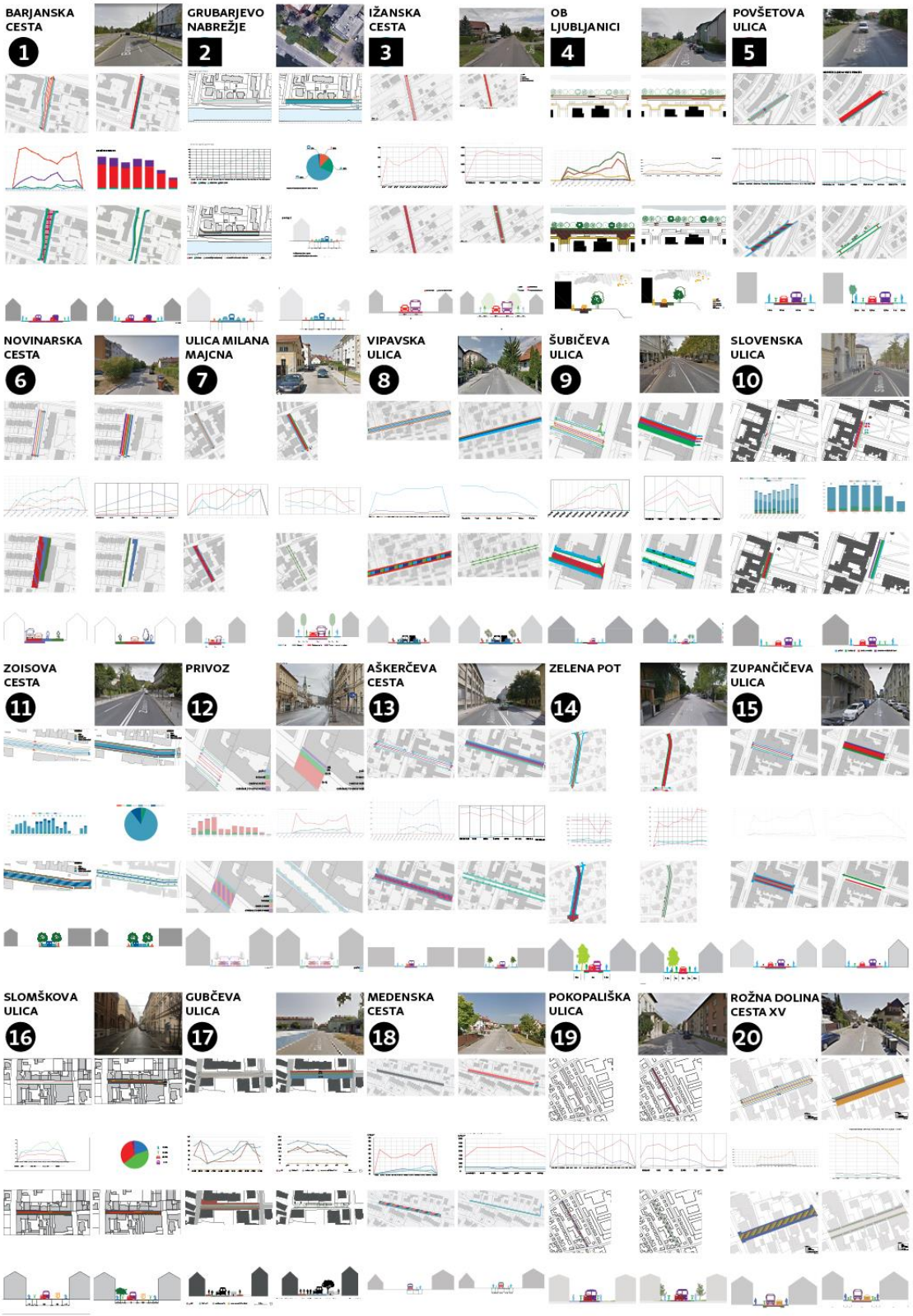

Figure 63: Student workshop results.

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4.3 Bridge to the Policy Level

The city of Ljubljana joined the project in September 2020. While searching for suitable windows, we came across several buildings owned by the City of Ljubljana with a suitable view of the street where a Telraam device could be installed, and traffic counted. Our first goal was to get permission to install the devices on the windows of the buildings. Discussions began, first a meeting with the Director of Administration Ljubljana Municipality. The project was presented, and the municipality showed great interest and recognized the many advantages of traffic counting with the Telraam device.

Electric scooters in Ljubljana

They were particularly interested in counting electric scooters, as they are growing rapidly in Ljubljana. Due to the lack of regulations and the danger for pedestrians, the city of Ljubljana wants to regulate the matter. The Slovenian government is currently preparing an amendment to the Traffic Act, which will also consider the increasing use of electric scooters in traffic. Therefore, the city administration would like to receive detailed statistics about electric scooters, with the Telraam sensor such separation is not possible, therefore they are not suitable for data collection.

Nevertheless, the reaction of the City of Ljubljana regarding participation in the WeCount project was positive.

Nova Gorica and LoReWan network

Through the local champion for Novo mesto, we contacted Mr. Robert Ambrož, who is one of the founding members of The Things Network Nova Gorica community and the Xiris Institute. We talked in detail about our WeCount project and the possibility of involving the population in Nova Gorica.

Mr. Ambrož's wish is to install many devices in Nova Gorica and connect the devices to the LoReWan network. Mr. Ambrož joined the volunteers to count the traffic, we provided him with two devices.

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5 Reflection, Legacy, and Conclusions

In the final phase of the research project, it is time to reflect on the whole working process that has taken place within WeCount, the results and the impact that the research will have. We have shared the findings throughout with other WeCount members in Wales, Spain and Ireland. We conclude by describing positive practices and difficulties encountered during project implementation.

The study was based on the latest evidence on citizen participation. Active citizens were involved in the project at different stages and using different strategies. With their help we were able to identify problems, they participated in the co-design of the traffic count network, the data analysis and the final reflection.

Not to be neglected are the mitigation measures of COVID-19 that significantly changed the course of project implementation. It was difficult to recruit new participants and build our network. Project implementation strategies had to be adapted and changed. Creating an initial plan to install 200 Telraam devices was set at a very ambitious level, but still feasible if a COVID-19 epidemic did not occur.

In terms of legacy, we can say that the Ljubljana Research Project left several useful contents in different areas.

- Video content about the installation of the device and the registration process, available for everyone on YouTube.
- Analysis of the strategies and methods used to recruit people
- Instructions on how to conduct online workshops, including presentations
- a complete guide on how to extend the case study to other neighbourhoods and cities in the country

In the future, we intend to continue traffic counting in Ljubljana and other areas of Slovenia even after the official end of the project. We will endeavor to present the results of the research to the population and draw attention to the problems where they have been perceived. As mentioned in the previous chapters, we are striving for the realization of cooperation with the municipality Nova Gorica, which wants to introduce Telraam devices and public participation in changing the living environment. We are in the final stage of negotiations with the City of Ljubljana and are expected to start installing Telraam devices in the near future, which would give an even clearer picture of traffic flows in the city.

Interviews

Interviews with the counters were conducted to gather their feedback information. Most of them did not like the idea of being recorded therefore their answers are in written form. The interviews were done online using Zoom or via phone call.

Questions asked:

- Why are you interested in counting traffic?
- What changes do you want to see in your neighbourhood?
- What bothers you the most in your neighbourhood?
- What characteristics do you think good road regulation should have?
- Do you think that a quality living environment is conditioned by good road regulation?
- With the help of the obtained data, would you be ready to approach the city authorities and demand changes?

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- Have initiatives been taken in the past to decision-makers on changes and improvements to transport infrastructure in your area?
- Do you know anyone else who would like to monitor the traffic in their area?
- Do you think that the WeCount project is addressing residents appropriately for their participation in urban transport policy?
- How will you use the obtained data?
- Overall, how have you found being involved in the project?
- From your experience, what aspects of the project do you think could be improved? (if they hesitate much say: e.g., technology, communication)
- What has been your experience of using the digital technology? (e.g. the Telraam device, website and dashboard)
- How active would you say you were in your street/neighbourhood before WeCount regarding traffic-related issues?
- Has your involvement in WeCount changed your level of activity, and if so, how?
- Do you have plans to continue using the Telraam beyond the end of the project? (please explain)
- How would you say the COVID-19 pandemic has impacted on your experience as a participant of WeCount?

Figure 64; Interviews with the counters were conducted to gather their feedback information.

Counter 01	Male	30-40
Counter 02	Female	20-30
Counter 03	Male	20-30
Counter 04	Female	20-30
Counter 05	Female	20-30
Counter 06	Male	20-30
Counter 07	Male	40-50
Counter 08	Male	30-40
Counter 09	Female	20-30
Counter 10	Male	40-50

Table 42: Survey participants demographics.

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6 Appendix 1: Local Communication and Dissemination Case Ljubljana

Title of publication	Title of the medium (e.g. name of the website/blog etc.)	Date of publication	Press article (x=YES)	Website article (x=YES)	Radio broadcast (x=YES)
Senzorji prometa tudi v stanovanja v Ljubljani. Kakšen je njihov namen?	https://avto-magazin.metropolitan.si/	22.01.2020		x	
Senzorji prometa tudi v Ljubljani	www.revija-tranzit.si	January2020		x	
Senzorji prometa tudi v stanovanja v Ljubljani. Kakšen je njihov namen?	www.novice.press	23.01.2020		x	
Senzorji prometa tudi v Ljubljani	https://www.racunalniske-novice.com/	22.01.2020		x	
ETM - Znanost z družbo in za njo: 5 evropskih mest za izboljšanje lokalne mobilnosti	www.mojaobcina.si	19.09.2020		x	
Evropski teden mobilnosti – znanost z družbo in za njo: pet evropskih mest za izboljšanje lokalne mobilnosti	https://www.uni-lj.si/	17.09.2020		x	
Fakulteta za arhitekturo z inovativnim projektom za izboljšanje prometa	http://znanost.sta.si/	1.10.2020		x	
Merjenje prometa se začenja, postanite del projekta za večjo varnost	https://avto-magazin.metropolitan.si/	5.10.2020		x	
Projekt državljanske znanosti: Štetje prometa (WeCount)	https://www.fdv.uni-lj.si/	30.11.2020		x	
Radio interview - Radio Študent	https://radiostudent.si/kultura/urbi-et-orbi/%C5%A1tejemo-promet-pod-na%C5%A1imi-okni	23.02.2021			x
Imate s svojega okna lep razgled na promet? Tako ga lahko koristno uporabite	https://tl.finance.si/8966745/Imate-s-svojega-okna-lep-razgled-na-promet-Tako-ga-lahko-koristno-uporabite?cctest&fbclid=IwAR3lbaJBbRFJKLhWMfXCzTzgeAZ1HKiVH3y50u5VHnJaLF6Fy-xZM82SD_A	9.10.2020	x	x	

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Name of event	Date (DD/MM/YYYY)	Location	Target audience	Nº of participants	Presentation title (& number of slides on WeCount) or info on how the project was promoted (in case no presentation given)
Meeting with Ljubljanska kolesarska mreža	15.04.2020	on-line	citizens	3	
Pre-kick off workshop	16.06.2020	Faculty of architecture	citizens	20-30	44 slides
Pre-kick off workshop - POSTPONED	9.07.2020	Okoljski center	citizens	20-30	
Katoliški inštitut	August 2020	meeting in person	citizens	4	Roundtable presentation
Solos	August 2020	meeting in person	citizens	3	Roundtable presentation
AMZS	August 2020	meeting in person	citizens	3	Roundtable presentation
OŠ Prule	August 2020	meeting in person	citizens - students	4	Roundtable presentation
Šola Janeza Levca	August 2020	meeting in person	citizens - students	3	Roundtable presentation
OŠ Prežihov Voranc	August 2020	meeting in person	citizens - students	4	Roundtable presentation
AMC	August 2020	meeting in person	citizens	3	Roundtable presentation
Šentjakobsko gledališče	August 2020	meeting in person	citizens	3	Roundtable presentation
Srednja ekonomska šola	August 2020	meeting in person	citizens - students	5	Roundtable presentation
Slovenski šolski muzej	August 2020	meeting in person	citizens	3	Roundtable presentation
Etno muzej	August 2020	meeting in person	citizens	4	Roundtable presentation
Meeting with SPTM, Ministrstvo za infrastrukturo	18.08.2020	Ministrvo za infrastrukturo	national authorities	9	Roundtable presentation
Meeting at Upper Secondary School Šolski center Ljubljana, Headmaster Počkar	21.08.2020	Aškerčeva 1	citizens	3	Roundtable presentation
Meeting at Primary School Prežihov Voranc, Headmaster Gorjup	24.08.2020		citizens	3	Roundtable presentation
Meeting at Gimnazija Ledina, Headmaster Vogrinec	25.08.2020	Gimnazija Ledina	citizens	4	Roundtable presentation
Meeting at Gimnazija Bežigrad, Manca Habjanič Gaberšek	30.08.2020		citizens	3	Roundtable presentation
Meeting at Upper Secondary School of Electrical and Computer Engineering and Technical Gymnasium Ljubljana	2.09.2020	Vegova	citizens	3	Roundtable presentation
Meeting with Zoran Bjelan, Administration office, City of Ljubljana	3.09.2020	Mačkova ulica 1	local authorities	3	Roundtable presentation
WeCount presentation at Gimnazija Ledina (high school)	9.09.2020	Gimnazija Ledina	citizens	2 x 30	Delavnica štetja prometa, 25 slides
Meeting at Faculty of Computer and Information Science	11.09.2020	FRI, Večna pot 113	citizens	6	Roundtable presentation

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Name of event	Date (DD/MM/YYYY)	Location	Target audience	Nº of participants	Presentation title (& number of slides on WeCount) or info on how the project was promoted (in case no presentation given)
Meeting at Gimnazija Šentvid, Headmaster Erker	22.09.2020	Gimnazija Šentvid	citizens	3	Roundtable presentation
Meeting with Urša Otoničar, Director of Administration office, City of Ljubljana	22.09.2020	Mačkova ulica 1	local authorities	5	Roundtable presentation
Meeting with Tomaž Šuklje, VARCITIES, H2020	7.10.2020	Online	citizens	6	Online meeting
Meeting with Luka Mali, local champion Novo mesto	7.10.2020	Online	local champion	6	Online meeting
Meetin with Urša Otoničar, Director of Administration office, City of Ljubljana	14.10.2020	Mačkova ulica 1	local authorities	5	Roundtable meeting
Online Kick off workshop	22.10.2020	online Zoom	citizens - students	6	Online presentation
Online presentation, FDV, Faculty of Social Sciences, Ljubljana	24.11.2020	online Zoom	citizens - students	30	Online presentation
Online presentation,FA	25.11.2020	online Zoom	citizens - students	30	
Online Workshop	3.12.2020	online Zoom	citizens	22 invitations/1 attended	Online presentation
Online presentation of students exercise,FA	6.01.2021	online Zoom	citizens - students	20	Online presentation
Online presentation of students exercise,FA	13.01.2021	online Zoom	citizens - students	11	Online presentation
Online Workshop	20.01.2021	online Zoom	citizens	6	Online - slides
Fire brigade Podgorica	4.02.2021	online meeting	citizens	2	Online presentation
Fire brigade Rudnik	5.02.2021	online meeting	citizens	2	Online presentation
Fire brigade Stanežiče	10.02.2021	online meeting	citizens	2	Online presentation
Fire brigade Črnuče	12.02.2021	meeting in person, Dunajska 369	citizens	3	Roundtable presentation
Fire brigade Ljubljana Barje	12.02.2021	meeting in person, Peruzzijeva 101	citizens	6	Roundtable presentation
Fire brigade Šmartno ob Savi	12.02.2021	meeting in person, Kopna pot 6	citizens	3	Roundtable presentation
Fire brigade zg. Šiška	14.02.2021	online meeting	citizens	2	Online presentation
Fire brigade Sostro	18.02.2021	online meeting	citizens	2	Online presentation
Fire brigade Vič	10.03.2021	meeting in person, Viška cesta 44	citizens	3	Roundtable presentation
Fire brigade Ježica	11.03.2021	meeting in person, Ježica 11	citizens	6	Roundtable presentation

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7 Appendix 2: Dissemination and Outreach Activities

7.1 Media activity online

Facebook posts

	Date	People reached
March 2020	12.03.2020	13
	15.03.2020	14
April 2021	11.04.2020	15
	15.04.2020	16
	17.04.2020	16
	21.04.2020	16
	29.04.2020	35
	30.04.2020	17
May 2020	5.05.2020	18
	12.05.2020	18
	28.05.2020	47
June 2020	1.06.2020	47
	10.06.2020	19
	16.06.2020	27
July 2020	2.07.2020	52
	6.07.2020	34
	9.07.2020	42
	23.07.2020	61
August 2020	6.08.2020	60
September 2021	14.09.2020	51
	20.09.2020	23
	23.09.2020	51
	28.09.2020	156
October 2020	1.10.2020	52
	1.10.2020	59
	1.10.2020	57
	2.10.2020	59
	6.10.2020	67
	7.10.2020	84
	14.10.2020	73
November 2021	3.11.2020	80
	17.11.2020	95
Debember 2020	9.12.2020	92
	9.12.2020	99
	11.12.2020	92
	14.12.2020	92
	18.12.2020	124
	23.12.2020	7065
	23.12.2020	123
January 2021	6.01.2021	79
	8.01.2021	76
	13.01.2021	81
	14.01.2021	75
	20.01.2021	55
	25.01.2021	54
	29.01.2021	36
	31.01.2021	36
February 2021	5.02.2021	34
	17.02.2021	19
	19.02.2021	25
	26.02.2021	20
March 2021	4.03.2021	22
	11.03.2021	18
	17.03.2021	4
	19.03.2021	18
	26.03.2021	15
	29.03.3021	3
	31.03.2021	3
April 2021	6.04.2021	5
	8.04.2021	5
	12.04.2021	18
	20.04.2021	3
	22.04.2021	3
	26.04.2021	3
	28.04.2021	3
May 2021	4.05.2021	1
	7.05.2021	1
	11.05.2021	1
	13.05.2021	1

Total: 70 posts

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Twitter

Date
18.08.2020
18.08.2020
18.08.2020
14.09.2020
21.09.2020
23.09.2020
7.10.2020
7.10.2020
7.10.2020
7.10.2020
14.10.2020
6.12.2020
7.12.2020
15.12.2020
23.12.2020
5.01.2021
27.01.2021
31.01.2021
22.02.2021
18.02.2021
5.03.2021
10.03.2021
14.04.2021
29.04.2021
29.04.2021

Total: 26 posts

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Instagram

Date	Likes
1.02.2021	7
1.02.2021	7
1.02.2021	8
12.02.2021	6
5.03.2021	2
18.02.2021	3

LinkedIn

	Likes	Comments
July 2020	0	0
September 2020	3	0
September 2020	3	0
November 2020	5	1

YouTube

Title	Date	Views
Telraam: postopek registracije	30.09.2020	37
Telraam: sestavljanje naprave	30.09.2020	44
Telraam: končna namestitev	30.09.2020	66

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8 Appendix 6: List of figures and tables

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