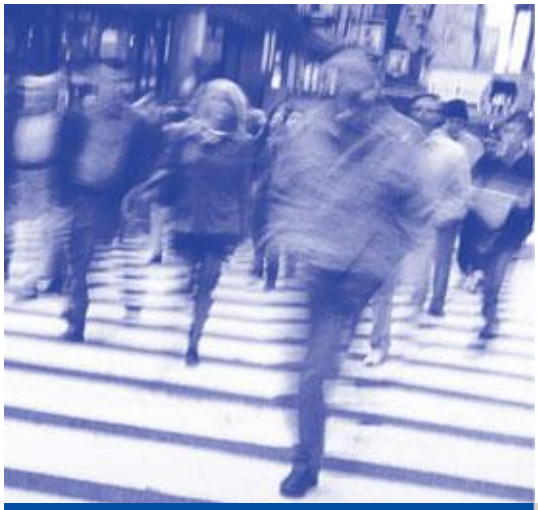

2020 CiViTAS
Cleaner and better transport in cities

SATELLITE

# D2.8 Summary of evaluation findings from RIA projects for IA projects

| | |
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2020 CiViTAS
Cleaner and better transport in cities
SATELLITE

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## Abstract

This deliverable provides a summary and overview of the measure evaluation results reports (MERs) from the CIVITAS Research and Innovation Action (RIA) projects funded between 2015 and 2018. A main target audience for this document has been are the project evaluation managers (PEMs) of the Innovation Actions (IAs) in order to learn from the evaluation methodologies and findings of the RIA projects. However, this document is also envisaged as useful for other interested partners from IA and RIA projects.

### Project Partners

| Organisation | Country | Abbreviation |
|---|---|---|
| Transport & Mobility Leuven | BE | TML |

### Document History

| Date | Person | Action | Status | Diss. Level |
|---|---|---|---|---|
| 21.12.2018 | Gitte Van Den Bergh | Preparation 1st draft | draft | WPL |
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Dissemination Level: WPL = Work Package Leader, PM = Project Manager, PC = Project Coordinator, PO = Project Officer

### Legal disclaimer

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## List of Tables



## List of abbreviations

ECG: Evaluation Coordination Group

IA: Innovation Action

MER: Measure Evaluation Results

PEM: Project Evaluation Manager

PT: Public Transport

RIA: Research and Innovation Action

UFT: Urban Freight Transport

# 1 Introduction

## 1.1 Evaluation Cooperation with the Research and Innovation Actions

One of the new elements in the approach of CIVITAS SATELLITE – building upon the work of previous support actions projects of the CIVITAS Initiative – is the establishment of an intensive cooperation on evaluation with the **CIVITAS Research and Innovation Action (RIA) projects**. In this context the Evaluation Coordination Group (ECG) was created in which both the Innovation Action (IA) projects and RIA projects are jointly discussing their evaluation approach.

Furthermore, CIVITAS SATELLITE will produce a "Completed Impact and Process Evaluation Framework" as an updated version of the already developed evaluation guidelines for the IA projects. The evaluation framework will also incorporate relevant elements of the evaluation methods used by the RIA projects to further strengthen the evaluation framework. For this, a **survey** was conducted with the RIA projects to collect information on the indicators and data collection methods used in relation to the types of measure being developed. A basic evaluation reporting template has been developed by SATELLITE for the RIA projects and has been made available to all of them. It includes chapters on evaluation results and findings, and is very similar to the Measure Evaluation Result (MER) template of the IA projects.

The report at hand (D2.8) summarises the results from the completed surveys with the RIA projects funded between 2015 and 2018.

## 1.2 Focus of the evaluation in the RIA projects

In most of the RIA projects the evaluation work has a double focus:

1. Evaluation of the impact and implementation process of mobility related measures that can be implemented by a city or region (or their stakeholders).
2. Evaluation of the activities of the project to assess the achievements and performance of the project itself, also in relation to the resources and funds used for it.

The first focus is linked to the main objectives of the CIVITAS 2020 evaluation: to understand the process and impact of sustainable urban mobility measures, to learn what works and what does not, and to understand the reasons why. As a result, measures can be optimised, up-scaled in the best way possible and relevant information can be made available to assess whether a measure can be successfully transferred to other cities or sites. This focus is crucial to develop further the urban mobility policy in Europe.

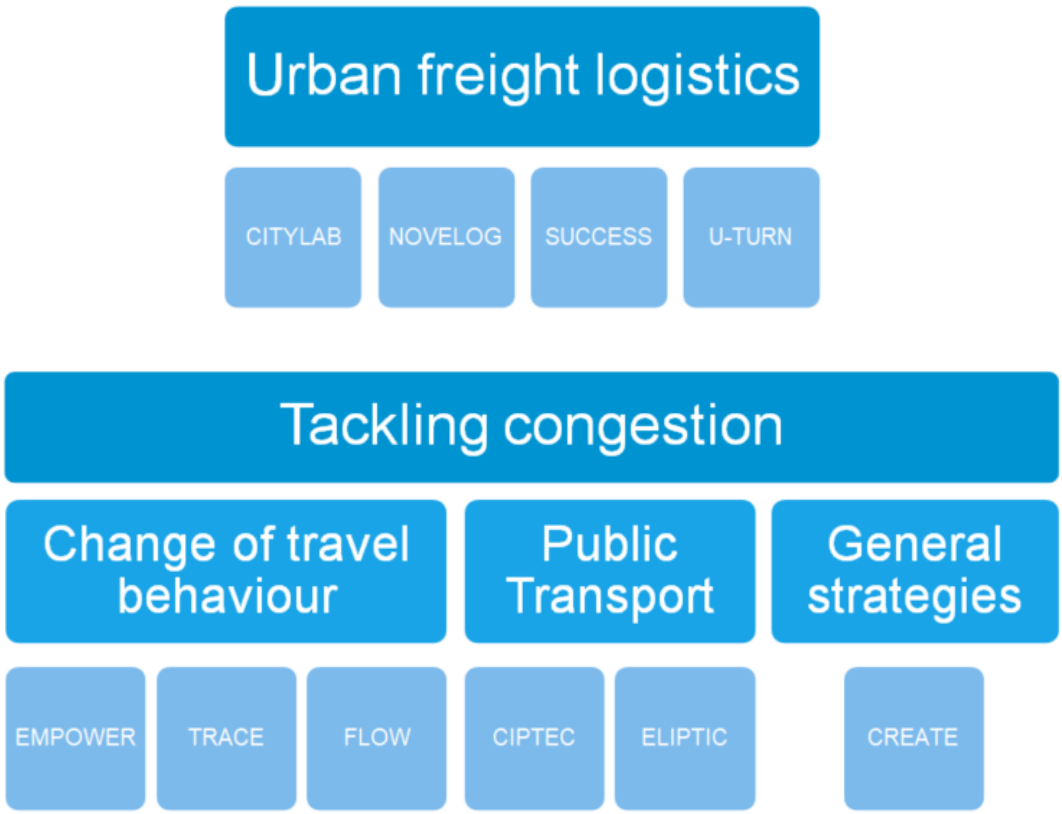
The first objective of the report at hand is to provide a structured understanding of the evaluation methods developed by the RIA project as a contribution to the overall CIVITAS 2020 evaluation framework.

Secondly, it is important to assess the activities RIA projects can develop and put in place to support a roll-out of good practices and a take-up of measures in other cities. The evaluation findings on the projects' activities are NOT in the scope of this reporting.

## 1.3 CIVITAS RIA projects funded between 2015 and 2018

The CIVITAS RIA projects funded between 2015 and 2018 are: CITYLAB, NOVELOG, SUCCESS and U-TURN for the 'Urban Freight Logistics' cluster and CREATE, ELIPTIC, EMPOWER, FLOW, CIPTEC and TRACE for the 'Tackling congestion' cluster.

Because of the variety in projects in the latter cluster, for the purpose of this report they have been subdivided into smaller subclusters. The 'Change of travel behaviour' cluster consists of EMPOWER, TRACE and FLOW. CIPTEC and ELIPTIC are part of the 'Public transport' cluster, and the CREATE project is the only project of the 'General strategies' cluster. The figure below provides an overview of all projects and their respective (sub)cluster.




## 1.4 Collecting information from the RIA projects

The information gathering through the survey was not as straightforward as anticipated in the beginning because the RIA projects were already in their last months of funding. Therefore, SATELLITE made the process as effortless as possible for the PEMs. SATELLITE went to meet them during their final conferences, telephone conferences were organised to discuss the input needed, work was limited to the most interesting measures, and SATELLITE even helped them with completing the survey, using information form their deliverables.

This resulted in completed measure evaluation results surveys for most of the finished RIA projects. Exceptions are the CREATE and CIPTEC projects, which have not implemented specific measures, and the CITYLAB project, for which the timing was not feasible in the end. An overview of the RIA evaluation reporting can be found in chapter 2 of this report. Chapter 3 includes all measure results evaluation reports (MERs).

# 2 Overview of RIA projects and their evaluation reporting

This chapter provides a short overview of all RIA projects funded between 2015 and 2018, together with an overview of the evaluation documents that are available. First of all, there are the measure evaluation results reports (MERs). However, because of the timing constraint – all RIA projects were in their last months or already finished when the surveys were completed – the measure evaluation results surveys were sometimes limited to a few measures. Additionally, an overview is provided of the other reports on evaluation and tools developed by the projects.

## Urban Freight Logistics

### CITYLAB

About the project:

The objective of the CITYLAB project was to develop knowledge and solutions that result in roll-out, upscaling and further uptake of cost-effective strategies, measures and tools for emission free city logistics. In a set of **Living Laboratories ("Living Labs")**, promising logistics concepts were implemented, tested and evaluated, and the potential for further roll-out and upscaling of the solutions was investigated and explained. The Living Lab concept looked beyond the traditional set-up of pilots. It changed the emphasis from the solution as an isolated object to the process of integration with its environment. This environment was to facilitate cooperation between real-world stakeholders, forming favourable conditions which speed up development and roll out of innovative solutions. In a Living Lab, citizens, governments, industry and research partners can co-design and co-create new policies, regulations and actions through a shared long-term goal.

CITYLAB focused on **four axes for intervention** (see Table 1) that call for improvement and intervention. Within these axes, the project supported **seven implementations** that were tested, evaluated and rolled out. These four axes for intervention were chosen because it was anticipated that if they are not explicitly tackled in the EU, the rising populations and densities of cities may produce such an increase in freight transportation that the economic and environmental sustainability can no longer be guaranteed.

**Table 1:** CITYLAB axes for invention and implementations

| Axes for intervention | Implementation | City | Partner |
|---|---|---|---|
| Highly fragmented last-mile deliveries in city centres | Growth of consolidation and electric vehicle use | London | TNT and Gnewt Cargo |
| | Floating depot and city centre micro-hubs | Amsterdam | PostNL |
| | Increasing load factors by utilising spare van capacity | Brussels | Procter & Gamble |
| Inefficient deliveries to large freight attractors and public administrations | Joint procurement and consolidation | Southampton | Meachers Global Logistics |
| | Common logistics functions for shopping centres | Oslo | Steen & Strøm |
| Urban waste, return trips and recycling | Integration of direct and reverse logistics | Rome | Poste Italiane, Meware |
| Logistics sprawl | Logistic hotels | Paris | SOGARIS |

MERs:

There are no MERs available for the CITYLAB project. Because of timing issues, the completion was not feasible in the end. However, due to the in-depth conversation with the PEM and the evaluation deliverables there was enough information available to learn from the project and to include it in the other SATELLITE deliverables.

Other evaluation-relevant outputs:

The following sources are useful for understanding and learning from the evaluation methodology and results of the CITYLAB project:

- Website: http://www.citylab-project.eu
- CITYLAB Deliverable D3.1 – Practical guidelines for establishing and running a city logistics living laboratory
- CITYLAB Deliverable D5.1 – Definition of necessary indicators for evaluation
- CITYLAB Deliverable D5.2 – CITYLAB dashboards
- CITYLAB Deliverable D5.3 – Impact and process assessment of the seven CITYLAB implementations
- CITYLAB Deliverable D5.4 – Sustainability analysis of the CITYLAB solutions
- CITYLAB Deliverable D5.5 – Evaluation of the willingness to pay
- CITYLAB Deliverable D5.6 – Assessment of roll-out potential of CITYLAB solutions
- CIVITAS Tool Inventory:
    - https://civitas.eu/tool-inventory/citylab-transferability-leaflet
    - https://civitas.eu/tool-inventory/city-logistics-living-lab-handbook
    - https://civitas.eu/tool-inventory/observatory-strategic-developments-impacting-urban-logistics

**NOVELOG**

About the project:

NOVELOG was a three-year research project focusing on gaining insight into **urban freight transport (UFT)** and providing **guidance for implementing effective and sustainable policies and measures**. This guidance has been given through a **4 step – 4 tool approach** aiming to help cities “Understand” their UFT environment, “Focus” on the most suitable measures and policies, “Assess” these measures and “Guide” the cities in their effective implementation.

12 cities and regions were involved in the project: Athens, Barcelona, Copenhagen, Emilia-Romagna Region, Gothenburg, Graz, London, Mechelen, Pisa, Rome, Turin, and Venice.

Each city has specific as well as common priorities and needs, different maturity levels, a different mix of measures and interventions, but the same objective: a more sustainable and liveable city. To this end, they have developed a pilot or case study to achieve the following results and impacts:

- Cost effective and green (non-vehicle technology) strategies, measures and business models
- Increased load factors and reduced vehicle movements
- Optimised governance and stakeholder cooperation in urban distribution, through a more powerful, consensus-oriented Decision Support System (DSS)
- Strengthened capacity of local authorities & public and private stakeholders for sustainable policy making and mobility planning (Sustainable Urban Mobility Plans – SUMPs).

MERs:

In NOVELOG there are six pilot cities where measures were implemented, and six cities who developed a case study. Because of the limited timing it was decided to complete the survey for only three pilots, the ones in Barcelona, Mechelen and Turin.

Other evaluation-relevant outputs:

Additionally, the project produced the following outputs:

- Website: http://novelog.eu/
- Download page for the deliverables: http://novelog.eu/downloads-2/downloads/
- NOVELOG Factsheets
- NOVELOG Deliverable D3.1 –Integrated assessment framework for UFT solutions
- NOVELOG Deliverable D3.2 – Evaluation Tool
- NOVELOG Deliverable D5.2 – Strategic Planning for Long Term Sustainability
- NOVELOG Deliverable D6.3 – Evaluation of UFT policies and measures
- CIVITAS Tool Inventory:
  - https://civitas.eu/tool-inventory/evaluation-tool
  - https://civitas.eu/tool-inventory/novelog-cities-regions-factsheets
  - https://civitas.eu/tool-inventory/novelog-roadmap-greener-and-efficient-urban-freight-transport
  - https://civitas.eu/tool-inventory/novelog-sulp-guidelines
  - https://civitas.eu/tool-inventory/novelog-toolkit
  - https://civitas.eu/tool-inventory/understanding-cities-tool-uct

**SUCCESS**

About the project:

SUCCESS targeted the **construction industry as a major impacting sector on city logistics** which has unexploited improvement potentials in the **efficiency of goods, waste and service trips** in EU cities. The project aimed to explore, find and test green and efficient

solutions regarding various issues in Construction Supply Chain and material freight logistics in urban areas.

To test those solutions, the SUCCESS project developed simulation tools in order to simulate several scenarios focusing on the implementation of Consolidation Centres for Construction within the framework of the pilot sites of Luxembourg, Paris, Valencia and Verona.

Eight scenarios have been defined: two scenarios without a Construction Consolidation Centre (CCC) and six with one or more Construction Consolidation Centre(s). Those scenarios were evaluated and compared to identify the best solutions for each type of construction projects represented by the pilot sites.

MERs:

The PEM of SUCCESS completed the survey for the two most interesting scenarios in the four pilot sites concerning the Consolidation Center. All other scenarios are variants of these scenarios. The results of all scenarios can be found in the evaluation deliverables.

Other evaluation-relevant outputs:

- Website: http://www.success-urbanlogistics.eu/
- SUCCESS Deliverable D3.3 – Business Models Development and Analysis
- SUCCESS Deliverable D5.1 – Solution report for each Pilot Site: preliminary version
- SUCCESS Deliverable D5.2 – Solutions evaluation and comparison report
- SUCCESS Deliverable D5.3 – Final validation report for each site and long-term sites implementation plan
- CIVITAS Tool Inventory: https://civitas.eu/tool-inventory/business-models-construction-logistics-optimisation-and-ccc-introduction

**U-TURN**

About the project:

The U-TURN project identified new models for **urban food transportation**. The challenges to the urban logistics of food come from population growth, congestion and environmental damage alongside, increased use of convenience stores and the home delivery of internet purchased groceries. The U-TURN project addressed the opportunities and barriers mentioned above and **showcased what logistics sharing in an urban context can deliver** in terms of supply chain efficiency and environmental performance. U-TURN is designed to contribute to the understanding of freight distribution in urban areas, addressing the special requirements of food transportation. It has developed and proposed innovative business models from a new focused toolkit to achieve more efficient operations – both environmentally and economically.

By analysing existing freight urban flows and identifying synergies that can be exploited by logistics sharing and collaboration strategies, the work has brought forward practical options for communities and operators.

These have aroused through

(1) comparative analysis based on actual market data,
(2) simulation experimentation and
(3) pilot execution in three different countries: UK, Italy and Greece.

Moreover, the project has delivered a toolset to further enable the evaluation and implementation of the suggested shared logistics practices.

Three different pilots were conducted in the context of the U-TURN project. These pilots were complementary, addressing different aspects of food distribution in an effort to cover the key requirements and main trends of food distribution in urban areas. The three pilots are shortly presented in the following table:

**Table 2:** U-TURN Pilots

| | **Description** | **Geography** |
|---|---|---|
| Pilot 1 | **Distribution of packaged goods from food manufacturers to retail outlets located in urban areas**<br>Two different shared logistics practices were identified and evaluated in terms of economic, social and environmental aspects:<br>A) Sharing a common vehicle for delivering goods<br>B) Sharing Urban Consolidation Centres for collaboratively distributing goods in the 'last mile' | Greece (Athens) |
| Pilot 2 | **Distribution of fresh food from local producers and online retailers to consumers in urban areas**<br>Farm businesses took part in an assessment to define existing business models. The collaborative logistics solutions, tested through the U-TURN platform, pointed out the opportunity to cut down travel distance, number of vehicles and their environmental impact, allowing the farmers to save time for their core business activity. | Italy (Milan) |
| Pilot 3 | **Food delivery from online retailers to consumers in urban areas**<br>This pilot assesses the opportunities for micro hubs to reduce costs and improve customer service. Three different supply chain structures were identified, with the micro hub playing a different role in each case, and then the scenarios were modelled to identify the potential benefits. | UK (London) |

MERs:

For the U-TURN project the survey was completed for all measures.

Other evaluation-relevant outputs:

Additionally, the project produced the following outputs:

- Website: http://www.u-turn-project.eu/
- U-TURN Deliverable D2.4 – Economic Comparative Assessment Report Second Version

- U-TURN Deliverable D2.5 – Smart Matching Algorithms and Tools Second Version
- U-TURN Deliverable D3.2 – Simulation Tools Prototype First Version
- U-TURN Deliverable D3.4 – Simulation Model Design Second Version
- U-TURN Deliverable D3.6 – Simulation Experiments and Impact Assessment Report Second Version
- U-TURN Deliverable D4.5 – U-TURN Platform Prototype Second Version
- U-TURN Deliverable D5.2 – Pilots Overall Assessment
- U-TURN Deliverable D5.4 – New Business Models and Practical Guidelines Second Version

## Change of Travel Behaviour

**EMPOWER**

About the project:

EMPOWER was a project about rewarding change. It researched **how positive incentives can encourage citizens to reconsider their travel choices** and reduce the extent to which they travel using conventionally fuelled vehicles.

Rewarding change also means rewarding a shift to travelling in off-peak hours, car sharing, and schemes to help people avoid travelling altogether. EMPOWER was about the use of positive incentives such as information, points, discounts, rewards, community support and games, rather than charging, pricing, rationing, restrictions and regulation.

For this type of scheme to be successful, it is important to consider who governs the different types of data, the sustainable provision of incentives and new collaborations between transport authorities, transport suppliers and third parties. As a result, the project also researched viable business models and how best to evaluate the success of such schemes.

EMPOWER introduced incentive implementations at eleven locations in Europe consisting of five Living Labs and seven Take-Up Cities. The Living Labs were in Enschede, Gothenburg, Helsinki, Manchester, Milton Keynes and Scotland and the Take-Up Cities included Antwerp, Bologna, Budapest, Milan, Newcastle, Odense and Reading. The Living Labs were selected before the project and served as a testbed for incentive scheme development. During the project the selection of the Take-Up Cities took place via a tendering procedure. The Take-Up Cities focused on upscaling successful schemes and creating impact.

MERs:

Because of timing issues, the survey was only completed for the Enschede Living Lab. However, the evaluation findings consists of the lessons learned in all Living Lab cities. The project has produced very extensive process evaluation findings.

Other evaluation-relevant outputs:

Additionally, the project produced the following outputs:

- Website: http://empowerproject.eu
- EMPOWER Deliverable D5.2 – Living Lab Report
- EMPOWER Deliverable D6.3 – Ex-ante and ex-post impact assessment of interventions
- EMPOWER Deliverable D7.3 – Take-up Cities Experiences
- CIVITAS Tool Inventory: http://civitas.eu/tool-inventory/empower-toolkit

**TRACE**

About the project:

The TRACE project assessed **the potential of movement tracking services to better plan and promote walking and cycling** in cities, and **developed tracking tools** that fuel the take-up of walking and cycling measures.

The project targeted established measures to promote cycling and walking to the workplace, to school, for shopping purposes or simply for leisure. More particularly, TRACE assessed the potential of ICT-based tracking services to optimise the planning and implementation of such measures and enhance their attractiveness and potential impact. Issues such as data privacy, cost, interoperability, financial/ tax incentives, infrastructure planning and service concepts were also addressed.

Dedicated TRACE tracking-based tools to promote behaviour change and support mobility planning were tested in eight pilot sites: Breda (NL), Agueda (PT), Southend-on-Sea Borough (UK), Bologna (IT), Esch (LU), Belgrade (RS), Plovdiv (BG) and Belgium, and evaluated in terms of impacts, success factors and benefits, while preparing for their full commercial exploitation. To that end, common, flexible and open access tools were developed, which address related ICT challenges and enable the development of products based on tracking services tailored to the requirements of specific measures by market-oriented application developers.

Users, policy makers, and walking and cycling practitioners were closely involved in all stages of the project.

MERs:

The PEM of the TRACE project completed the survey for all four tools that were demonstrated and evaluated during the project.

Other evaluation-relevant outputs:

Additionally, the project produced the following outputs:

- Website: http://h2020-trace.eu
- TRACE Deliverable D7.1 – Evaluation plan
- TRACE Deliverable D7.2 – Evaluation of pilots and update of knowledge base
- TRACE Deliverable D8.6 – TRACE Toolkit. Guidelines and recommendations on tracking walking & cycling for mobility planning and behaviour change

- CIVITAS Tool Inventory:
  - https://civitas.eu/tool-inventory/biklio
  - https://civitas.eu/tool-inventory/positive-drive
  - https://civitas.eu/tool-inventory/tatoo-tracking-planning-tool
  - https://civitas.eu/tool-inventory/trace-toolkit
  - https://civitas.eu/tool-inventory/traffic-snake-game-tracking-device

**FLOW**

About the project:

The FLOW project's aim was to put walking and cycling on an equal footing with motorised transport modes as a solution to tackle urban congestion. It has developed a user-friendly methodology, involving transport modelling, to assess the effectiveness of walking and cycling measures.

The FLOW objectives were:

- **Define** the role of walking and cycling in congestion reduction;
- **Develop and apply tools** for assessing the congestion-reducing potential of various walking and cycling measures;
- **Increase awareness** of the congestion reduction potential of walking and cycling;
- **Actively support take-up** of congestion reducing walking and cycling measures by public administrations;
- **Foster the market** for new walking and cycling products and services for congestion reduction;
- **Communicate** congestion reduction facts of walking and cycling.

FLOW involved six partner cities: Budapest, Dublin, Gdynia, Lisbon, Munich and Sofia. All employed the FLOW tools and methodology to assess the role of walking and/ or cycling in congestion reduction. Within this context, each city prepared a local implementation scenario to plan their activities.

The assessment of the scenarios was done using traffic modelling and impact assessment:

**Table 3:** The FLOW measures

| City | Mode | Congestion busting measures | Assessment level |
|---|---|---|---|
| **BKK Budapest** | | 1. Public bike share system<br>2. Bike-friendly area | Macro level modelling |
| **Dublin** | | 1. Signal sequencing<br>2. Specific infrastructure challenges | Micro level modelling |
| **Lisbon** | | 1. Green time for pedestrians at signals<br>2. Replacing over- and underpasses with level crossings<br>3. Reallocation of public space | Micro level modelling |
| **Munich** | | 1. Reallocation of public space | Micro level modelling |
| **SUMC Sofia** | | 1. Bike to work campaigns | Impact assessment |
| **Gdynia** | | 1. Establishing a baseline for walking<br>2. Planning a cycle network | Macro level modelling |

The cities of Dublin, Gdynia, Lisbon and Munich undertook microscopic modelling using PTV VISSIM/ VISWALK to test and visualise options to improve conditions for pedestrians and cyclists and measure impact on congestion.

The cities of Budapest and Gdynia developed a macroscopic cycling modelling capability within the FLOW project. Both cities had existing macroscopic highway and public transport models in PTV VISUM into which they wanted to integrate cycling to assess mode shift for congestion management.

MERs:

The survey was completed for two out of 11 measures that were implemented in Munich and Sofia.

Other evaluation-relevant outputs:

Additionally, the project produced the following outputs:

- Website: http://h2020-flow.eu/
- The FLOW leaflet
- FLOW Deliverable D3.4 – Implementation scenarios and action plans of FLOW partner cities
- FLOW Deliverable D3.5 – Implementer's Guide to Using the FLOW Tools for Multimodal Assessments
- CIVITAS Tool Inventory:
    - https://civitas.eu/tool-inventory/flow-quick-facts-cities
    - https://civitas.eu/tool-inventory/flow-congestion-impact-assessment-tool-walking-and-cycling

## Public Transport

**CIPTEC**

About the project:

CIPTEC (Collective Innovation for Public Transport in European cities) intended to **stimulate the public transport sector to adopt a modern marketing perspective, promoting creativity and innovation**, with the aim of significantly increasing its modal share and attracting new customers at limited extra cost.

CIPTEC had the following main objectives:

1. Analysis of market trends and users' needs per customer group;
2. Mapping and evaluation of existing innovative services and practices;
3. Promoting innovation in PT sector by collective intelligence cooperation (crowdsourcing and co-creation approaches), engaging people and bridging PT sector with other businesses;
4. Performing advanced marketing research and consumer experimentation and synthesising the findings for the decision maker in the simplest way (what to offer, to whom and how);
5. Developing a Toolbox for providing support to PT Operators and Authorities in introducing innovation towards integration of services and customers' satisfaction;
6. Developing a "model" strategy plan for PT Operators/ Authorities.

CIPTEC followed both a top-down and bottom-up approach to investigate needs, identify gaps and define potential solutions.

MERs:

As no specific measures were im plemented within the CIPTEC project, it was not possible to complete the survey. However, in-depth discussions with the project coordinator and access to their deliverables ensure that there is enough information available to learn from the project and to include it in the other SATELLITE deliverables.

Other evaluation-relevant outputs:

- Website: http://ciptec.eu/
- CIPTEC Deliverable D1.4 – Development of a "workshop and interview" guide for surveying experts' opinions
- CIPTEC Deliverable D2.1 – Guidelines for field research design and relevant material on existing innovative practices
- CIPTEC Deliverable D3.3 – Plan for co-creation/ co-design workshops
- CIPTEC Deliverable D3.5 – Evaluation report for the Collective intelligence process's output
- CIPTEC Deliverable D4.2 – Lab experiments report
- CIPTEC Deliverable D4.3 – Field experiments report

- CIVITAS Tool Inventory:
  - https://civitas.eu/tool-inventory/ciptec-crowdsourcing-platform-0
  - https://civitas.eu/tool-inventory/toolbox-public-transport-innovation & http://toolbox.ciptec.eu/

**ELIPTIC**

About the project:

ELIPTIC has developed new concepts and business cases in order to **optimise existing electric public transport infrastructure and rolling stock**, saving both money and energy. The project strengthened the role of electric public transport, leading to reduced fossil fuel consumption and improved air quality.

ELIPTIC focused on the use of existing electric public transport systems (including light rail, metro, tram and trolleybus) for the electrification of multimodal mobility approaches in the urban, sub-urban and also less urban context. The overall concept and main assumption underpinning ELIPTIC is that further take-up of electric vehicles can be supported cost-efficiently by integrating existing electric public transport infrastructure for multi-purpose use.

To achieve this goal, ELIPTIC analysed 20 concepts within 11 cities (Barcelona, Bremen, Brussels, Eberswalde, Gdynia, Lanciano, Leipzig, London, Oberhausen, Szeged and Warsaw) and in three thematic pillars; these are:

- *Pillar A*: safe integration of electric buses using existing electric public transport infrastructure, through the assessment of potential replacement of diesel buses with trolley-hybrids or electric buses, with a focus on opportunity (re)charging operations (fast or overnight), exploiting tram or metro local infrastructure.
- *Pillar B*: innovative energy storage systems to increase operational efficiency, by the recovery of braking energy from light rail or tram networks, or the conversion of a dismissed rural line into a light rail one
- *Pillar C*: multi-purpose use of electric public transport infrastructure, via the possibility of supplying energy to other types of electric modes (commercial vehicles, passenger cars, taxis).

The project has supported the uptake and exploitation of results by developing guidelines and tools for upgrading and regenerating electric public transport systems. ELIPTIC also advocated for an electric public transport sector at the political level and helped develop political support across Europe.

MERs:

In order to reduce additional work for the project's PEM, it was decided that the survey would be completed for one measure from each Thematic Pillar, i.e. three measures in total. However, the evaluation approach and findings that are described in the survey are a synthesis of the learning in all use cases.

Other evaluation-relevant outputs:

Additionally, the project produced the following outputs:

- Website: http://www.eliptic-project.eu/
- ELIPTIC Deliverable D3.1 – Impacts Evaluation Plan
- ELIPTIC Deliverable D3.2 – Process Evaluation Plan
- ELIPTIC Deliverable D3.3 – Conventional Full Evaluation, the reference scenarios
- ELIPTIC Deliverable D3.6 – Evaluation findings and transferability potential at European level
- CIVITAS Tool Inventory:
    - https://civitas.eu/tool-inventory/eliptic-factor-100
    - https://civitas.eu/tool-inventory/eliptic-policy-recommendations
    - https://civitas.eu/tool-inventory/eliptic-use-cases-brochure

## General Strategies

**CREATE**

About the project:

CREATE's (Congestion Reduction in Europe: Advancing Transport Efficiency) main objective was to **reduce road congestion** in European cities, by **encouraging a switch from cars to more sustainable transport modes**.

CREATE has explored historical patterns of urban road traffic and car use, identified success factors in encouraging modal shift and lessons learned in Western European capital cities, and worked with Eastern Europe and Euro-med city partners to assist them in developing sustainable strategies.

Furthermore, CREATE has carried out quantitative analysis of trends in car use and influencing factors, along with qualitative studies of governance facilitators and constraints. It has also looked at scheme funding, modelling and appraisal issues.

Moreover, the project has identified future challenges and opportunities for urban mobility and produced a range of policy and technical documents.

Through its research, CREATE has developed a better understanding of: measuring congestion and network performance; changing urban transport policy priorities and their consequences; and the triggers for change and consequences of car use.

The project has sought to define future city challenges and successful delivery mechanisms as well as new ways of developing business models and applying techniques for forecasting and appraisal.

MERs:

As no specific measures were im plemented within the CREATE project, it was not possible to complete the survey. However, in-depth discussions with the PEMs and access to their deliverables ensure that there is enough information available to learn from the project and to include it in the other SATELLITE deliverables.

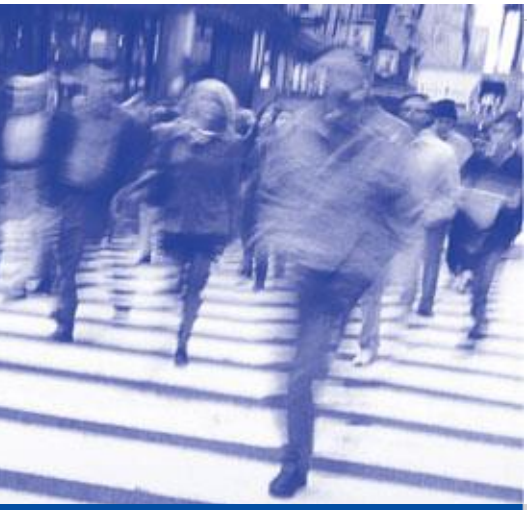
Other evaluation-relevant outputs:

- Website: http://www.create-mobility.eu
- CREATE Deliverable D2.1 – Urban Congestion and Network Operation: Towards a Broader Set of Metrics for Assessing Performance.
- CREATE Deliverable D3.3 – Report of Cross-City Comparison
- CREATE Deliverable D7.5 – Project Summary and Conclusions for Cities & CREATE leaflet

# 3 Measure evaluation results

This chapter contains all completed measure evaluation results reports from the RIA projects.

Table of content:



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# Measure reporting on evaluation approach and evaluation findings

## - RIA project NOVELOG

| | |
|---|---|
| Measure | Micro-Platforms for Trans-shipments for Superblocks |
| Short description | Barcelona, in Spain, studies on the realization of macro-blocks (or superblocks) concept and its incorporation and integration within the city logistics perspective. Each macro-block consists of LTZs incorporating small micro-platforms into the urban web serviced by clean vehicles during last mile deliveries. |
| | |
| **Report developed by** | |
| Project: | NOVELOG |
| City/cities | Barcelona |
| Author(s) | Gitte Van Den Bergh, Teti Nathanail, Ioannis Karakikes, Georgia Ayfantopoulou |
| Mail address | gea@certh.gr |
| Version | Final |
| Date | 18/07/2018 |
| | |
| ***Template** by* | *CIVITAS SATELLITE* |
| *Review:* | *Dirk Engels, Gitte Van Den Bergh* |

novelog

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# 1 Measure description

## 1.1 Objectives of the measure

(Source: D3.2 – CHAPTER 2.3.3)

| City's primary objectives | City's secondary objectives |
|---|---|
| Economic<br>• increase UFT system efficiency<br>Environmental<br>• reduce CO2 emissions<br>• reduce noise emissions<br>Social<br>• increase safety | • increase delivery load factor<br>• introduce Urban Consolidation Centres (UDCs)<br>• increase use of clean technologies/delivery means (electric vehicles (EVs), bikes, walk)<br>• adopt new business models<br>• provide evidence/incentives for further adoption |

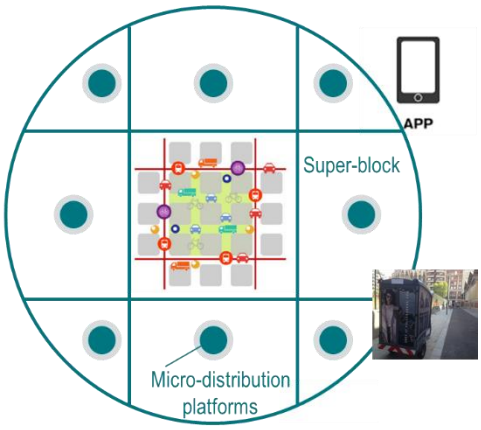
## 1.2 Description of the measure: what is implemented ? How ?

### 1.2.1 General

(Source: D5.2 CHAPTER 8)

The Municipality of Barcelona aims at evaluating the use of micro-distribution platforms for the delivery of goods. Through agreement between large logistic operators (those operating line haulage) and a small operator that runs electric tricycles (Last Mile Operator), it will be possible for large operators to deliver goods to receivers at destinations in a way that minimizes the distance travelled by trucks in the urban area. The Municipality helps the LMOs reduce operating costs by granting a cession of public space in exchange for information about the delivery activity. This policy is a development from the previous (successful-but-not-sustainable) one of granting a subsidy for running a pilot service to help the LMO enter the logistics chain.

*Urban transhipment centre in each super-block (public land leased to private operators)*




Parcels and packages will be transhipped in a special designated area to a small carrier that will use electric vehicles such as tricycles to perform the last mile delivery, reducing noise and pollutant emissions. The areas of trans-shipment will be facilitated by the Municipality, and a range of public spaces have been searched to identify appropriate candidates, including land adjacent to the Estació França rail terminal and municipal markets. The project started with the idea that there would be one “micro-platform per superblock (neighbourhood with restriction on vehicle access). Assessment realized within NOVELOG is summarized in the poster presented at the April 2018 CIVITAS conference in Brussels.

Additional monitoring is being investigated in the H2020 Growsmarter project.

Localisation: the pilot concerns micro-distribution (the last-mile delivery by cargo-trikes of good transshipped at micro-platforms in two localities of the city of Barcelona. El Ninot Market and Estació França are the micro-platforms that have been chosen for pilot activities.

The implementation of the micro-distribution pilot is one part of Barcelona Municipality's contribution to NOVELOG. In addition it has realised a case study of the app (software application; case study) that facilitates the management of on-street deliveries from unloading/loading spaces.

### 1.2.2 **Outputs**

Two micro-platforms are implemented: El Ninot Market and Estació França

### 1.2.3 **Supporting activities**

(Source: D5.2 CHAPTER 8)

Stakeholder participation is an important part of the measure. The following stakeholders were involved:

- Public Authority: Department of Mobility - Authority planning department responsible for SUMP, identification of appropriate location for trans-shipment, scheme development, Heritage department, Barcelona Municipality - regulatory conditions, permits, Townscape - authority protecting the urban townscape, validation of the location of the platform, District Authority, Barcelona Municipality - major land owner. Municipal Market El Ninot – main leasee of public space.
- Research: CENIT, scientific support to take decision, evaluate pilot activities,
- Logistics Operator: Last mile operator - support for running the service, VanaPedal - support for running the existing SMILE service, E-market - logistics operators of Ninot market pilot, LMO (ECOPOL) - logistics operators of Ninot market pilot, Logistics operators (DHL, TNT, SEUR), involvement in discussions on standard procedures, adaptation of tracking systems,
- Retailers/other private: Mercat Ninot, owner of the market - provision of a space for the trans-shipment,
- Associations: the progress is periodically reported to the Freight group of the city's Mobility Pact. Local Traders constitute a part of the Receivers (who receive delivered parcels).
- Technology Provider: I2CAT and Municipal institute of ICT - technological supporter; GROWSMARTER project,
- Citizens: constitute a part of the Receivers (who receive delivered parcels).

### 1.2.4 **Interaction with other measures**

The off-street micro-distribution innovation is complemented by the on-street app-based management of on-street deliveries from unloading/loading spaces.

# 2 Evaluation approach

## 2.1 Impacts and indicators

(Source: D6.3 CHAPTER 3 & D6.3 ANNEX A)

The evaluation of the Urban Consolidation Center was performed based on a set of indicators that was selected for the stakeholder categories of Supply chain, Public authorities and Others. Supply chain stakeholder selected in total 11 indicators that correspond to 4 impact areas. Public authority stakeholders selected 8 indicators that correspond to 4 impact areas, while Other stakeholders selected 10 indicators that correspond to 5 impact areas. Qualitative indicators account for 45% of total selected indicators by Supply chain stakeholders, 50% of total selected indicators by Public authority stakeholders and 50% of total selected indicators by Other stakeholders.

Barcelona stakeholders' selected impact areas:

| Supply chain stakeholders | Public Authorities | Other Stakeholders |
|---|---|---|
| Economy and Energy | Environment | Economy and Energy |
| Transport and Mobility | Transport and Mobility | Environment |
| Society | Policy and Measure Maturity | Transport and Mobility |
| User Uptake | | Society |
| | | User Uptake |

Barcelona supply chain stakeholders' selected aspects and indicators:

| Aspect | Indicator | Data Units |
|---|---|---|
| Energy | Energy consumption | Mjoule |
| Safety and security | Accidents | Number / veh-km |
| | Damages | Number / veh-km or Number / shipment |
| | Vandalism | Likert scale {1 (lowest value) - 5 (highest value)} |
| UFT vehicles | Traffic throughput | Veh-km |
| | Load factor | Percentage (%) |
| | Vehicle utilisation factor | Percentage (%) |
| Greening | Green reputation | Likert scale {1 (lowest value) - 5 (highest value)} |
| Living standards | Uncertainty of continuation of earlier activities | Likert scale {1 (lowest value) - 5 (highest value)} |
| Stakeholder acceptance | Stakeholder acceptance | Likert scale {1 (lowest value) - 5 (highest value)} |
| | Adoption rate | Likert scale {1 (lowest value) - |

| Aspect | Indicator | Data Units |
|---|---|---|
| | | 5 (highest value)} |

Barcelona public authorities' selected aspects and indicators:

| Aspect | Indicator | Data Units |
|---|---|---|
| GHG emissions | $CO_2$ | Kg |
| Noise | Noise | dB(A) |
| UFT vehicles | Traffic throughput | Veh-km |
| | Load factor | Percentage (%) |
| Background | Experience | Likert scale {1 (lowest value) - 5 (highest value)} |
| | Research | Likert scale {1 (lowest value) - 5 (highest value)} |
| Stakeholder approval | Adoption rate | Likert scale {1 (lowest value) - 5 (highest value)} |
| | Promotion | Likert scale {1 (lowest value) - 5 (highest value)} |

Barcelona other stakeholders' selected aspects and indicators:

| Aspect | Indicator | Data Units |
|---|---|---|
| Development | Local / Regional development | Likert scale {1 (lowest value) - 5 (highest value)} |
| GHG emissions | $CO_2$ | Kg |
| | $CH_4$ | Kg |
| | $N_2O$ | Kg |
| Noise | Noise | dB(A) |
| Level of service | Customer satisfaction | Likert scale {1 (lowest value) - 5 (highest value)} |
| UFT vehicles | Traffic throughput | Veh-km |
| Convenience | Perceived visual and audio nuisance | Likert scale {1 (lowest value) - 5 (highest value)} |
| Living standards | Uncertainty of continuation of earlier activities | Likert scale {1 (lowest value) - 5 (highest value)} |
| Stakeholder acceptance | Stakeholder acceptance | Likert scale {1 (lowest value) - 5 (highest value)} |

## 2.2 Further analysis of data

(Source: D3.1 & D3.2)

Evaluation incorporates a multiple weighting scheme, and elimination and ranking techniques and models, for the facilitation of “shared” decision-making, taking into account the participation, viewpoint and contribution of all involved stakeholders to the conformation of the final decision made on the measures. The functions of the evaluation, following the concept of multi-stakeholder multi-criteria assessment methodologies, lead to the estimation of the Logistics Sustainability Index (LSI). This LSI depicts not only the overall performance of the measure/policy implemented, but also the degree of objectives’ achievement and the possibility for further improvement.

In the case that more than one stakeholder group is involved in the evaluation of a set of measures then a Global Logistics Sustainability Index (GLSI) can be estimated by combining the LSI per measure with the relevant weights for each stakeholder category for each impact area. The weights per stakeholder category is the outcome of a Delphi process that captures the weights of each stakeholder category for the seven impact areas. Weights are given by experts, following a Delphi method, when a 70% consensus is achieved.

## 2.3 Process evaluation activities

The following activities are set in place to understand and assess the implementation process:

- Stakeholder survey before and after implementation of the measure

Additional surveys with the Last Mile Operators (LMO) were realised in WP8 in collaboration with CENIT and Panteia to examine the business models of the respective LMOs.

## 2.4 Appraisal of evaluation approach

(Source: D6.3 CHAPTER 5)

Based on the evaluation work in this project, the following observations and recommendations concerning the evaluation approach seem important for other projects (including specific interesting elements in the approach):

- The Evaluation Tool constitutes an effective tool for evaluating UFT (urban freight transport) solutions, under different stakeholder categories’ viewpoint, while it allows easy extraction of all evaluation results. It allows stakeholders to run their own evaluation scenario, based on their own interests. It also allows to combine the interests of the different stakeholders into one common indicator.
- This assessment stresses the importance of recording and maintaining high quality data for improving policy making and monitoring periodically the progress of implementations.

## 2.5 Annexes and reference documents

The following documents present further details on the evaluation approach (e.g. the evaluation plan, a presentation, ..) or are used as a reference document for the development of the evaluation approach:

- D3.2 “Evaluation tool”
- CIVITAS Conference 2018 poster

# 3 Evaluation findings

## 3.1 Impact of the measure

(Source: D6.3 CHAPTER 3)

Figure 1 presents the percentage change for each indicator and stakeholder category based on before and after measurements (indicators with 0% change are excluded). The indicator that did not present any changes between before and after cases, include Uncertainty of continuation of earlier activities. It should be noted that the indicator Damages is not presented in Figure 1 as it presents an increase of 2100% for before and after cases.

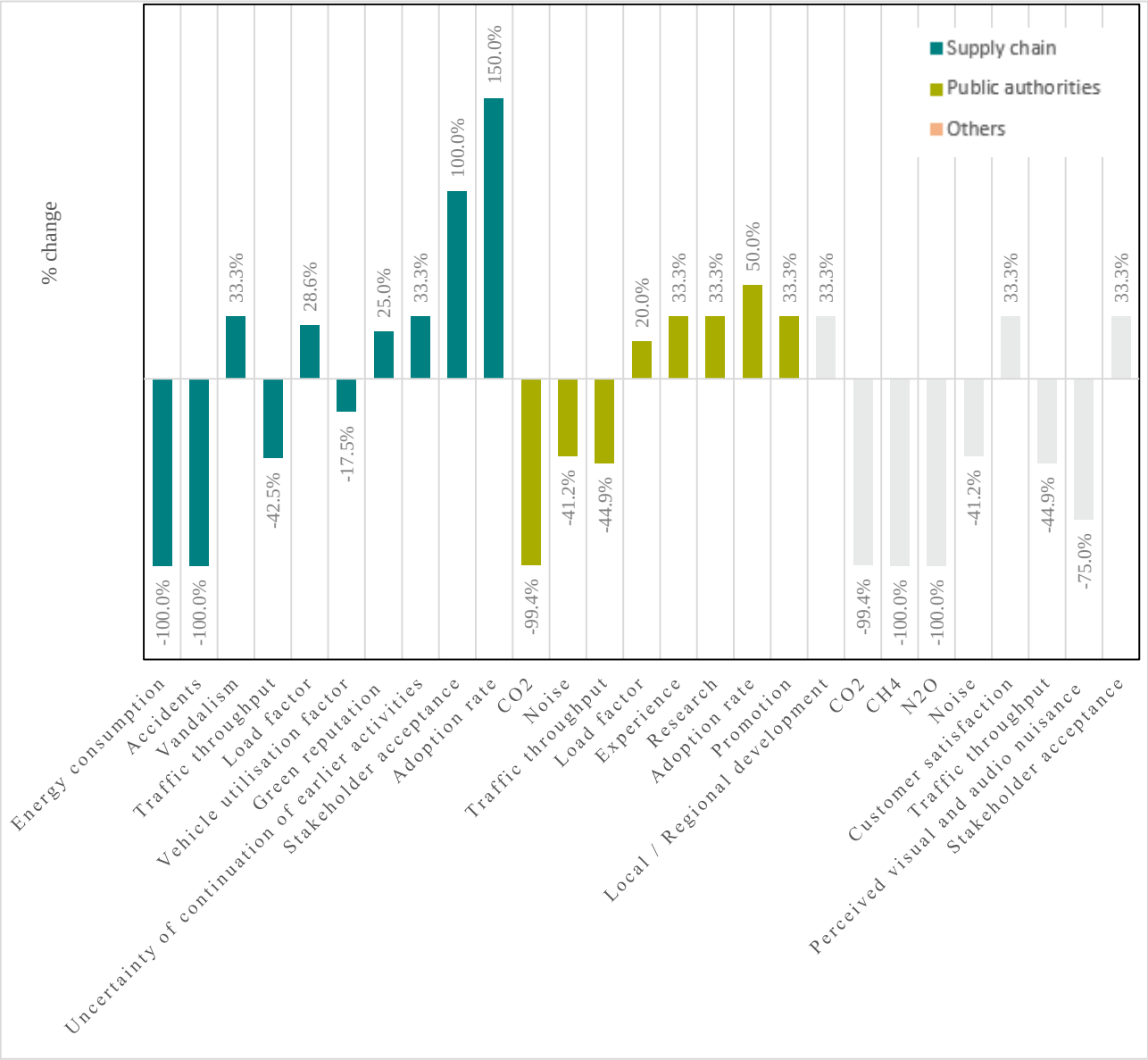



**Figure 1 Percentage change for selective indicators per Barcelona stakeholder category**

Supply chain stakeholders selected the impact areas of Economy and Energy, Transport and Mobility, Society and User Uptake. All three stakeholder categories have not accounted for indicators in the impact area of Social Acceptance; which shows their concerns over the remaining six impact areas when

implementing logistics measures in their area. There are no common selected indicators between the three stakeholder categories. In total 48% of selected indicators by all stakeholder categories are qualitative.

In terms of decision making, the different stakeholder categories in the City of Barcelona have assigned diverse degrees of 'importance' towards achieving a particular objective. More specifically, as shown in Table 1, Supply chain stakeholders present a balanced weight assignment. They have assigned a weight of 0.391 to the impact area of Transport and Mobility showing the importance over Society and User Uptake which are weighed with 0.195 and 0.138, respectively. Similarly, Other stakeholders show a balanced prioritization of impact areas with the User Uptake impact area being the most important area (0.331). Finally, Public authorities weighing shows the importance of Environment (0.331) relative to the impact area of Policy and Measure Maturity (0.127). In overall, weighing for Barcelona follows a balanced assignment of weights between impact areas, which reveals that although different stakeholders set diverse priorities, within the same stakeholder category priorities are balanced when selecting a logistics measure for implementation.

**Table 1 Barcelona stakeholder weights per impact area**

| | | Supply chain | Public authorities | Others |
|---|---|---|---|---|
| impact area | Economy and Energy | 0.276 | | 0.190 |
| | Environment | | 0.311 | 0.144 |
| | Transport and Mobility | 0.391 | 0.281 | 0.190 |
| | Society | 0.195 | | 0.144 |
| | Policy and Measure Maturity | | 0.127 | |
| | Social Acceptance | | | |
| | User Uptake | 0.138 | 0.281 | 0.331 |

As shown in Table 2, all indicators present an improvement for before and after cases, which resulted to an improvement of 76%, 77% and 55% for the LSI for Supply chain, Public authority and Other stakeholders, respectively. Towards estimating the GLSI, different weights have been assigned by all stakeholder categories resulting to an overall improvement of 18% between before and after cases as shown in Table 2. More specifically for Barcelona, Supply chain and Public authority stakeholders have been assigned a weight of 0.400 showing their contribution to decision making process, while Other stakeholders are assigned the weight of 0.200.

**Table 2 Barcelona "Before" and "After" values**

| | Supply chain | Public authorities | Others |
|---|---|---|---|
| Weight | 0.400 | 0.400 | 0.200 |
| LSI before | 0.497 | 0.564 | 0.647 |
| LSI after | 0.876 | 1.000 | 1.000 |
| GLSI Before: | | 0.836 | |
| GLSI After: | | 0.986 | |

The primary objectives are fully achieved. The KPIs which refers to the environment impact area such as traffic throughput reduction witnessed a strong drop by overcoming the target. Furthermore, load factor increased by fully reaching the objective. Finally, even though the vehicle utilisation factor witnessed a good result if compared with ones obtained by the other cities, a comparison with the previous situation cannot be done since no datum is available. Also by giving a look to the environmental impact area is possible to notice that all KPIs obtained significant results. Indeed, carbon dioxide and noise had a deep fall more than the expected results. Furthermore, other substances such as CH4 and NO2 was not revealed at all after the pilot implementation. Finally, by giving a look to the safety impact area is possible to note that the number of accident damage and vandalism is very low, however it is not possible to have data before the pilot implementation.

## 3.2 Process Evaluation Findings

### 3.2.1 Barriers

(Source: D5.4 CHAPTER 1.1.2.2 Risks & D5.4 CHAPTER 1.4 Transferability)

The following barriers were observed (including actions to overcome these barrier):

- **Barrier 1 –** Micro-platforms are based on a lease of public space, based on agreements that must be renewed periodically. There is a risk that the benefits achieved will be lost (if the space lease is stopped), but other sites are being studied.
- **Barrier 2 –** Publicity regulations limit the possibility of offering a discounted service to other shippers (the Shared-Box activity in the SMILE pilot) in Barcelona, but this maybe not the case in other cities.

### 3.2.2 Drivers

(Source: D5.4 CHAPTER 1.1.4 Transferability)

The following drivers were observed:

- **Driver 1 –** Positive delivery performance (over 80,000 parcels over the 5-month pilot) validates the Municipal policy of space concession, has opened dialogue with two Last-Mile Operators, committed to sustainable urban goods delivery. So, showing good performance through running a pilot helped to convince LMOs.

## 3.3 Evaluation Conclusions

### 3.3.1 Main lessons learned

(Source: D7.2 CHAPTER 3.2.3.5 Lessons Learned for Barcelona city & D5.4 CHAPTER 1.1.4 Transferability)

Implementing this measure, these are the main lesson learnt, important for future sustainable mobility strategies:

- **Key lesson 1 –** A first key finding is that, in a densely populated city like Barcelona, an LMO (last-mile operators) that has a significant level of control of the logistics consolidation chain can make a micro-platform work successfully even if no access restriction policy is applied to the streets around the micro-platform (the case of POL Serveis, El Ninot Market).
- **Key lesson 2 –** A second finding comes from the discussions about enhancing the data exchange to include geo-location data. Currently, and in cooperation with GROWSMARTER project, there is a discussion about how the geo-location data can best be added to the space concession protocol.

This discussion is based upon visualisations of the services that vanAPEDAL is making from the Estació de França micro-platform – showing service catchments way beyond Ciutat Vella. These findings suggest that a smaller number of micro-platforms may be required for the city, and there are additional implications for the optimisation of the transhipment process and the platform space (layout) design.

### 3.3.2 Long term impact

(Source: D7.2 CHAPTER 3.2.3.5 Lessons Learned for Barcelona city)

The long term impact of the microplatforms is not yet assessed. However, the City of Barcelona is itself engaged in developing micro-distribution in its next SUMP (2019-2024) and in further researching the micro-distribution process.

### 3.3.3 Potentials for transferability in other cities

(Source: D5.4 CHAPTER 1.1.4 Transferability)

Based on the conclusions of the evaluation of this measure and the available knowledge on the context and challenges of other cities, the following conclusions on the transferability potential of the measure can be made:

**Key conclusion– Microplatforms (pilot)**: Any city that is willing to identify public space and make it available to Last-Mile Operators could take up the micro-distribution solution. If the city has no logistics operators interested in a cargo-bike solution or has no start-up cargobike company, then these aspects would need to be addressed first.

**Key conclusion– App (case study)**: any city that operates (a considerable number of) un/loading spaces using a cardboard disc, and has a centralised capacity to manage on-street regulations enforcement could adopt the app solution. Barcelona has 8500 spaces; maybe cities having 1000+ spaces could consider this measure.

Furthermore, the metropolitan authority of Barcelona has commissioned a study to examine how the micro-distribution experience of the City of Barcelona is transferable to the other municipalities of the Metropolitan Area. The findings of this study aim to coordinate micro-distribution actions that may feature in the SUMPs of certain municipalities.

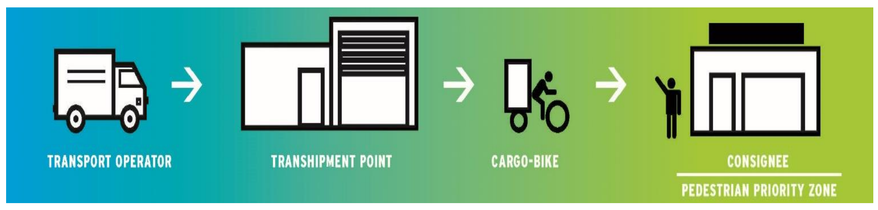
## 3.4 Annexes and reference documents

The following documents present further details on the evaluation findings (e.g. the evaluation report, a presentation, ..):

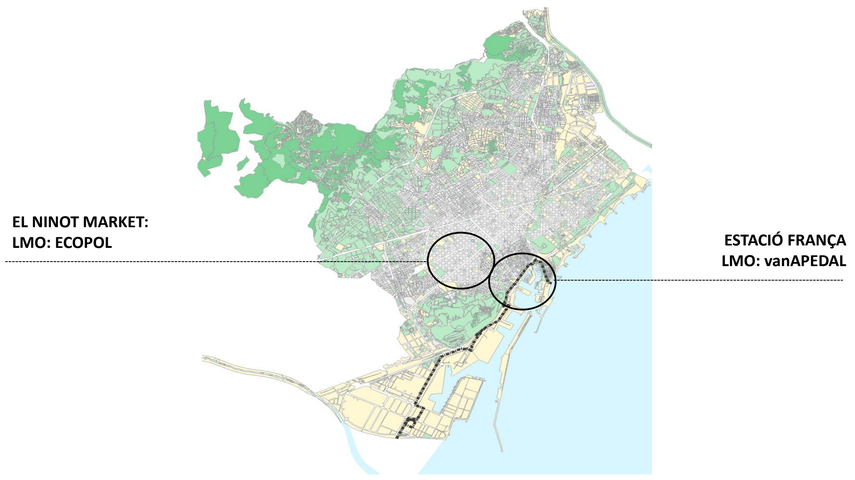
- D6.3 “Evaluation of UFT policies and measures”
- CIVITAS Conference 2018 posters (see next pages)

# NOVELOG Pilot action
# Micro-distribution BARCELONA

**Micro-distribution** is a service to shippers who bring parcels by van or truck to a transhipment hub or micro-platform, from where cargo-bikes are used for last mile delivery.




**MODEL:** Barcelona City Council located two suitable public off-street spaces that it cedes to last mile pperators. In exchange for the cost savings of space rental the LMOs provide monthly data on the deliveries made each day. The LMOs assume the role of a neutral operator, i.e. they deliver parcels for any carrier requesting service.




**IMPACTS:** In a 5-month pilot in 2017, bikes and trikes of the two hubs covered 19,000 km delivering 81,506 parcels. CENIT, the evaluation partner, has quantified a saving of 9,472kg in $CO_2$ emissions and important reductions in other air pollutants. Only one case of damage – only one accident.

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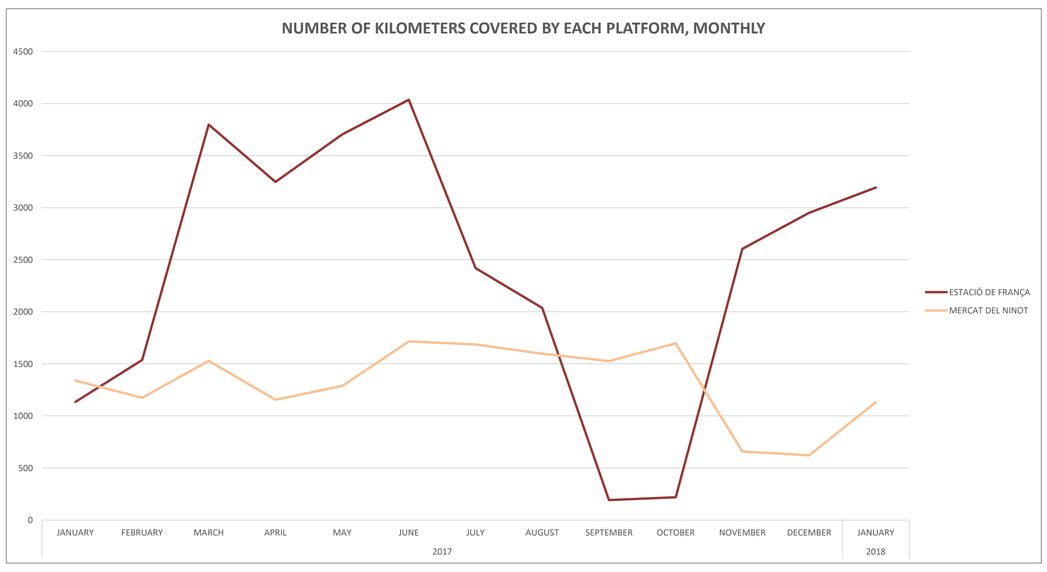
| Air pollutant emissions savings (kg) | Estació de França | Mercat El Ninot | Both Platforms |
|---|---|---|---|
| $CO_2$ | 6172 | 3301 | 9472 |
| $NO_x$ | 72 | 5 | 77 |
| PM | 39 | 3 | 41 |

## FINDINGS:

The LMOs extended the catchment of delivery services as the pilot evolved, so the city considers one platform per district might suffice.




In July 2017, ECOPOL started serving Ciutat Vella from a private platform, reducing traffic reported to the municipality. In 2018 vanAPEDAL is collaborating with the Growsmarter project extending the time series of the Estació de França platform.

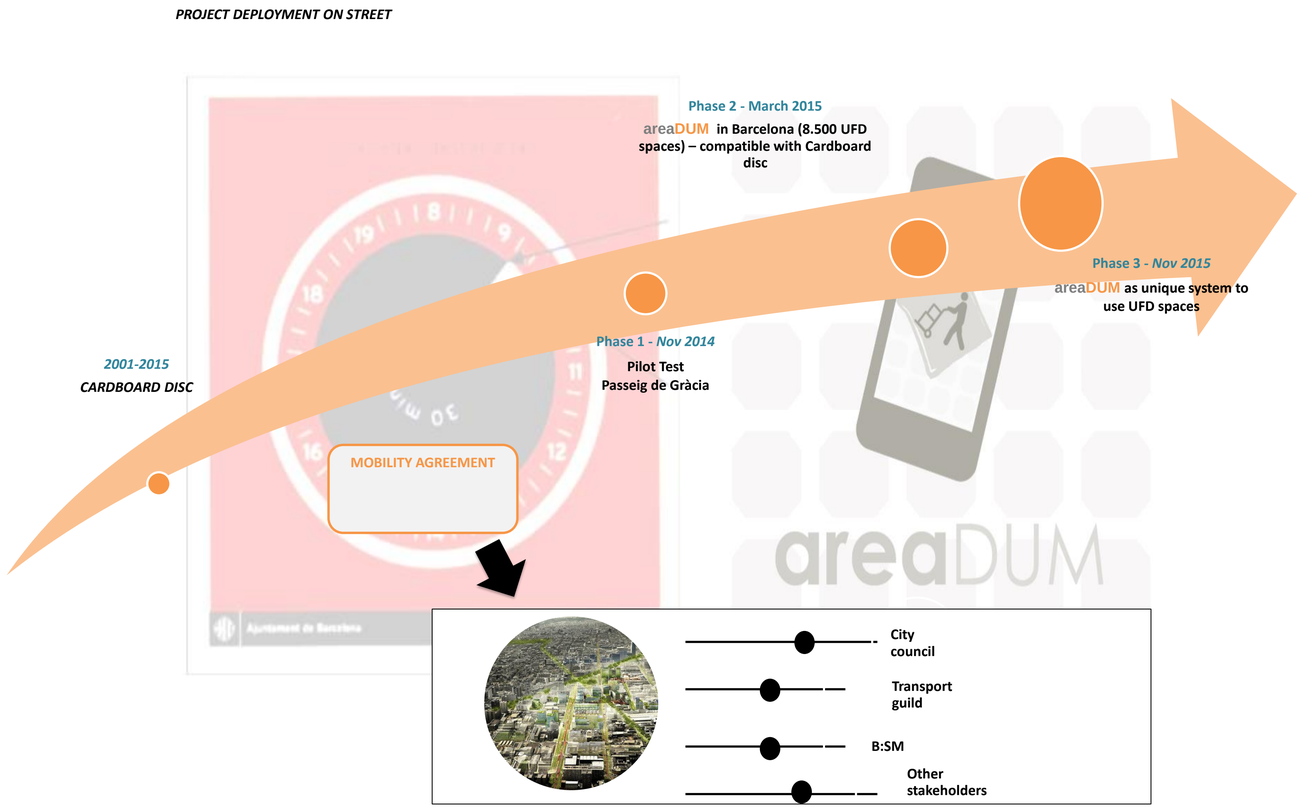
Contact: Xavier Cruzet *xcruzet@bcn.cat*

These projects have received funding from the European Union's Horizon 2020 research and innovation programme under grants agreements No 635898, 636626, 633338, 635773

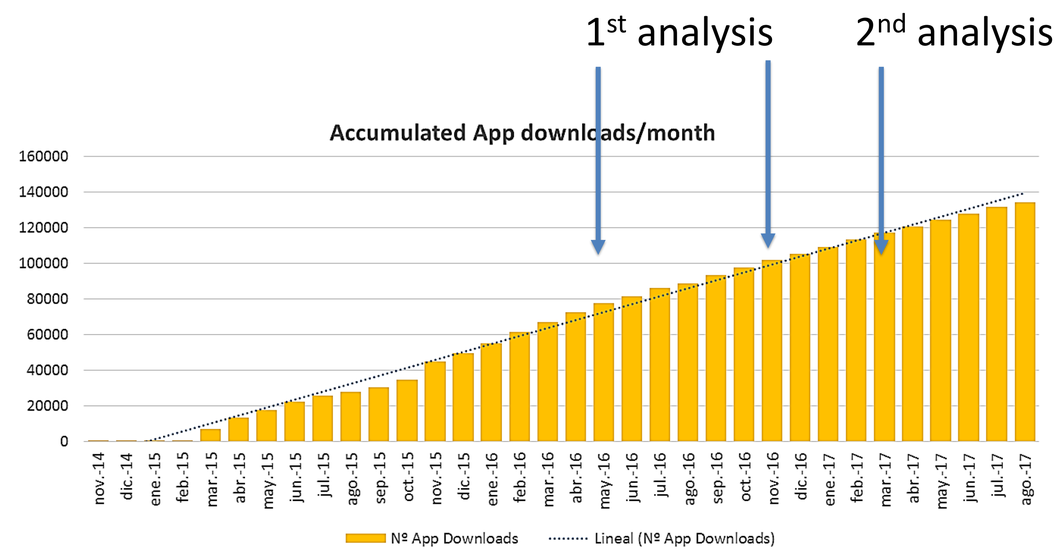
# NOVELOG Case study
# AreaDUM app BARCELONA

B:SM is a municipal agency that manages on-street parking and the enforcement of 10,000 on-street goods delivery spaces.

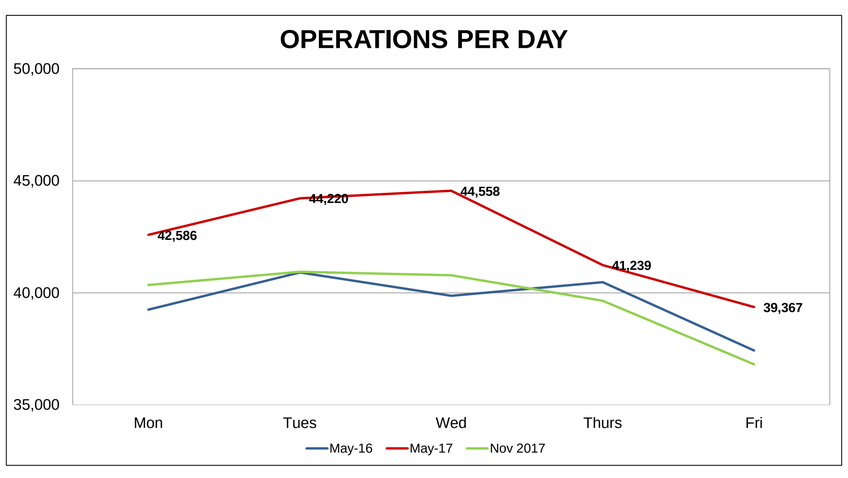
B:SM's deployment of an app to substitute the cardboard disc coincided with the start of NOVELOG. The City Council's Mobility Services Dept has analysed data from the app as a NOVELOG case study.

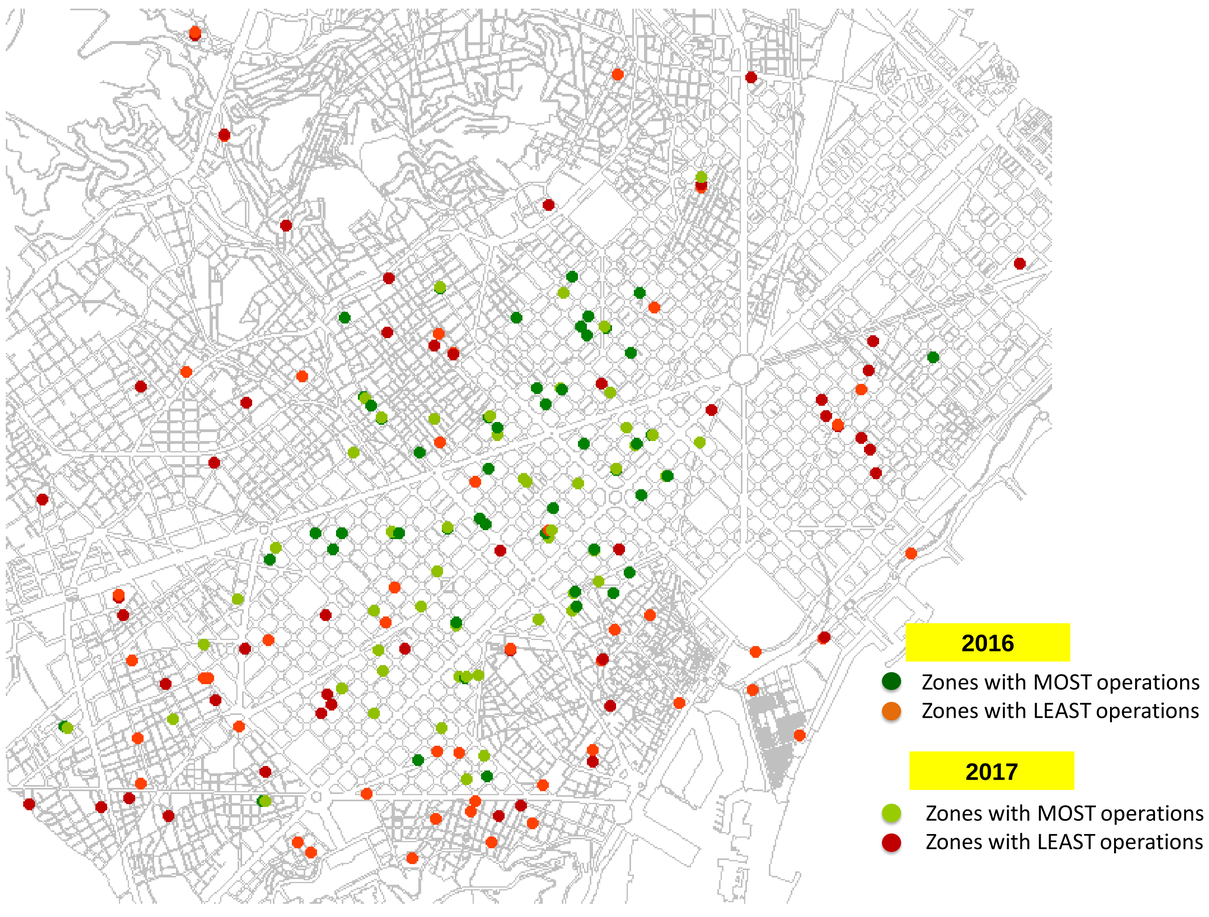



The app was adopted as the compulsory means of validation in Nov 2015. EPIM analysed transactions for weeks of May & Nov 2016 and May 2017.




We now know a LOT more about deliveries in Barcelona: which of the 1900 zones are least/most used, that there are 40,000 to 45,000 operations per weekday, etc.




Contact: Xavier Cruzet *xcruzet@bcn.cat*

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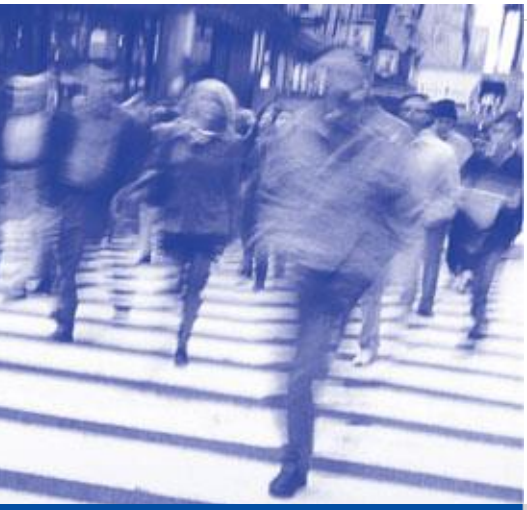

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# Measure reporting on evaluation approach and evaluation findings

## - RIA project NOVELOG

| | |
|---|---|
| Measure | Locker walls and UDC in last mile distribution |
| Short description | Mechelen, given the existing monitoring system including a total of 40 ANPR cameras, intended to promote the UDC operation in combination with the deployment of locker walls for last mile distribution |
| | |
| **Report developed by** | |
| Project: | NOVELOG |
| City/cities | Mechelen |
| Author(s) | Gitte Van Den Bergh, Teti Nathanail, Ioannis Karakikes, Georgia Ayfantopoulou |
| Mail address | gea@certh.gr |
| Version | Final |
| Date | 18/07/2018 |
| | |
| ***Template** by* | *CIVITAS SATELLITE* |
| *Review:* | *Dirk Engels, Gitte Van Den Bergh* |

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# 1 Measure description

## 1.1 Objectives of the measure (or type of measure) ? Why ?

(Source: D3.2 – CHAPTER 2.3.3)

| City's primary objectives | City's secondary objectives |
|---|---|
| Economic<br>• increase logistics services quality<br>Environmental<br>• reduce $CO_2$ emissions'<br>Social<br>• reduce congestion<br>• improve service accessibility | • increase delivery load factor<br>• introduce/adopt/exploit ICT/ITS<br>• provide evidence/incentives for further adoption<br>• introduce new/adapted regulatory schemes (Sustainable Urban Logistics Plans (SULPs), Limited Traffic Zones (LTZs), car restrictions) |

## 1.2 Description of the measure: what is implemented ? How ?

### 1.2.1 General

(Source: D5.2 CHAPTER 10)

The measure involves the implementation of the following:

- **Lockers**: The purpose is to introduce a freight solution in the city centre specifically for e-commerce, hands-free shopping and home delivery, in order to reduce own account transport, freight distribution traffic (both in number of vehicles as in number of kilometers) and CO2 emissions in the city centre. Originally 4 different locations in Mechelen, a Bringme locker wall will be installed. The selected locations are 1 car park outside the city centre, two underground car parks in the city centre and 1 locker which will be placed close to the main square where each Saturday the market takes place. Variation from description of work: only 2 lockers instead of 4 will be installed for lack of budget; the installation and test will last only during six months instead of one year, the reason is the same, lack of budget.
- **Urban distribution centre**: the purpose is to introduce a last-mile freight solution in the city centre, specifically in the (extension of the) car free zone, in order to reduce freight distribution traffic, both in number of vehicles as in number of kilometers, and in lower CO2 emissions in the city centre. Retailers will be offered the possibility to have their goods delivered at the urban distribution centre, which is a warehouse outside the city centre owned by a private company, using a c/o address. Deliveries from there on will be done by a bike courier. Secondly, traditional couriers and transporters will be asked to assign their last mile in the city centre to a bike courier. Extension of car free zone is now in the following streets: part of IJzerenleen, Geitestraat, Borzestraat, Blauwhondstraat and part of Vleeshouwerstraat

### 1.2.2 Outputs

Direct results of the measure:

- Installation of locker walls on two locations in the city

### 1.2.3 Supporting activities

(Source: D5.2 CHAPTER 10)

For achieving the pilot implementation, the stakeholder involvement was fundamental. The following stakeholders were involved:

- Public Authority: City of Mechelen - rental of Bringme lockers, communications towards retailers, facilitation with Bubble Post, Local Police - data provision related to the vehicle entering the city center, arranging free parking space for UPS cargo bike deliveries in the parking lot just outside city center.
- Research: Flanders Institute for Logistics (VIL) - support for the online survey to retailers to identify positive and weak players, VUB MOBI, research group of the university in Brussels, - support in the on-line surveys,
- Logistics Operator: Bringme supplier (sub pilot Locker) - Provide, install and maintain Bringme locker walls and contribute to the communication plan, Bike couriers such as Bubble Post, (sub pilot UDC) - Provide last mile service in cooperation with as many logistic service providers as possible, Share data with the City, Logistics service provider (GLS, DHL) (both pilots), Deliver to the UDC, responsible of last mile delivery in the city centre to bike courier, UPS will deliver in the city center by cargobike, using their own UPS cargo bike, departing from a parking lot just outside the center.
- Retailers/other private: Shop owners (both pilots) - participation in the online survey, identification of logistics service providers, E-shops - responsible to offer delivery in the boxes (sub pilot Locker), ODTH or other warehouse as UDC (sub case UDC),
- Associations: Belgian Courier Association, as expert stakeholder in the pilot activities,
- Technology Provider: Imec (former iMinds) for data developing,

### 1.2.4 Interaction with other measures

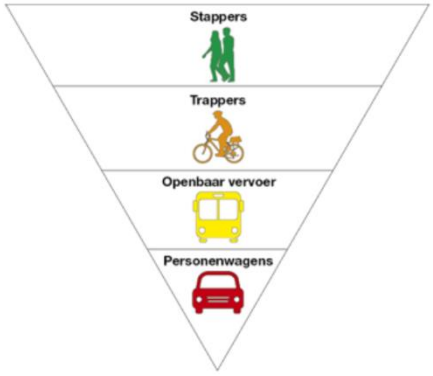
(Source: D5.4 CHAPTER 1.3.2.1 Policy framework & sustainability principles)

Apart from the implementation of the proposed pilot actions, the city of Mechelen aims to enhance the implementation of energy-efficient and environmental friendly measures. Therefore, they will provide their know-how and support collaboration actions among different stakeholders exploiting previous experiences and initiatives.

The city of Mechelen has formulated a set of horizontal strategies which support the evolution into sustainable and efficient freight.

- **Covenant of mayors**: Mechelen has signed the European covenant of mayors which implies that it has to obtain a C02 reduction of 20% by 2020.
- **Climate neutral**: Mechelen has the ambition of becoming one of the first climate neutral cities. An action plan prepared in which freight transport has been also considered.
- **Smart city**: Mechelen also strives to be a smart city and wants to invest in IT implementations that improve the quality of life in a sustainable way. Mobility is also considered in this horizontal strategy.

- **Sustainable mobility**: The city has already a SUMP in implementation organizing its mobility according to the STOP-principle, giving priority to pedestrians and cyclists. There is also already an area of car restriction with time frames for deliveries. It is the ambition of the city to evolve from a SUMP into a SULP.




*The stop principle*

# 2 Evaluation approach

## 2.1 Impacts and indicators

(Source: D6.3 CHAPTER 3.6 & D6.3 ANNEX A)

The stakeholders of the city of Mechelen evaluated the measure of “Lockers introduction”. Supply chain stakeholders selected for the evaluation eight indicators, while Public authority stakeholders and Other selected ten and eleven, respectively.

Mechelen stakeholders’ selected impact areas:

| Supply chain stakeholders | Public Authorities | Other Stakeholders |
|---|---|---|
| Transport and Mobility | Economy and Energy | Economy and Energy |
| Society | Transport and Mobility | Transport and Mobility |
| Policy and Measure Maturity | Society | Society |
| Social Acceptance | Policy and Measure Maturity | Policy and Measure Maturity |
| User Uptake | Social Acceptance | Social Acceptance |
| | User Uptake | User Uptake |

Mechelen supply chain stakeholders’ selected aspects and indicators:

| Aspect | Indicator | Data Units |
|---|---|---|
| Level of service | Customer satisfaction | Likert scale {1 (lowest value) - 5 (highest value)} |
| Greening | Green reputation | Likert scale {1 (lowest value) - 5 (highest value)} |
| Living standards | Quality of life | Likert scale {1 (lowest value) - 5 (highest value)} |
| Awareness | Awareness level | Likert scale {1 (lowest value) - 5 (highest value)} |
| Social approval | Adjustability | Likert scale {1 (lowest value) - 5 (highest value)} |
| | Final user acceptance | Likert scale {1 (lowest value) - 5 (highest value)} |
| Stakeholder approval | Stakeholder acceptance | Likert scale {1 (lowest value) - 5 (highest value)} |
| Success | Success rate | Likert scale {1 (lowest value) - 5 (highest value)} |

Mechelen public authorities' selected aspects and indicators:

| Aspect | Indicator | Data Units |
|---|---|---|
| Benefits | Strength and diversification of local economy | Likert scale {1 (lowest value) - 5 (highest value)} |
| Costs | Enforcement cost | EURO - € (or other monetary unit) |
| Level of service | Supply chain visibility | Likert scale {1 (lowest value) - 5 (highest value)} |
| IT, infrastructure and technology | Urban space engagement | Likert scale {1 (lowest value) - 5 (highest value)} |
| Greening | Green concern | Likert scale {1 (lowest value) - 5 (highest value)} |
| Living standards | Changes in consumer behavior society | Likert scale {1 (lowest value) - 5 (highest value)} |
| | Quality of life | Likert scale {1 (lowest value) - 5 (highest value)} |
| Awareness | Awareness level | Likert scale {1 (lowest value) - 5 (highest value)} |
| Managerial risks | Lack of cooperation | Likert scale {1 (lowest value) - 5 (highest value)} |
| Social approval | Final user acceptance | Likert scale {1 (lowest value) - 5 (highest value)} |
| Stakeholder approval | Adoption rate | Likert scale {1 (lowest value) - 5 (highest value)} |

Mechelen other stakeholders' selected aspects and indicators:

| Aspect | Indicator | Data Units |
|---|---|---|
| Benefits | Strength and diversification of local economy | Likert scale {1 (lowest value) - 5 (highest value)} |
| Level of service | Customer satisfaction | Likert scale {1 (lowest value) - 5 (highest value)} |
| Transport System | Delays | Veh-hrs |
| UFT vehicles | Traffic throughput | Veh-km |
| Greening | Green concern | Likert scale {1 (lowest value) - 5 (highest value)} |
| Convenience | Perceived visual and audio nuisance | Likert scale {1 (lowest value) - 5 (highest value)} |
| Living standards | Quality of life | Likert scale {1 (lowest value) - 5 (highest value)} |

| Aspect | Indicator | Data Units |
|---|---|---|
| Awareness | Awareness level | Likert scale {1 (lowest value) - 5 (highest value)} |
| Managerial risks | Lack of knowledge about stakeholders' requirements | Likert scale {1 (lowest value) - 5 (highest value)} |
| Social approval | Public acceptance | Likert scale {1 (lowest value) - 5 (highest value)} |
| Stakeholder approval | Stakeholder acceptance | Likert scale {1 (lowest value) - 5 (highest value)} |

## 2.2 Further analysis of data

(Source: D3.1 & D3.2)

Evaluation incorporates a multiple weighting scheme, and elimination and ranking techniques and models, for the facilitation of “shared” decision-making, taking into account the participation, viewpoint and contribution of all involved stakeholders to the conformation of the final decision made on the measures. The functions of the evaluation, following the concept of multi-stakeholder multi-criteria assessment methodologies, lead to the estimation of the Logistics Sustainability Index (LSI). This LSI depicts not only the overall performance of the measure/policy implemented, but also the degree of objectives’ achievement and the possibility for further improvement.

In the case, that more than one stakeholder group is involved in the evaluation of a set of measures then a Global Logistics Sustainability Index (GLSI) can be estimated by combining the LSI per measure with the relevant weights for each stakeholder category for each impact area. The weights per stakeholder category is the outcome of a Delphi process that captures the weights of each stakeholder category for the seven impact areas. Weights are given by experts, following a Delphi method, when a 70% consensus is achieved.

## 2.3 Process evaluation activities

The following activities are set in place to understand and assess the implementation process:

- Stakeholder survey before and after implementation of the measure

## 2.4 Appraisal of evaluation approach

(Source: D6.3 CHAPTER 5)

Based on the evaluation work in this project, the following observations and recommendations concerning the evaluation approach seem important for other projects (including specific interesting elements in the approach):

- The Evaluation Tool constitutes an effective tool for evaluating UFT (urban freight transport) solutions, under different stakeholder categories’ viewpoint, while it allows easy extraction of all evaluation

results. It allows stakeholders to run their own evaluation scenario, based on their own interests. It also allows to combine the interests of the different stakeholders into one common indicator.

- This assessment stresses the importance of recording and maintaining high quality data for improving policy making and monitoring periodically the progress of implementations.

## 2.5 Annexes and reference documents

The following documents present further details on the evaluation approach (e.g. the evaluation plan, a presentation, ..) or are used as a reference document for the development of the evaluation approach:

- D3.2 “Evaluation tool”

# 3 Evaluation findings

## 3.1 Impact of the measure

### 3.1.1 Results in the impact categories

(Source: D6.3 CHAPTER 3.6)

Based on Supply chain and Other stakeholders' evaluation results the new measure brought non negative impacts in all considered indicators, whereas under Public authority viewpoint the new measure has a negative impact on "Urban space engagement", "Changes in consumer behaviour society", "Lack of cooperation" and "Final user acceptance" indicators (Figure 1). Specifically, the two highest negative changes are due to the fact that the engagement of the urban space for storage, loading/unloading and other related activities has been increased to 11-20% from 0-10% and the changes in consumer behavior society influences now the management of the UFT activity in 91-100% of its schedule as compared to 21-50% that was before implementing the lockers. Finally, four indicators remained unchanged for Other stakeholders including "Strength and diversification of local economy" that remained unchanged for Public authorities as well.

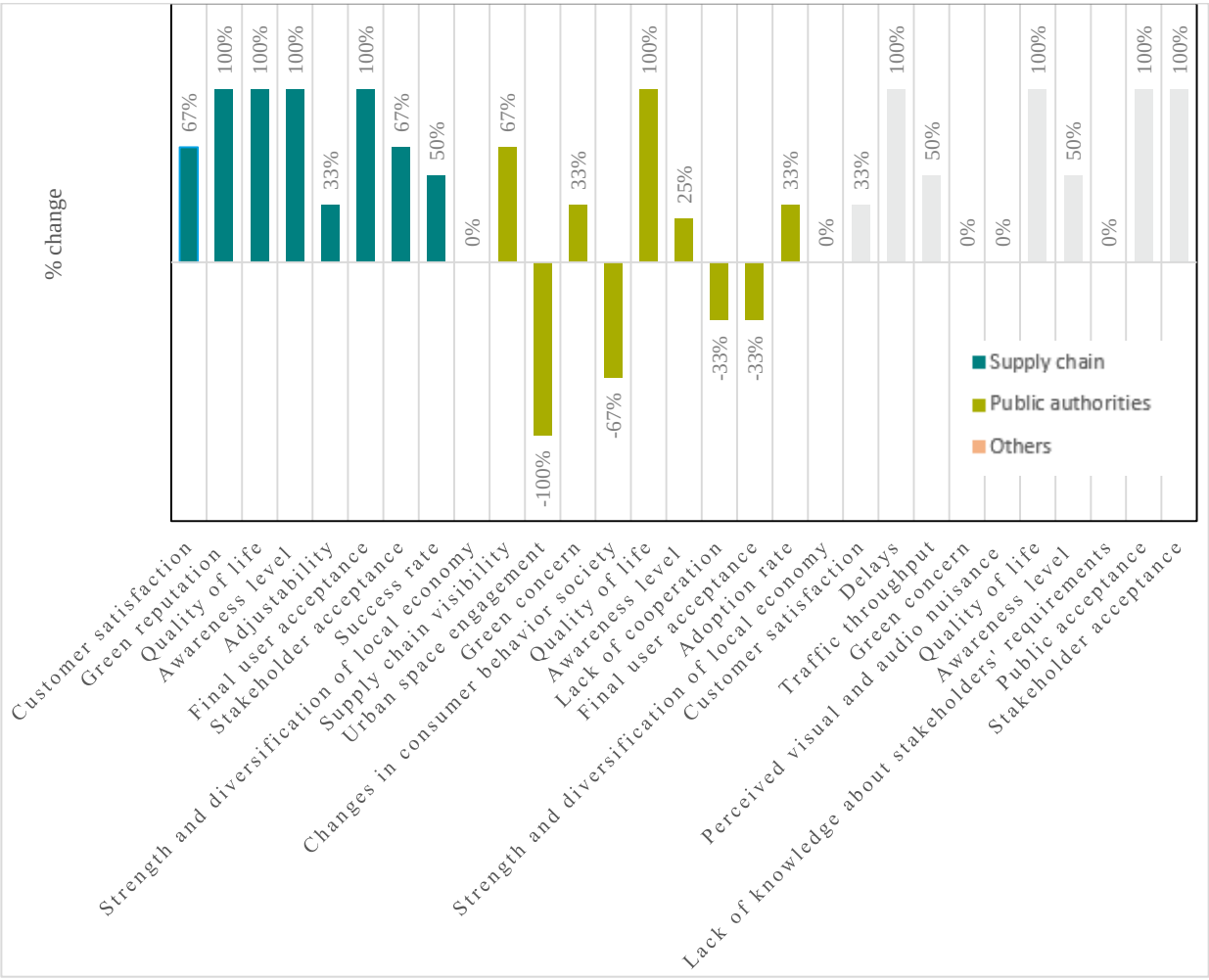



**Figure 1** Percentage change for selective indicators per Mechelen stakeholder category

The three stakeholder categories of the city of Mechelen selected all impact areas except the Environment (Table 1). The most important impact area for Supply chain and Other stakeholders is the "User Uptake",

while “Policy and Measure Maturity” impact area was given a weight of 0.029 and 0.045, respectively. Public authorities believe that Transport and Mobility is the most important impact area as compared to the rest.

**Table 1** Mechelen stakeholder weights per impact area

| | | Supply chain | Public authorities | Others |
|---|---|---|---|---|
| impact area | Economy and Energy | | 0.101 | 0.072 |
| | Environment | | | |
| | Transport and Mobility | 0.057 | 0.531 | 0.150 |
| | Society | 0.094 | 0.060 | 0.150 |
| | Policy and Measure Maturity | 0.029 | 0.115 | 0.045 |
| | Social Acceptance | 0.239 | 0.102 | 0.165 |
| | User Uptake | 0.581 | 0.091 | 0.417 |

Finally, Table 2 shows the before and after LSI value per stakeholder category as well as the weights attributed to each stakeholder category for the estimation of the before and after GLSI values. Based on the results Suppy chain and Other stakeholders believe that the Lockers introduction as a measure will improve significantly the overall logistics system performance in Mechelen, since on the one hand efficiency will be increased (less time to deliver the same number of parcels) and on the other hand fail deliveries trips will be eliminated. Public authority stakeholders believe that the new measure will impact both positively and negatively therefore no significant changes will arise from the new measure.

At city level, given that each stakeholder category was attributed an equal relevant weight, the new measure will contribute to the improvement of the overall performance of the logistics system by 33%.

**Table 2** Mechelen “Before” and “After” values

| | Supply chain | Public authorities | Others |
|---|---|---|---|
| Weight | 0.330 | 0.340 | 0.330 |
| LSI before | 0.668 | 0.802 | 0.622 |
| LSI after | 0.980 | 0.804 | 1.000 |
| GLSI Before: | | 0.699 | |
| GLSI After: | | 0.927 | |

### 3.1.2 **Key impact results**

(Source: D7.2 CHAPTER 3.2.3.3 Pilot implementation and outcomes)

The pilot showed interesting results:

- The impacts referring to traffic throughput showed a high drop, more than the expectations, probably since the presence of lockers reduced the distance of delivery trips and a warehouse for last-mile deliveries by bike, freed roads from heavier vehicles. However, cargo-bike deliveries did not show a time reduction for vehicle utilisation factor.
- CO2 emission dropped very strongly, more than the expectations and this is a very positive result. This can be explained by the introduction of lockers which reduced the deliveries trips in their number

and lengthiness. Moreover, a warehouse close to the city centre for last-mile deliveries made by bike caused a further emission reduction.

- Deliveries cost increased about 6 € per delivery and cost per year might be estimated about 6000€. It is worthy to say that even if the cost increase for the City, on the other way very positive impacts are envisaged: high drop of CO2 emissions and the traffic throughput fall. Moreover, this approach permits a drop of other externality costs that directly impact on the citizen health and congestion costs.

## 3.2 Process Evaluation Findings

### 3.2.1 Barriers

(Source: D7.2 CHAPTER 3.2.3.3 Pilot implementation and outcomes)

The following barriers were observed:

- Retailers did not perceive any advantage from cargo-bike since they did not trust about them. They were afraid of their lack of competences, and of goods lost or damages. However, it was proven that their fears were not founded. Other retailers instead did not trust overall about innovation and did not show any interest for improving their activity sustainability since no economic benefits were present; some others instead presented unsuitable needs for cargo-bike such as large deliveries (pellets). Hence, collaboration with shopkeepers for cargo-bike employment was very hard in this pilot. Lockers instead were welcome. However also logistic service provider did not want to have a partnership with cargo-bike couriers (Bubble post) since they offered elevate prices and some of them would have preferred remain in full ownership of the complete transport chain.
  UPS and GLS decided to use its-own cargo-bike. Sadly, Bubble Post stopped deliveries by cargo-bike in Mechelen at the end of March 2017. For improving city logistic is important to understand urban freight distribution and communication amongst actors is needed. Indeed, they are appreciating the interest from the city towards their situation. Awareness among different stakeholders like retailers, policy and city administration is getting stronger and stronger by this pilot implementation.
- Some problems happened also with the locker installation, the installation needed technical requirements (Wi-Fi, COAX cable) and an external company (Telenet) took care of the installation and dead line are difficult to manage. Furthermore, these installations require bigger budgets.

### 3.2.2 Drivers

(Source: D7.2 CHAPTER 3.2.3.3 Pilot implementation and outcomes)

The following drivers were observed:

- Fundamental for achieving the positive results have been the policies adopted for this pilot: the use of a depot close to the city centre combined with the use of cargo-bikes for last-mile deliveries. The pilot project has showed the importance of the intervention of the city authority that has provided incentives for a further adoption of the policies employed into this pilot, which meant financing the service of the cargo-bike company.

### 3.2.3 Recommendations on the implementation process

(Source: D5.4 CHAPTER 1.3.2.2 Requirements and risks)

The following recommendations can be given:

- **Recommendation 1 –** The main challenge is the participation of the **private sector** in innovative solutions for UFT due to their **lack of awareness**. Most of the companies are not informed about the potential benefits derived implementing energy-efficient and environmental friendly measures for urban freight deliveries. Moreover, special focus should be given on technical issues and requirements since innovative solutions require advanced technological tools. The design process should be carefully implemented and details should be considered as technical issues may result to severe delays and cause significant increase in budget.
- **Recommendation 2 –** Another challenge is to adapt the city's policy according to the ambition the city has in city logistics. We can conclude that there is still a regulative framework that still allows non-sustainable transport into the inner city centre. If the city really wants to evolve to a zero emission first and last mile, it will have to tighten the policy. To achieve this, zero emission urban logistics should be a topic of high interest on the political agenda.

## 3.3 Evaluation Conclusions

### 3.3.1 Main lessons learned

(Source: D5.4 CHAPTER 1.3.3.1 Mainstreaming in the existing policy framework)

Implementing this measure, this are the main lesson learnt, important for future sustainable mobility strategies:

- **Key lesson 1** – The main results for the Mechelen city are the reductions achieved in the traffic flows in the inner city and in the corresponding CO2 emissions generated due to urban freight transport. In this context, two pilot actions were implemented developing an urban distribution centre to operate bike services for last mile deliveries and installing lockers for both pickups and deliveries in the inner city.

### 3.3.2 Long term impact

(Source: D5.4 CHAPTER 1.3.3.1 Mainstreaming in the existing policy framework & D7.2 CHAPTER 3.4.3.5 Lessons Learned for Mechelen city)

Based on the conclusions of the evaluation of this measure in the lifetime of the CIVITAS project, we can conclude the following concerning the long term impact of this measure:

- Capitalizing upon these measures and other NOVELOG pilot cases, the sustainable urban logistics and mobility plan of the city will promote energy efficient and environmental friendly measures and the public authorities will support collaboration actions among different stakeholders in order to implement innovative solutions. This will enhance future interventions and the know-how obtained within these pilot actions could be used for large scale implementation.
- Currently there is no tangible plan for a SULP. However, participating in projects as Cycle-logistics Ahead and NOVELOG offers Mechelen the opportunity to have a testing ground and to obtain first experiences in how to manage sustainable logistics in the city centre. This experience will be translated in a first concept note, which will be transmitted to the Municipal Council. But for now, the Municipal Council has recently decided to freeze any new mobility (and therefor also logistic) related measure until the end of 2018.

### 3.3.3 Potentials for transferability in other cities

(Source: D5.4 CHAPTER 1.1.4 Transferability)

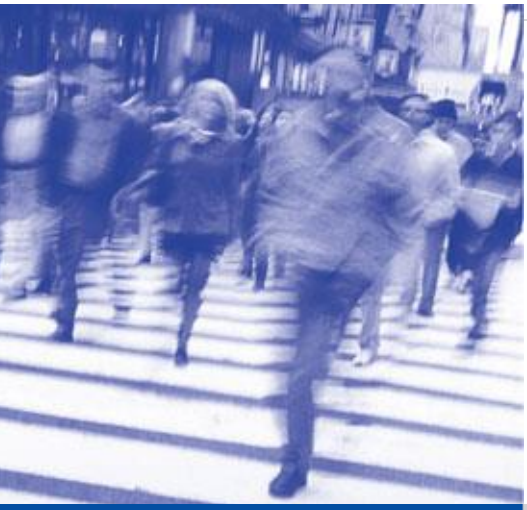
The following aspect of the Mechelen pilots can be considered transferable to other cities:

- Planning and implementation of communication activities
- Planning and implementation of evaluation process
- Development of lockers for both pickups and deliveries in the inner city (know-how and implementation processes)
- Development of an urban distribution centre to operate bike services for last mile deliveries (know-how and implementation processes)

## 3.4 Annexes and reference documents

The following documents present further details on the evaluation findings (e.g. the evaluation report, a presentation, ..):

- D6.3 “Evaluation of UFT policies and measures”



CIVITAS 2020
Cleaner and better transport in cities

SATELLITE

# Measure reporting on evaluation approach and evaluation findings

## - RIA project NOVELOG

| | |
|---|---|
| Measure | Seamless urban freight distribution |
| Short description | The City of Turin has designed and has been already running since June 2016 a soft, 'pull' measure dedicated to stimulating the replacement of highly polluting vehicles. New measures are tested to share existing infrastructures dedicated to public transport also with goods delivery, considering freight transport as a public service. New permission schemes encourage logistics operators available to replace their vehicles with a clean one, equipped with an on-board ITS system. |
| **Report developed by** | |
| Project: | NOVELOG |
| City/cities | Turin |
| Author(s) | Gitte Van Den Bergh, Teti Nathanail, Ioannis Karakikes, Georgia Ayfantopoulou |
| Mail address | gea@certh.gr |
| Version | Final |
| Date | 18/07/2018 |
| ***Template** by* | *CIVITAS SATELLITE* |
| *Review:* | *Dirk Engels, Gitte Van Den Bergh* |

novelog

CIVITAS 2020
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THE CIVITAS INITIATIVE
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# 1 Measure description

## 1.1 Objectives of the measure (or type of measure) ? Why ?

(Source: D3.2 – CHAPTER 2.3.3)

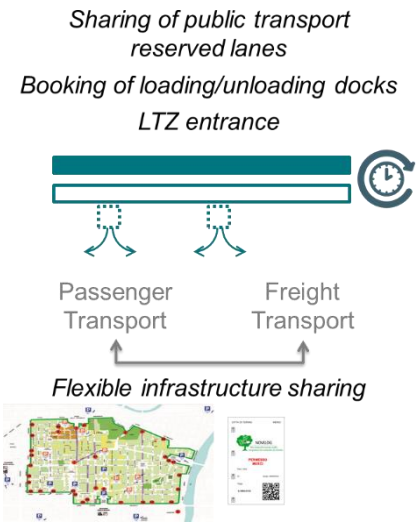
| City's primary objectives | City's secondary objectives |
|---|---|
| Economic<br>• increase logistics services quality<br>• increase Urban Freight Transport (UFT) system efficiency<br>• reduce congestion<br>Environmental<br>• reduce CO2 emissions<br>Social<br>• improve city accessibility<br>• ensure efficient deliveries for citizens and shopkeepers | • introduce/adopt ICT/ITS<br>• develop sustainable business models<br>• implement innovative regulatory schemes (Sustainable Urban Logistics Plans (SULPs), Limited Traffic Zones (LTZs))<br>• introduce shared freight/passenger schemes (common use of infrastructures) |

## 1.2 Description of the measure: what is implemented ? How ?

### 1.2.1 General

(Source: D5.2 CHAPTER 9)

City of Turin designed a NOVELOG pilot as further enhancement of the following pull measures: a) development of a dedicated recognition scheme; b) exploitation of existing ITS; c) share of existing infrastructures between passengers and goods transport. Among these the Municipality Recognition Scheme (MRS) was in fact the enabler of an innovative governance model. The MRS is based on the sustainability concept from environmental (i.e. adoption of low emission freight vehicles), economic (i.e. fair competition without public funding) and social (i.e. city centre accessible for registered operators) side. There are two core measures to be implemented, the **multi-users lanes** and the **loading/unloading parking lots management** in selected subset of city centre Limited Traffic Zones, incorporating bus lane sharing with freight vehicles and access control with already installed cameras for the monitoring of parking booking and control system respectively.




**The Multi-users lanes** measure aims at managing access to reserved bus lanes. This is, in fact, the main innovative strategy introduced by the “NOVELOG” project that concerns the possibility of sharing dedicated bus lanes by logistics operators without affecting public transport system (maintaining acceptable level of

service) and reducing congestion for all categories of users in the city road network. The usability of preferred lanes by recognised commercial vehicles will be monitoring by dedicated ITS and recognition schemes incorporated in the regulatory framework.

The identification of reserved lanes has already started and under agreement with the key actors that signed the Freight Quality Partnership (FQP) signed amongst freight transport operators and the Italian Ministry of Transport. The FQP is the first tool for sharing and developing the most significant experiences in the field of urban freight distribution in Turin.

**The Loading/unloading parking lots management** measure is related to implementation of a system for loading/unloading parking lots management and for an efficient monitoring of the areas. The implementation of this measure will increase the number of slots and decrease delivery times

### 1.2.2 Supporting activities

(Source D5.2 CHAPTER 9)

Stakeholders involvement is an important part of the measure. The following stakeholders were involved:

- Public Authorities: Local Chamber of Commerce, Municipality of Turin, Ministry of Infrastructure and Transport, Piedmont Region, discussion with freight quality partnership and application/ tuning of administrative/regulatory rules,
- Logistics Operator: TNT, SDA, BARTOLINI, DHL, UPS, GLS, Interporto - all supporting the pilot activities, by participating directly with their transport means,
- Retailers/other private shops,
- Associations: Industrial, ANFIA, API, Confindustria, Federauto, Unione Industriali, UNRAE association of logistics operators: AICAI, Apsaci, FEDIT, Federdistribuzione, Confartigianato Trasporti, FITA C.N.A, FAI, ASCOM – Confcommercio, C.N.A., Confartigianato, Confcooperative, Confesercenti - supporting the freight quality partnership operation, hints and decisions for discussions,
- Technology Provider: 5T, Viasat, Torino Wireless - Responsible of operations and management of the technologies to monitor freight traffics in LTZ, parkings and bus lanes.

# 2 Evaluation approach

## 2.1 Impacts and indicators

(Source: D6.3 CHAPTER 3.7 & D6.3 ANNEX A)

For the evaluation of the measure Turin stakeholder categories Supply chain, Public authority and Other stakeholders selected seven, four and six indicators, respectively.

Turin stakeholders' selected impact areas**:**

| Supply chain stakeholders | Public Authorities | Other Stakeholders |
|---|---|---|
| Economy and Energy | Environment | Environment |
| Transport and Mobility | Transport and Mobility | Transport and Mobility |
| Social Acceptance | Social Acceptance | Society |

Turin supply chain stakeholders' selected aspects and indicators:

| Aspect | Indicator | Data Units | Before Values | After Values |
|---|---|---|---|---|
| Benefits | Income generated | EURO - € (or other monetary unit) | 1 | 1.1 |
| Costs | Fuels | EURO - € (or other monetary unit) | 10,347 | 9,408 |
| Level of service | Quality | Percentage (%) | 90 | 95 |
| | Customer satisfaction | Likert scale {1 (lowest value) - 5 (highest value)} | 3 | 3 |
| Safety and security | Accidents | Number / veh-km | 4 | 0.5 |
| Social approval | Final user acceptance | Likert scale {1 (lowest value) - 5 (highest value)} | 3 | 5 |
| Regulations' acceptance | Motivation for eco-driving practice | Likert scale {1 (lowest value) - 5 (highest value)} | 3 | 4 |

Turin public authorities' selected aspects and indicators:

| Aspect | Indicator | Data Units | Before Values | After Values |
|---|---|---|---|---|
| Air quality | PM10 concentration | µg/m3 | 100 | 20 |
| GHG emissions | CO2 | kg | 27,42 | 24,93 |
| Level of service | Supply chain visibility | Likert scale {1 (lowest value) - 5 (highest value)} | 3 | 3 |
| Social approval | Final user acceptance | Likert scale {1 (lowest value) - 5 (highest value)} | 3 | 5 |

Turin other stakeholders' selected aspects and indicators:

| Aspect | Indicator | Data Units | Before Values | After Values |
|---|---|---|---|---|
| Air quality | PM10 concentration | µg/m3 | 100 | 15 |
| GHG emissions | CO2 | kg | 100 | 90 |
| Level of service | Customer satisfaction | Likert scale {1 (lowest value) - 5 (highest value)} | 3 | 4 |
| Greening | Green concern | Likert scale {1 (lowest value) - 5 (highest value)} | 2 | 3 |
| Convenience | Diffusion of information | Likert scale {1 (lowest value) - 5 (highest value)} | 3 | 3 |
| Living standards | Quality of life | Likert scale {1 (lowest value) - 5 (highest value)} | 2 | 5 |

## 2.2 Further analysis of data

(Source: D3.1 & D3.2)

Evaluation incorporates a multiple weighting scheme, and elimination and ranking techniques and models, for the facilitation of "shared" decision-making, taking into account the participation, viewpoint and contribution of all involved stakeholders to the conformation of the final decision made on the measures. The functions of the evaluation, following the concept of multi-stakeholder multi-criteria assessment methodologies, lead to the estimation of the Logistics Sustainability Index (LSI). This LSI depicts not only the overall performance of the measure/policy implemented, but also the degree of objectives' achievement and the possibility for further improvement.

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The following activities are set in place to understand and assess the implementation process:

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Based on the evaluation work in this project, the following observations and recommendations concerning the evaluation approach seem important for other projects (including specific interesting elements in the approach):

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- This assessment stresses the importance of recording and maintaining high quality data for improving policy making and monitoring periodically the progress of implementations.

## 2.5 Annexes and reference documents

The following documents present further details on the evaluation approach (e.g. the evaluation plan, a presentation, ..) or are used as a reference document for the development of the evaluation approach:

- D3.2 "Evaluation tool"

# 3 Evaluation findings

## 3.1 Impact of the measure

### 3.1.1 Results in the impact categories

(Source: D6.3 CHAPTER 3.7)

Based on Supply chain and Public authority stakeholders' evaluation results the new measure brought both positive and negative impacts (Figure 1). The main concerns of the stakeholders regard the number of accidents as well as the level of Final user acceptance. Other stakeholders believe that the new measure presents only non-negative impacts as compared to the previous operating logistics system with significant improvement (+150%) on the indicator of Quality of life. Specifically, they perceive that the quality of living in the city owing to the impacts of goods' deliveries is now "Excellent" as compared to the previous "Fair".

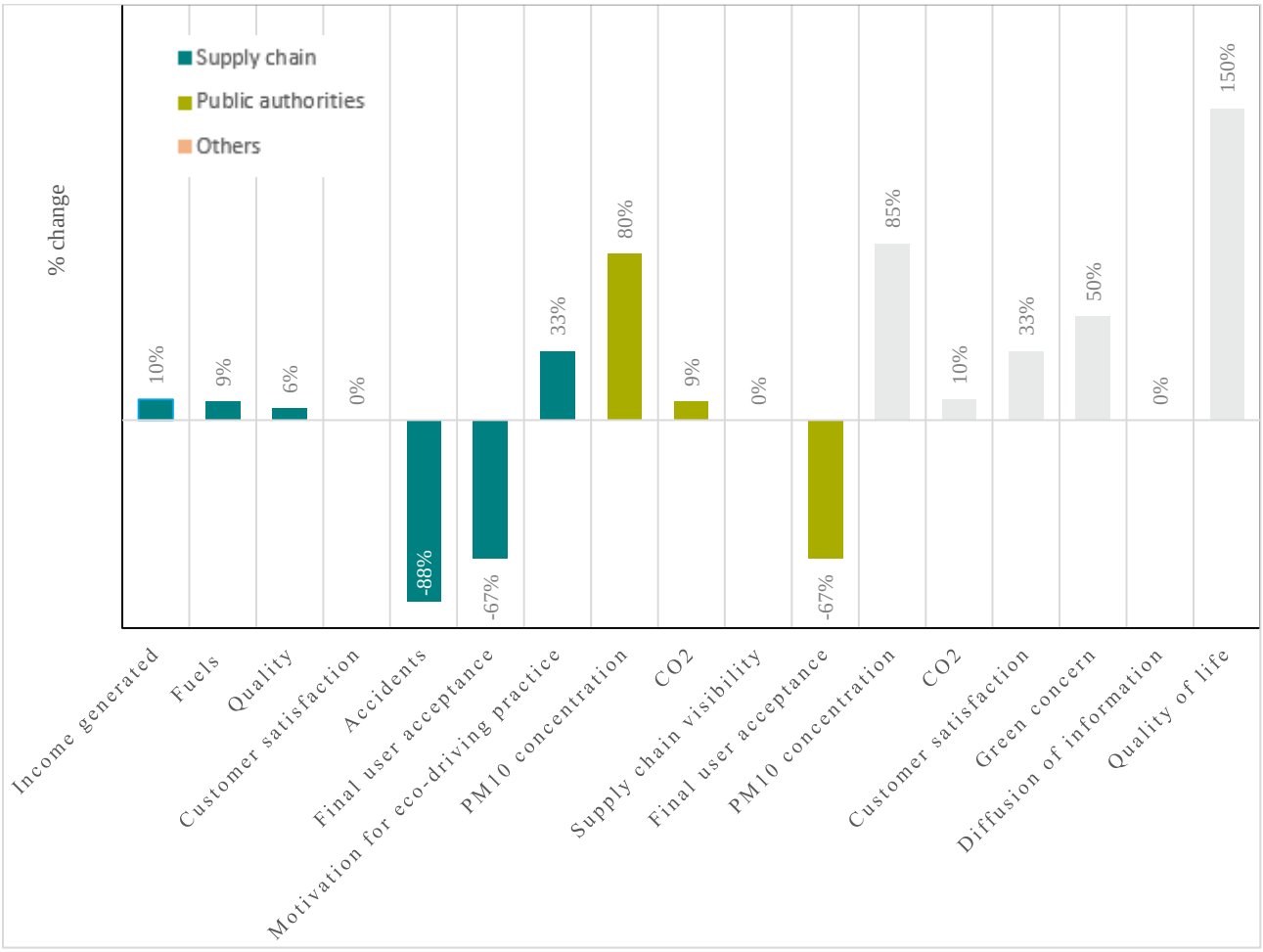



**Figure 1** Percentage change for selective indicators per Turin stakeholder category

Each stakeholder category of the city of Turin has selected three impact areas. Transport and Mobility impact area was selected by all stakeholders, while the Policy and Measure Maturity and the User Uptake impact areas constitute no evaluation component for any stakeholder category (Table 1). The highest weighted impact area for Supply chain stakeholders was the Social Acceptance (0.493) and for the Public authority and Other stakeholders the Environment.

**Table 1** Turin stakeholder weights per impact area

| | | Supply chain | Public authorities | Others |
|---|---|---|---|---|
| impact area | Economy and Energy | 0.311 | | |
| | Environment | | 0.493 | 0.594 |
| | Transport and Mobility | 0.196 | 0.311 | 0.249 |
| | Society | | | 0.157 |
| | Policy and Measure Maturity | | | |
| | Social Acceptance | 0.493 | 0.196 | |
| | User Uptake | | | |

Moreover, Table 2 shows the before and after LSI values per stakeholder category as well as the weights attributed to each stakeholder category for the estimation of the before and after GLSI values. Based on the results, Other stakeholders strongly believe (+94%) that the Multi-user lanes measure improves the conditions in the city, reduces $CO_2$ emissions and maintains the current acceptable levels of service for public transportation, thus, it contributes positively to the upkeep of a high system performance. On the contrary, Supply chain stakeholders consider the new measure as passive and therefore no significant changes have arisen from its implementation.

At city level, given that each stakeholder category was attributed an equal relevant weight, the new measure will contribute to the improvement of the overall performance of the logistics system by 29%.

**Table 2** Turin "Before" and "After" values

| | Supply chain | Public authorities | Others |
|---|---|---|---|
| Weight | 0.330 | 0.340 | 0.330 |
| LSI before | 0.809 | 0.693 | 0.516 |
| LSI after | 0.842 | 0.922 | 1.000 |
| GLSI Before: | | 0.704 | |
| GLSI After: | | 0.906 | |

### 3.1.2 Key impact results

- Reduction of $CO_2$, reduction of pollutant emissions (in particular the *particulate matters* because euro 5 vehicles directive strongly reduce such emissions respect the previous euro 3 and euro 4; i.e. from 0.025g/km for Euro 4 to 0.005g/km for Euro 5 that means a reduction of 80%);
- Reduction of traffic (no queue at the LTZ gates to wait for the entry time window and no bus speed reduction albeit the presence of passengers and freight on the same lanes).

## 3.2 Process Evaluation Findings

(Source: D7.2 CHAPTER 3.7.3.5 Lessons Learned & D5.4 CHAPTER 1.5.2.2 Requirements and risks)

- The Pilot benefits of a strong participation of the stakeholders that have released a series of lessons learned, very useful for the future sustainable mobility planning of the city: Logistics operators are very comfortable with the proactive and effective policy measures introduced. In general, operators

agree to improve their freight vehicles in favour of new and more eco-friendly ones in change of more flexibility in the use of bus lanes and access into the LTZ. Furthermore, a permanent dialog between operators, associations and public authorities has been set up (pull measures): the new approach proposed by the Municipality of Turin was based on possibility to have benefits in change of an improvement of the fleet instead of restrictions has been welcomed by the operators. A good participation to the project has been registered (48 vehicles = 80% of the totals; all the main national and international logistics operators have been involved) and very strong stakeholder participation in the pilot implementation (i.e. very high participation to meetings, availability to share data and needs and to give feedbacks on the policy measures) was witnessed. Implementation of Task Force with different stakeholder categories to share opinions, feedbacks and needs and cooperate has been conducted.

- The possibility of reserve a freight parking slot is not a priority of the logistics operators, they likes more the possibility to share reserved lanes with buses and wider time window to access into the LTZ.
- The main issue of the Turin pilot could be in the future when all the freight vehicles will be converted into alternative fuel vehicles (electric, CNG,..) and new policies will be needed focused on the load factor of the vehicles to continue to improve the city logistics**.**

## 3.3 Evaluation Conclusions

### 3.3.1 Main lessons learned

Implementing this measure, this are the main lesson learnt, important for future sustainable mobility strategies:

- **Key lesson 1** – The whole implemented measure package allows to improve the environment:
  - Reduction of $CO_2$, reduction of pollutant emissions
  - Reduction of traffic
- **Key lesson 2** – Logistics associations report the positive feedback on implemented measures of the operators: they have achieved more flexibility in the arrangement of the delivery and pick up tour therefore they save time, reduce the number of fees, improve their quality of life (by reducing stress), reduce the number of stops and reduce the number of returns to the depot.

### 3.3.2 Long term impact

(Source: D5.4CHAPTER 1.5.3.3 Mainstreaming in the existing policy framework)

The Novelog project gave the opportunity to the City of Turin to continue the experimentation already introduced in the PUMAS project and implementing innovative solutions in this contest for a more sustainable city logistics.

The Freight Quality Partnership (FQP) among the City of Turin, the Chamber of Commerce and 17 associations was indeed already signed in the scope of the PUMAS project and other more stakeholders have been following enclosed to work together and achieve common agreement to improve the efficiency of goods distribution within the LTZ.

The results of the Pilot implementing within the Novelog projects are good and the policies applied will be taken into consideration by the City of Turin when updating the SUMP (within 2-3 years)

A specific part, dedicated to logistics, will be included in the new release of the SUMP.

### 3.3.3 Potentials for transferability in other cities

(Source: D5.4 CHAPTER 1.5.4 Transferability)

The following aspect of the Turin Pilots can be considered transferable to other cities:

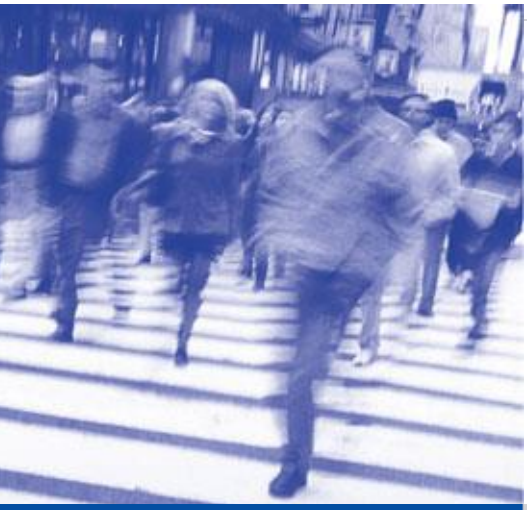
- innovative governance model relying on a proactive and effective stakeholders' cooperation (FQP - Freight Quality Partnership)
- non-mandatory policy-mix implemented, based on different benefits for different stakeholder categories (citizens included)
- Evaluation methods based on KPI methodology (Pilot scenario vs Baseline scenario)
- Evaluation of KPIs based on collection of information through the use of questionnaires to different stakeholder categories

Policies introduced are general city-specific and referred to the specific target identified by the municipality (e.g. Multi-Users Lanes measure, use of reserved parking plot in pedestrian area have been implemented in Turin but could be also applied in other cities with the same targets).

## 3.4 Annexes and reference documents

The following documents present further details on the evaluation findings (e.g. the evaluation report, a presentation, ..):

- D6.3 "Evaluation of UFT policies and measures"



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# Measure reporting on evaluation approach and evaluation findings

## - RIA project SUCCESS

| | |
|---|---|
| Measure | Consolidation Centres for Construction |
| Short description | Implementing a new logistics organization between the suppliers and the construction sites in order to reduce the negative impacts of construction freight to urban environnement (congestion, pollution, noise…) while improving the performance of construction activities on site. |
| | |
| **Report developed by** | |
| Project: | SUCCESS |
| City/cities | Luxembourg / Paris / Valencia / Verona |
| Author(s) | Régis Fontaine |
| Mail address | regis.fontaine-ext@vinci-construction.fr |
| Version | Final |
| Date | 14/06/2018 |
| ***Template** by* | *CIVITAS SATELLITE* |
| *Review:* | *Dirk Engels, Gitte Van Den Bergh* |

SUCCESS

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# 1 Measure description

## 1.1 Objectives of the measure (or type of measure)? Why?

| Ranking | Objectives | Target group |
|---|---|---|
| 1 | Decrease the negative impacts of the construction freight on the urban environment in terms of pollution, congestion, noise… | All cities: Luxembourg, Paris, Valencia and Verona |
| 2 | Improve the performance of the construction activities on construction site through a better manpower productivity and an optimized use of the material resources | Private companies from the construction sector |

## 1.2 Description of the measure: what is implemented? How?

### 1.2.1 General

The main measure that has been identified in the SUCCESS project to improve the logistics activities in the construction sector is the implementation of consolidation centres for construction (CCC).

Consolidation centres are logistics platforms located outside the city centres. Those consolidation centres aim at offering different services to the construction sites:

- Unloading / loading activities
- Storage
- Order preparation
- Kitting
- Prefabrication / Pre-assembly activities
- Reverse logistics (circular economy): waste sorting, return of unused materials…
- Area for mockups

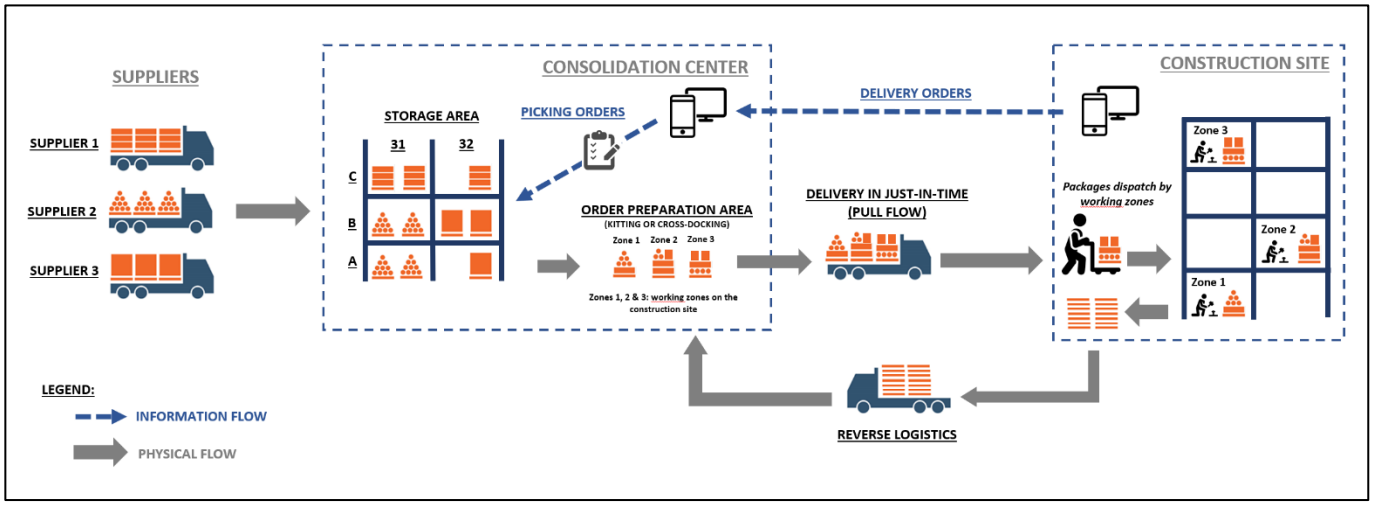



Figure 20: CCC scheme

A CCC can be managed by a construction company or a logistics operator. The second option is preferred as the logistics companies have the skills and expertise needed to operate a CCC in an efficient way and it

gives the opportunity to construction companies to concentrate on their core activities and work on the improvement of the performance of their operations on site.

The CCC solution has not been tested in a real case during the SUCCESS project but an evaluation of the solution has been made including an analysis of quantitative indicators calculated through simulations and qualitative opinions collected during different workshops organized during the SUCCESS project life.

### 1.2.2 Outputs

Direct outputs of the measure can be given on the basis of the simulations results. The simulations showed us that the implementation of a CCC helps to reduce significantly the number of km travelled by the delivery vehicles, the number of deliveries on the construction site and the emissions of $CO_2$ and particulates ($PM_{2.5}$ and $PM_{10}$).

### 1.2.3 Supporting activities

The supporting activities that we can identify are the communication activities that were organized during the life of the project.

2 main events were organized in order to communicate about the SUCCESS results: local events and Joint Transfer Exercises. Local events were organized by each partner city of the project in order to communicate about the SUCCESS project and its results. The participants were various: construction companies, public authorities, clients, consultants, architects… The Joint Transfer Exercises aimed at inviting non partners cities in order to share about their freight policy and see with them how the solutions identified by the SUCCESS project could answer (or not) to their issues in term of construction logistics.

### 1.2.4 Interaction with other measures

This measure has a significant interaction with the urban access regulations implemented by cities: low-emission zones, urban road tolls… Indeed those regulations are great incentives to push the construction sector to rethink its logistics and implement new solutions like CCCs.

# 2 Evaluation approach

## 2.1 Impacts and indicators

The following Key Performance Indicators (KPI) have been defined in the SUCCESS project to evaluate the current situation of the logistics and construction activities on construction sites.

| Impact category / aspects | Expected impacts - Indicators | Data collection methods | Observed groups/areas |
|---|---|---|---|
| **Economic / Haulier journey time** | Travel time (outside and inside the city center) | Data collected on 4 pilot construction sites | 4 cities: Luxembourg, Paris, Valencia and Verona |
| | Truck waiting time (outside and inside the site) | Data collected on 4 pilot construction sites | 4 cities: Luxembourg, Paris, Valencia and |

| | | | |
|---|---|---|---|
| | | | Verona |
| | Construction site punctuality | Data collected on 4 pilot construction sites | 4 cities: Luxembourg, Paris, Valencia and Verona |
| | Loading / Unloading time | Data collected on 4 pilot construction sites | 4 cities: Luxembourg, Paris, Valencia and Verona |
| **Economic / Haulier route** | Number of intermediate storage | Data collected on 4 pilot construction sites | 4 cities: Luxembourg, Paris, Valencia and Verona |
| | Distance from the suppliers to the construction site | Data collected on 4 pilot construction sites | 4 cities: Luxembourg, Paris, Valencia and Verona |
| **Economic / Workforce productivity** | Waiting time for material | Data collected on 4 pilot construction sites | 4 cities: Luxembourg, Paris, Valencia and Verona |
| | Rework in connection with material issue | Data collected on 4 pilot construction sites | 4 cities: Luxembourg, Paris, Valencia and Verona |
| | Waiting time for the workforce | Data collected on 4 pilot construction sites | 4 cities: Luxembourg, Paris, Valencia and Verona |
| | Looking for material / equipment | Data collected on 4 pilot construction sites | 4 cities: Luxembourg, Paris, Valencia and Verona |
| | Several handling time | Data collected on 4 pilot construction sites | 4 cities: Luxembourg, Paris, Valencia and Verona |
| | Truck punctuality | Data collected on 4 pilot construction sites | 4 cities: Luxembourg, Paris, Valencia and Verona |
| **Economic / Supply Chain management effort** | Time dedicated to logistics activities | Data collected on 4 pilot construction sites | 4 cities: Luxembourg, Paris, Valencia and Verona |
| **Economic / Waste management costs** | Costs of unsorted bins | Data collected on 4 pilot construction sites | 4 cities: Luxembourg, Paris, Valencia and Verona |
| **Social / Safety on construction site** | Number of accidents and related causes | Data collected on 4 pilot construction sites | 4 cities: Luxembourg, Paris, Valencia and Verona |
| **Environmental** | $CO_2$ emissions | Data collected on 4 pilot construction sites | 4 cities: Luxembourg, Paris, Valencia and Verona |
| | Particulates emissions ($PM_{2.5}$ & $PM_{10}$) | Data collected on 4 pilot construction sites | 4 cities: Luxembourg, Paris, Valencia and Verona |
| **Social** | Number of deliveries at the construction site | Data collected on 4 pilot construction sites | 4 cities: Luxembourg, Paris, Valencia and Verona |

| | | | |
|---|---|---|---|
| | Congestion on construction site | Data collected on 4 pilot construction sites | 4 cities: Luxembourg, Paris, Valencia and Verona |
| | Rate of obstructing vehicles | Data collected on 4 pilot construction sites | 4 cities: Luxembourg, Paris, Valencia and Verona |

**Additional comment:**

- The data collection has been made in 4 construction sites located in 4 cities. Those construction sites were directly delivered from the suppliers without any CCC. So this data collection aimed at evaluating the current situation in terms of impacts to the urban environment and opportunities of performance improvement of the logistics and construction activities.

## 2.2 Further analysis of data

Simulations have been run in the SUCCESS project in order to estimate what would be the consequence of implementing a CCC some of the KPIs listed in the previous paragraph. The KPIs that have been computed through those simulations are: the travel time, the distance from suppliers to the construction site, the $CO_2$ emissions, the $PM_{2.5}$ and $PM_{10}$ emissions and the number of deliveries.

Those simulations helped us to estimate the improvement we can reach on those KPIs thanks to the implementation of a Consolidation Centre for Construction (CCC).

To operate the comparison and evaluation tasks of Work Package 5 of the SUCCESS project we used the **Choosing By Advantages method** to compare different solutions identified as possible business models of logistics organization for construction activities (with and without CCC).

Choosing By Advantages is a collaborative and transparent decision-making system developed by Jim Suhr and described in his book The Choosing By Advantages Decision-making System (1999). The CBA method can be used for moderately complex to very complex decisions allowing for documenting these decisions in a transparent fashion.

The main purpose of this method is to help decision makers to differentiate alternatives and to understand the importance of those differences. In the Choosing By Advantages method, decisions are based on advantages of alternatives which are positive differences, not advantages and disadvantages; this avoids double counting. By following this method, decisions are anchored to relevant facts.

The steps of the Choosing By Advantages method are the following:

- Step 1: list the alternatives. The alternatives are people, things, or plans from which one will be chosen. In the SUCCESS project, the alternatives will be chosen among the eight scenarios defined in the project.
- Step 2: identify the factors that we will use to differentiate the alternatives. The factors are elements for comparison of alternatives. Factors contain data that are required to decide or evaluate.
- Step 3: decide the criteria for judging. The criteria are used to evaluate the attributes of the alternatives. A criterion is a standard, rule, or test on which a judgment or decision can be based.

- Step 4: identify the attributes. An attribute is a characteristic, quality or quantity of one alternative.
- Step 5: decide the advantages of each alternative. An advantage is a difference between attributes of the 2 alternatives. I can be a benefit, a gain, an improvement or a betterment.
- Step 6: decide the importance of each advantage by weighing the advantages.
- Step 7: evaluate cost data.

The alternatives are the solutions that were identified in the SUCCESS project.

We considered the following factors to differentiate the alternatives using the Choosing By Advantages method:

| FACTORS |
|---|
| **F1. Number of deliveries at the construction sites** |
| **F2. $CO_2$ emissions** |
| **F3. $PM_{2.5}$ & $PM_{10}$ emissions in urban area** |
| **F4. Potential short-term improvement of pollutant emissions performance of the trucks delivering the construction sites** |
| **F5. Deliver the construction sites in Just-In-Time** |
| **F6. Goods packaging optimization (kitting) / Standardization of unloading equipment used on construction sites** |
| **F7. Tracking and tracing system implementation** |
| **F8. Delivery time windows flexibility** |
| **F9. Use of reverse logistics / Recycling of waste and non-used materials** |
| **F10. Deliveries punctuality (according to delivery planning)** |
| **F11. Impact of urban access regulations (low-emission zones, urban road tolls...)** |
| **F12. Sensitivity of site operations to supplier delivery delays** |
| **F13. Space availability for prefabrication, systems preassembly and mock-up building out of working zones** |
| **F14. Safety level inside and outside the construction sites** |
| **F15. Materials delivery reliability (the right reference in the right quantity) at the construction sites** |
| **F16. Materials and equipment security level** |
| **F17. Quality of the drivers reception (facilities)** |

Table: List of factors

We organized a workshop in each pilot city (Luxembourg, Paris, Valencia and Verona) in order to make the comparison and evaluation exercise for each city based on the data collected in the construction sites and the simulations run in Work Package 4.

As an example, we present below the results we got for Paris city:

| FACTORS | ALTERNATIVES | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scenario 4<br>No CCC / Multiple sites | | | Scenario 5<br>1 CCC / Multiple sites / Optimization 2nd echelon | | | | Scenario 6<br>1 CCC / Multiple sites / Optimization 1st and 2nd echelons | | | |
| **F1. Number of deliveries at the construction sites**<br>Criterion: the fewer deliveries, the better | Attribute: | 61 617 deliveries | | Attribute: | 35 410 deliveries | | | Attribute: | 35 410 deliveries | | |
| | Advantage: | | Importance: | Advantage: | 26 207 fewer | Importance: | 95 | Advantage: | 26 207 fewer | Importance: | 95 |
| **F2. $CO_2$ emissions**<br>Criterion: the lower $CO_2$ emissions, the better | Attribute: | 7 254 tons | | Attribute: | 5 665 tons | | | Attribute: | 5 621 tons | | |
| | Advantage: | | Importance: | Advantage: | 1 589 tons lower | Importance: | 75 | Advantage: | 1 633 tons lower | Importance: | 80 |
| **F3. $PM_{2.5}$ & $PM_{10}$ emissions in urban area**<br>Criterion: the lower PM emissions, the better | Attribute: | 549 kg | | Attribute: | 472 kg | | | Attribute: | 472 kg | | |
| | Advantage: | | Importance: | Advantage: | 77 kg lower | Importance: | 85 | Advantage: | 77 kg lower | Importance: | 85 |
| **F4. Potential short-term improvement of pollutant emissions performance of the trucks delivering the construction sites**<br>Criterion: the faster improvement, the better | Attribute: | we can have more than 50 different suppliers delivering one site / imply to renew the fleets of many transport companies which will take time | | Attribute: | one CCC means one truck fleet to deliver the construction sites: in this case we can consider feasible to implement quickly a fleet only equipped with low-emission vehicles (electrical, hydrogen, gas) | | | Attribute: | one CCC means one truck fleet to deliver the construction sites: in this case we can consider feasible to implement quickly a fleet only equipped with low-emission vehicles (electrical, hydrogen, gas) | | |
| | Advantage: | | Importance: | Advantage: | faster | Importance: | 100 | Advantage: | faster | Importance: | 100 |
| **F5. Deliver the construction sites in Just-In-Time**<br>Criterion: the more deliveries in JIT, the better | Attribute: | No space on site to organize a JIT delivery of working zones from an inventory managed locally / Unrealistic to deliver in JIT on a daily basis directly from suppliers located far from the sites as it would generate huge transport costs and increase the number of km travelled and the pollutant emissions / from closer suppliers it would increase the number of deliveries per day on site with consequences on congestion | | Attribute: | A CCC as a logistics platform can store materials, prepare orders per task and packages per working zone to deliver the sites in JIT + consolidation of deliveries | | | Attribute: | A CCC as a logistics platform can store materials, prepare orders per task and packages per working zone to deliver the sites in JIT + consolidation of deliveries | | |
| | Advantage: | | Importance: | Advantage: | more deliveries in JIT | Importance: | 90 | Advantage: | more deliveries in JIT | Importance: | 90 |
| **F6. Goods packaging optimization (kitting) / Standardization of unloading equipment used on construction sites**<br>Criterion: the more the packaging is optimized, the better | Attribute: | more adapted packaging to site logistics constraints can be developped and implemented with suppliers but no consolidation is possible i.e. packages including goods from different suppliers (kitting) | | Attribute: | New packaging systems can be developped and implemented in the CCC and materials from different sources consolidated in the same package (kitting) | | | Attribute: | New packaging systems can be developped and implemented in the CCC and materials from different sources consolidated in the same package (kitting) | | |
| | Advantage: | | Importance: | Advantage: | more optimized | Importance: | 65 | Advantage: | more optimized | Importance: | 65 |
| **F7. Tracking and tracing system implementation**<br>Criterion: the easier implementation, the better | Attribute: | Many suppliers with different traceability systems (when there is one) / Would take time to standardize the tracking system applied on all materials packages delivered on site | | Attribute: | A commun system can be implemented for all the packages leaving the CCC to be delivered on site to ensure a good traceability of all materials from the CCC to their consumption on the construction site | | | Attribute: | A commun system can be implemented for all the packages leaving the CCC to be delivered on site to ensure a good traceability of all materials from the CCC to their consumption on the construction site | | |
| | Advantage: | | Importance: | Advantage: | easier | Importance: | 25 | Advantage: | easier | Importance: | 25 |
| **F8. Delivery time windows flexibility**<br>Criterion: the more flexible, the better | Attribute: | Many transport companied involved: difficult to align all companies to the constraints of the construction sites and specially for trucks coming from far. | | Attribute: | With a specific fleet dedicated to the transport of the materials from the CCC to the sites, the working time can be organized to fit with the best time windows according to the sites constraints: night shift to deliver all materials at night for example + 1 or 2 drivers on day shift for emergency deliveries at day time. | | | Attribute: | With a specific fleet dedicated to the transport of the materials from the CCC to the sites, the working time can be organized to fit with the best time windows according to the sites constraints: night shift to deliver all materials at night for example + 1 or 2 drivers on day shift for emergency deliveries at day time. | | |
| | Advantage: | | Importance: | Advantage: | more flexible | Importance: | 55 | Advantage: | more flexible | Importance: | 55 |
| **F9. Use of reverse logistics / Recycling of waste and non-used materials**<br>Criterion: the more the reverse logistics is used, the better | Attribute: | Most of the delivery trucks leave the sites empty. Some leave the site with returnable materials (like pallets when the quantity collected is sufficient) or no more used equipment. Waste management companies pick up the waste at site. Difficult to implement a compliant waste sorting (many unsorted bins in Paris pilot (it costs more than 7000€/month to the site): difficult to make workers respect the sorting rules + no space to organize an area where waste sorting could be done by a dedicated team on site. Low or no recycling of non-used materials. | | Attribute: | The delivery trucks can be used to bring back to CCC returnable materials, equipment and tools. A sorting area can be implemented in the CCC: reverse logistics is then used to bring the unsorted waste to the CCC. When sorted, the waste management companies pick up the waste at the CCC (so fewer pick-up at the construction sites and less congestion in city centre). As materials can be delivered more easily in just in time, less rick to have non-used materials on site. Non-used materials will be kept stored in the CCC and a recycling solution can be found at the end of the project (circular economy). | | | Attribute: | The delivery trucks can be used to bring back to CCC returnable materials, equipment and tools. A sorting area can be implemented in the CCC: reverse logistics is then used to bring the unsorted waste to the CCC. When sorted, the waste management companies pick up the waste at the CCC (so fewer pick-up at the construction sites and less congestion in city centre). As materials can be delivered more easily in just in time, less rick to have non-used materials on site. Non-used materials will be kept stored in the CCC and a recycling solution can be found at the end of the project (circular economy). | | |
| | Advantage: | | Importance: | Advantage: | more used | Importance: | 60 | Advantage: | more used | Importance: | 60 |
| **F10. Deliveries punctuality (according to delivery planning)**<br>Criterion: the more on time, the better | Attribute: | Trucks coming from far are more exposed to the road hazards (traffic jam, breakdown, wrong estimation of the travel time). Or trucks anticipate their arrival with a long waiting time at the site entrance as a consequence. 30% of the trucks were late ine the Paris pilot. | | Attribute: | CCC must be located at 15 km maximum from the construction sites. Low exposition to road hazards. | | | Attribute: | CCC must be located at 15 km maximum from the construction sites. Low exposition to road hazards. | | |
| | Advantage: | | Importance: | Advantage: | more on time | Importance: | 45 | Advantage: | more on time | Importance: | 45 |
| **F11. Impact of urban access regulations (low-emission zones, urban road tolls)**<br>Criterion: the less impact, the better | Attribute: | In Paris low-emission zones are activated during pollution peak periods and the municipality plans to implement an urban road toll. All delivery vehicles can be potentially impacted. | | Attribute: | All delivery can also be impact but thanks to consolidation fewer deliveries results in less financial impact globally and a CCC fleet less pollutant in average than the haulier fleets reduces the impact of low-emission zones during the peaks of pollution | | | Attribute: | All delivery can also be impact but thanks to consolidation fewer deliveries results in less financial impact globally and a CCC fleet less pollutant in average than the haulier fleets reduces the impact of low-emission zones during the peaks of pollution | | |
| | Advantage: | | Importance: | Advantage: | less impact | Importance: | 35 | Advantage: | less impact | Importance: | 35 |

| FACTORS | ALTERNATIVES | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scenario 4<br>No CCC / Multiple sites | | | Scenario 5<br>1 CCC / Multiple sites / Optimization 2nd echelon | | | | Scenario 6<br>1 CCC / Multiple sites / Optimization 1st and 2nd echelons | | | | |
| **F12. Sensitivity of site operations to supplier delivery delays**<br>Criterion: the less sensitive, the better | Attribute: | No space for buffer/security stock on site | | Attribute: | Space available to implement a normative stock policy (stock min, stock max, security stock)<br>+ If one reference is common to more than 1 site, then we have the possibility to pick in the stock of another site to ensure that there is no shortage in the site that suffers from a delivery delay. | | | Attribute: | Space available to implement a normative stock policy (stock min, stock max, security stock)<br>+ If one reference is common to more than 1 site, then we have the possibility to pick in the stock of another site to ensure that there is no shortage in the site that suffers from a delivery delay. | | |
| | Advantage: | | Importance: | Advantage: | less sensitive | Importance: | 30 | Advantage: | less sensitive | Importance: | 30 |
| **F13. Space availability for prefabrication, systems preassembly and mock-up building out of working zones**<br>Criterion: the more available space, the better | Attribute: | In most urban construction sites, there is no and very few space free out of working zones. | | Attribute: | A space can be dedicated in the CCC for those activities apart the logistics activities with good conditions in terms of security, dust protection, light, temperature… | | | Attribute: | A space can be dedicated in the CCC for those activities apart the logistics activities with good conditions in terms of security, dust protection, light, temperature… | | |
| | Advantage: | | Importance: | Advantage: | more available | Importance: | 50 | Advantage: | more available | Importance: | 50 |
| **F14. Safety level inside and outside the construction sites**<br>Criterion: the higher level, the better | Attribute: | Accidents outside the construction sites can involve delivery trucks (with cars or pedestrians). The rate of obstructing vehicules measured in Paris pilot is 57% and those obstructing vehicules generate important risks of accidents. In pilot sites an important number of accidents are due to logistics issues: not adapted storage area, no appropriate handling means.. | | Attribute: | Less stock on site (JIT from CCC) = better pedestrian ways, standardization of packaging = less handling issues<br>Fewer deliveries on site and deliveries planned out of the road peak time can reduce the risks of accidents due to delivery trucks. | | | Attribute: | Less stock on site (JIT from CCC) = better pedestrian ways, standardization of packaging = less handling issues<br>Fewer deliveries on site and deliveries planned out of the road peak time can reduce the risks of accidents due to delivery trucks. | | |
| | Advantage: | | Importance: | Advantage: | higher level | Importance: | 70 | Advantage: | higher level | Importance: | 70 |
| **F15. Materials delivery reliability (the right reference in the right quantity) at the construction sites**<br>Criterion: the more reliable, the better | Attribute: | A quality control can be implemented at the unloading area in order to check that the quantities and references delivered are in compliance with the delivery note | | Attribute: | A first quality control can be done when the materials are delivered at the CCC (before entering the stock) and a second one before the packages are delivered to the construction sites. Double check. | | | Attribute: | A first quality control can be done when the materials are delivered at the CCC (before entering the stock) and a second one before the packages are delivered to the construction sites. Double check. | | |
| | Advantage: | | Importance: | Advantage: | more reliable | Importance: | 15 | Advantage: | more reliable | Importance: | 15 |
| **F16. Materials and equipment security level**<br>Criterion: the higher level, the better | Attribute: | Difficult to secure all the storage areas on site, during and out of the opening hours, as those areas are multiple, evolving many times during the life of the project and not equipped most of the time with efficient security systems. | | Attribute: | Materials and equipment stored in an area dedicated for inventory with all security systems required depending on the values of the materials stored (CCTV, guards, access control…) | | | Attribute: | Materials and equipment stored in an area dedicated for inventory with all security systems required depending on the values of the materials stored (CCTV, guards, access control…) | | |
| | Advantage: | | Importance: | Advantage: | higher level | Importance: | 40 | Advantage: | higher level | Importance: | 40 |
| **F17. Quality of the drivers reception (facilities)**<br>Criterion: the higher quality, the better | Attribute: | No facilities dedicated to drivers and site facilities are sometimes far from truck parking area or unloading area with no authorized access to drivers who have to wait in their truck | | Attribute: | Facilities for drivers to take a rest can be easily fit out in the CCC | | | Attribute: | Facilities for drivers to take a rest can be easily fit out in the CCC | | |
| | Advantage: | | Importance: | Advantage: | higher quality | Importance: | 20 | Advantage: | higher quality | Importance: | 20 |
| **Total Importance** | | | 0 | | | 955 | | | | 960 | |

## 2.3 Process evaluation activities

Not applicable.

## 2.4 Appraisal of evaluation approach

We highly advice to use the Choosing By Advantages method as the most powerful multi-criteria evaluation method. As this method is collaborative it is a great tool to involve all the stakeholders of a project and reach a shared agreement based on a decision mixing quantitative and qualitative evaluations.

## 2.5 Annexes and reference documents

For more information, refer to the deliverables submitted by the SUCCESS project and available on the website of the project (http://www.success-urbanlogistics.eu/):

- D5.1_Solutions evaluation report for each Pilot Site_preliminary version
- D5.2_Solutions evaluation and comparison report
- D5.3_Final validation report for each site and long-term sites implementation plan

# 3 Evaluation findings

## 3.1 Impact of the measure

### 3.1.1 Results in the CIVITAS impact categories

The impact evaluation results in the following before and after scores of the indicators, changes and interpretations in the relevant impact categories (including figures, graphs and tables):

- **Society – social:**
  - Reduction of congestion in urban areas thanks to the reduction of deliveries in the construction sites

- **Society – economy:**
  - Improvement of manpower productivity on the construction sites
  - Reduction of materials waste
  - Improvement of the productivity of the transport activities involved in the deliveries of the construction sites

- **Society – environment:**
  - Reduction of $CO_2$ and particulates emissions ($PM_{2.5}$ and $PM_{10}$)
  - Better waste management

### 3.1.2 Key impact results

- **Key result 1 – Number of deliveries** – Reduction of the number of deliveries between 14 and 57% thanks to the implementation of a CCC, depending on the pilot city and its context,
- **Key result 2 – Particulates emissions** – Reduction of the particulates emissions between 17 and 41% thanks to the implementation of a CCC, depending on the pilot city and its context.

## 3.2 Process Evaluation Findings

### 3.2.1 Barriers

The following barriers were observed:

- **Barrier 1: Difficulty to evaluate the financial sustainability and market for the initiative**

With regards to the most promising solution in construction logistics, a key aspect in the implementation of a CCC is the choice and analysis of a suitable business model for the CCC and, most importantly, the quantification and the description of the processes through which the CCC will make its profit need to be clear to all the actors involved in the initiative.

Based on the case studies examined in SUCCESS project, many CCCs were first initiated by public authorities driven by the will to target specific problems caused by urban logistics. However, the ETP programme and the events that were held made it clear that the viability of CCCs raised questions among different actors, due to high implementation costs (and lesser known return), need for support from public authorities, difficulty in cost and benefit allocation. These weaknesses were also identified in the SWOT

analysis performed on existing Urban Consolidation Centres and CCCs around Europe (D3.3 “Business models for construction logistics optimisation and CCC introduction”).

- **Barrier 2: Land availability, location and price**

An important element contributing to the CCC’s financial sustainability is the availability, price of and location of the land where it is located.

In particular, if the CCC area is the city centre and if this is sold at market prices for commercial activities (which are higher than those for areas normally dedicated to logistics activities), this may make the CCC initiative not profitable. In this sense, authorities may act to secure acceptable land prices (for example with financial support for their acquisition) or to make land available to CCC initiatives.

- **Barrier 3: Lack of integrated supply chains**

Construction logistics consists of fragmented and often uncoordinated supply chains, which itself is a very important barrier against optimisation. The main contractor very often has a very limited view of the different stages of the process, and each sub-contractor looks at its own activities. Activities are carried out in parallel and many assembling activities take place. The issue is that there are several services related to construction projects but no one has a global overview.

- **Barrier 4: Lack of innovation**

The construction sector is particularly resilient to change and introduction of advanced technologies to optimise logistics. The Enlarged Transfer Programme showed that cities display different levels of maturity, and that construction logistics is a niche topic. We found that, in general, there is low awareness of this topic and even less of the innovations in this field. This may worsen if the different actors involved perceive that some solutions, such as ICT tools or CCCs, do not display sufficient evidences to assess their viability and profitability.

### 3.2.2 Drivers

The following drivers were observed:

- **Driver 1: City logistics policies, regulations and planning**

The construction industry is heavily affected by regulatory measures and consequently it needs to optimize its relations with the public sector, thus the cooperation and fluent communication between the different players of the construction industry becomes essential.

Through regulatory measures, public authorities directly intervene in the behaviour and choices of the urban freight and construction logistics operators. In this sense, CCCs and urban logistics measures will most optimally operate in synergy with specific decisions or packages of measures implemented by the city’s transport or traffic departments, planning authorities or regulators.

Regulatory measures can be seen as drivers for construction logistics, as they can effectively incentivize supply chain optimisation and CCCs implementation. These measures are designed to control private activities and are supported by a control or enforcement system. Generally speaking, regulations and policies make room for optimisation because they can make outsourcing processes more convenient.

- **Driver 2: Standard and training**

Authorities or contracting actors can clearly communicate their focus on certain impacts of urban logistics by requiring the main contractors or sub-contractors to comply with standards or attend specific trainings. Standards and trainings are very important enabling factors because they are essential to raise awareness on safety (especially with respect to vulnerable road users), environmental issues and improve

the efficiency of the supply chain. Construction sites are risk-prone working environments, due to the inherent hazards of the activities: slips, trips, falls from heights, noise, hazardous materials etc. Optimization of the supply chain can drastically improve safety in construction, addressing those accidents that can be ascribed to logistics issues, both on and off site.

- **Driver 3: Collaboration to create long-lasting solutions**

The construction sector affects urban logistics, yet its important impacts in city centres have often been neglected in urban policies. Construction logistics issues are set to grow very intense, and especially mature cities have started to include measures targeting this sector. For this reason, it is essential to organize consultations and cooperation arrangements that would lead to the adoption and, to some degree, the acceptance of the policies or regulations set by the authorities. Ultimately, the main interest for the authority is to approve measures that combine environmental and economic sustainability.

Public authorities are becoming increasingly aware of such consultations as tools to ensure the success of specific urban logistics measures such as the CCC. In fact, the CCC as an urban logistics measure deeply affects the supply chain and the stakeholders in the city and the construction sites.

Depending on the CCC business model, the objectives of the CCC, its operations and the desired outcome of the project, different types of engagement can be possible with different stakeholders: Public Private Partnerships (PPPs), Freight Quality Partnerships…

### 3.2.3 Supporting activities

The communication activities organized during the project showed a big interest of the participants to the SUCCESS solutions and mainly the CCC solutions. Most of the participants agreed that CCC is the main solution that can help to improve on the long term the construction logistics.

### 3.2.4 Recommendations on the implementation process

The key point to ensure an efficient implementation of the solutions is the involvement of all the stakeholders at the early stage of the implementation project. It is essential to get the engagement of all the partners.

## 3.3 Evaluation Conclusions

### 3.3.1 Main lesson learned

The different evaluation and comparison workshops that we have organized along the SUCCESS project lead us to conclude that the CCC is a key solution to improve sustainably the performance of the logistics activities in the construction field by reducing all the negative impacts of those activities to the urban environment (pollution, congestion, noise…) and by increasing the productivity and the sustainability of the construction activities on site (less wastage, better materials consumption, safer conditions of work…). The CCC must be the main component of a new construction Supply Chain. This new Supply Chain involves deep changes in the current construction value chain: refocus the construction companies on their core activities (“build”), consider the logistics activities as a full and essential support service that requires new skills and the development of new partnerships and create a new scheme in the contractual relationship between all actors of the construction sector to improve the collaboration.

### 3.3.2 Long term impact

Timing for the implementation plan is very much dependent on the specific situation of the city but also on the external drivers that were previously described. The need for decarbonisation, the push for circular

economy, the increasing political and societal pressure for sustainability and liveability in cities will encourage construction logistics' optimisation within the next 25-30 years. However, we notice that different actors influence enabling factors and barriers and that, specifically, public authorities have therefore a big role to play in the timing through their planning.

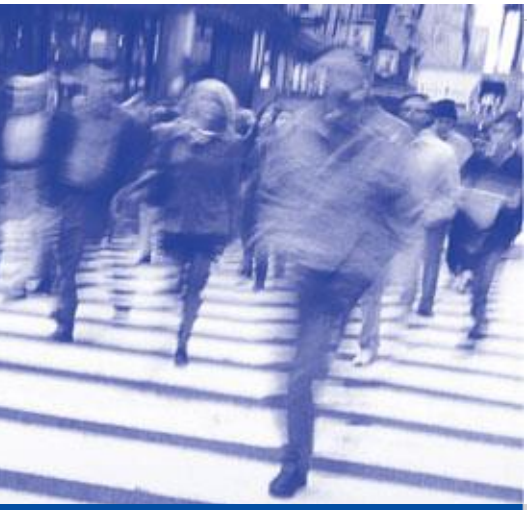
### 3.3.3 Potentials for transferability in other cities

The Joint Transfer Exercises organized with non-partners cities showed us that cities are interested by the results of SUCCESS projects as most of the cities that participated consider the construction logistics issues and did not yet implement policies to reduce the impacts of those logistics activities. So we consider that the solutions identified (and mainly the CCC) by SUCCESS project have a big transferability potential for cities highly impacted by construction freight.

## 3.4 Annexes and reference documents

For more information, refer to the deliverables submitted by the SUCCESS project and available on the website of the project (http://www.success-urbanlogistics.eu/):

- D5.1_Solutions evaluation report for each Pilot Site_preliminary version
- D5.2_Solutions evaluation and comparison report
- D5.3_Final validation report for each site and long-term sites implementation plan



CIVITAS 2020
Cleaner and better transport in cities

SATELLITE

# Measure reporting on evaluation approach and evaluation findings

## - RIA projects

| | |
|---|---|
| Measure | Collaboration in food distribution |
| Short description | Consolidated transportation flows of food products and pooling food demand |
| | |
| **Report developed by** | |
| Project: | U-TURN |
| City/cities | Athens, London, Milan |
| Author(s) | Dimitris Zissis, Gitte Van Den Bergh |
| Mail address | Dimitris.Zissis@Cranfield.ac.uk |
| Version | Final |
| Date | 11-05-2018 |
| | |
| ***Template** by* | *CIVITAS SATELLITE* |
| *Review:* | *Dirk Engels, Gitte Van Den Bergh* |

U-TURN
NEW MODEL FOR URBAN FOOD TRANSPORTATION

CIVITAS 2020
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THE CIVITAS INITIATIVE IS CO-FINANCED BY THE EUROPEAN UNION

# 1 Measure description

## 1.1 Objectives of the measure

An important factor in every sustainable logistics model is efficiency. This means that an efficient logistics model should be flexible to follow new trends and customers' preferences without increasing significant the operational costs, decreasing the provided services, and losing its utilisation. U-TURN project aims to address freight urban distribution, focusing on food logistics. The project addresses the special requirements and needs of food transportation, develops collaborative practices and tools towards achieving more efficient operations from both an environmental and cost perspective. In this context, it is crucial to exist horizontal collaboration among different enterprises designing a more sustainable logistics model. Through collaboration could be achieved a better cost allocation (via reduction of the total operational cost), with significant environmental and social benefits while firms continue to provide at least the same service levels. KPIs such as: 'Total distance travelled', 'Total time', and 'Fleet utilisation' are important to identify economic, environmental, and social benefits that will arise under our proposed collaborative business models. Reductions and improvements on 'Total distance travelled'' and 'Total time' will lead to a reduction to the emissions and noise levels.

| Ranking | Objectives | Target group |
|---|---|---|
| 1 | **Economic:** Reduce logistics and operational costs of food distribution. Provide cheaper delivery services to end-consumers | Food manufacturers, farmers and food retailers |
| 2 | **Environmental:** Less gas emissions, energy consumption and air pollution. Less food waste | Municipalities, society |
| 3 | **Social:** Less traffic congestion and fewer accidents | Municipalities, society |

## 1.2 Description of the measure

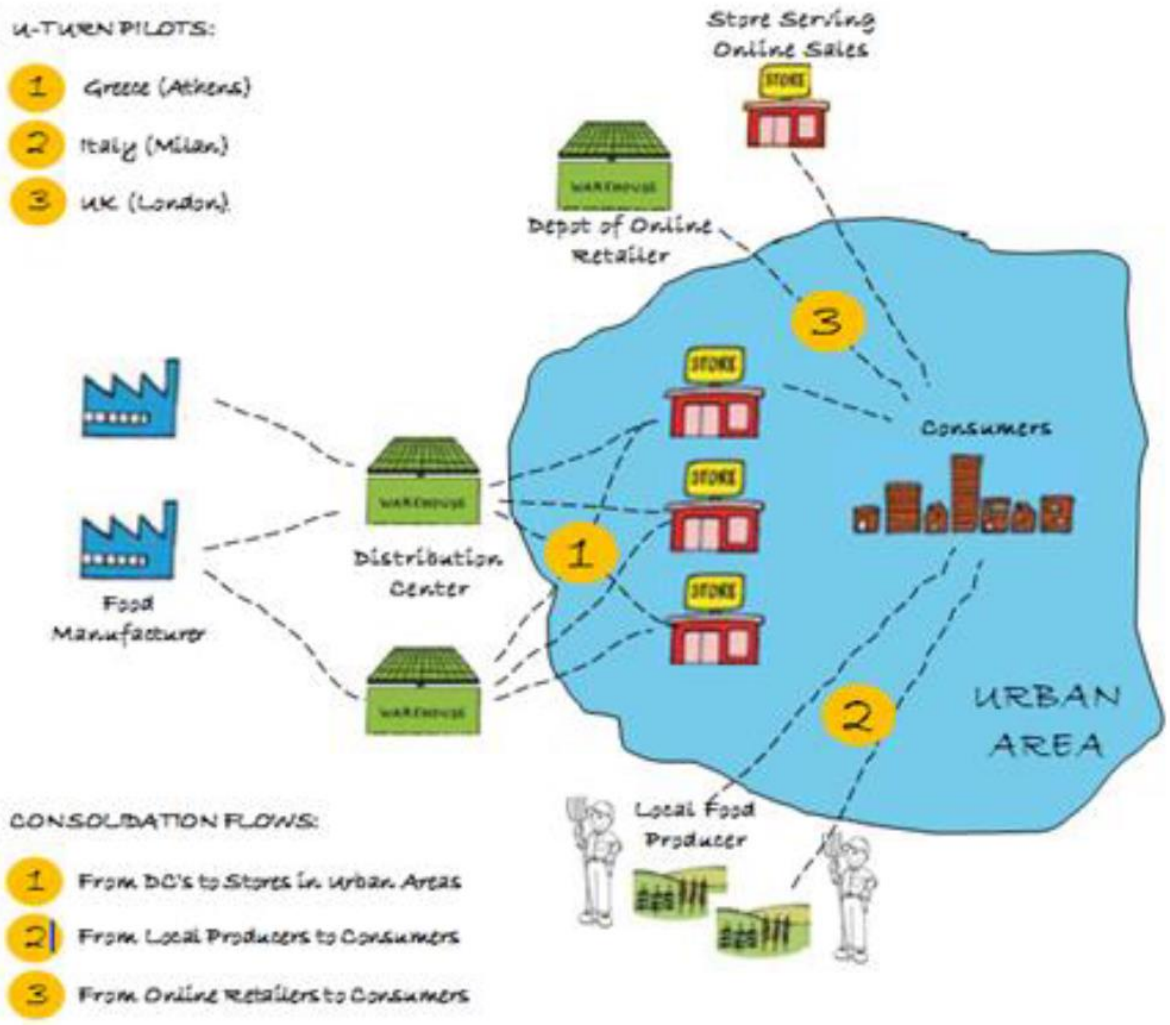
### 1.2.1 General

Three different pilots are conducted in the context of the U-TURN project. The three pilots are complementary, addressing different aspects of food distribution in an effort to cover the key requirements and main trends of food distribution in urban areas. The three pilots are shortly presented in the following table:

Table 1: U-TURN Pilots

| | **Description** | **Geography** |
|---|---|---|
| Pilot 1 | Distribution of packaged goods from food manufacturers to retail outlets located in urban areas.<br>For these report, we focus on two possible scenarios:<br>A. Sharing a common vehicle for delivering goods<br>B. Sharing Urban Consolidation Centres for collaboratively distributing goods in the 'last mile' | Greece (Athens) |
| Pilot 2 | Distribution of fresh food from local producers and online retailers to consumers in urban areas | Italy (Milan) |
| Pilot 3 | Food delivery from online retailers to consumers in urban areas | UK (London) |

The pilots address the consolidation of different flows corresponding to the aforementioned consumer and distribution trends in various market contexts, as depicted in the figure below:



The measures involve the implementation of the following:

- Identify in the existing operations; i.e. how much is: i) the necessary total distance to be covered by the fleet of vehicles for different companies to satisfy the food demand, ii) the total time that the iii).
- Based on the proposed collaborative model, to measure the three KPIs: 'Total distance travelled', 'Total time', and 'Fleet utilisation' to measure the benefits from the collaboration in freight urban distribution.

### 1.2.2 Outputs

Direct results of the measure:

- Distribution centers

### 1.2.3 Supporting activities

One of the U-TURN project objectives is to support market stakeholders (e.g. suppliers, logistics providers, online retailers, food producers, etc.) on finding the right partners to further implement consolidation in distribution flows in the urban context. Information sharing among interested parties is a key prerequisite in order to identify to the potential synergies depending on the delivery features (e.g. pick-up point, delivery point, time window, etc.). Moreover, information sharing is one of the key challenges in the implementation of collaborative logistics projects especially when the involved stakeholders are especially competitors. In the context of U-TURN, information sharing is supported by the U-TURN platform that was also embeds the Smart Matching Algorithm that identifies potential synergies and consolidation flows opportunities. Aimed to logistics operation models optimise Platform Design & Implementation. The UTURN Platform was finalized by the project partners in charge of Work Package 4 and then shared with all the others to test the tool functionalities. Furthermore, the platform has also been used across the pilot execution presented in previous sections, to support the pilot tests.

### 1.2.4 Interaction with other measures

There is no interaction with other measures.

# 2 Evaluation approach

## 2.1 Impacts and indicators

The KPIs are:

- **Total distance travelled**: It describes the total distance travelled by the total number of the freight vehicles to satisfy the grocery demand. It is calculated by summing up the total distance travelled for the total number of the vehicles.
- **Total time**: It is the driving time plus the drop-off time for the whole fleet.
- **Fleet utilisation** (or **Truck loading factor**) (%): The average percentage of the utilisation of the fleet (according to the different types of vehicles) at the beginning of route.

The measures involve the implementation of the following:

- Identify the existing operations; i.e. how much is: i) the necessary total distance to be covered by the fleet of vehicles for different companies to satisfy the food demand, ii) the total time that the iii).
- Based on the proposed collaborative model, to measure the three KPIs: 'Total distance travelled', 'Total time', and 'Fleet utilisation' to measure the benefits from the collaboration in freight urban distribution.

A synthesis of the above KPIs indicates business model efficiency, which is the base of model sustainability. Based on these three key indicators, a set of other indicators can be derived:

- 'Total distance travelled' and 'Fleet utilisation' have a direct impact on the logistics cost and operational cost (economic aspect) while has an indirect impart to gas emissions, noise levels (environmental aspect), and traffic (social aspect). In U-TURN project, we focus only on three large cities; London (UK), Milan (Italy), and Athens (Greece).
- 'Total time' is an important factor in business operations, based on which managers can determine the optimal number of employees, so it has an indirect impact on the total cost.
- Compare the three KPIs (Total distance travelled, Total time, and Fleet utilisation) between the existing operations (no collaboration) with the proposed collaborative models to quantify the potential benefits, in each case and model. Based on these comparisons, we evaluate the benefits that can arise from pooling demand from different sources.

| Impact category / aspects | Expected impacts - Indicators | Data collection methods | Observed groups/areas |
|---|---|---|---|
| **Society-people** | Less noise | | London, Milan, and Athens |
| | | | |
| **Society-governance** | Reduced number of road accidents | | London, Milan, and Athens |
| | Become cities more friendly places to live | | London, Milan, and Athens |
| | | | |
| **Transport system** | Lees traffic congestion | | London, Milan, and Athens |

| | | | |
|---|---|---|---|
| | More efficient distribution system | | London, Milan, and Athens |
| | | | |
| **Economy** | Reduced fuel cost | | London, Milan, and Athens |
| | Reduced logistics cost | | London, Milan, and Athens |
| | | | |
| **Energy** | Less consumption of fuel | | London, Milan, and Athens |
| | | | |
| **Environment** | Less emissions | | London, Milan, and Athens |
| | Less traffic in urban areas | | London, Milan, and Athens |
| | | | |

**Comments to the table:**

1. Primary data set from: 3pl companies in Greece, farmers in Italy, and online retailers in the UK.
2. Secondary data in the UK case.
3. Simulation for two out of three cases (Athens and London).

## 2.2 Further analysis of data

Based on the data, the project team has calculated the three KPIs (Total distance travelled, Total time, and Fleet utilisation) in the existing operations. Then, U-TURN team developed different business collaborative models according the specific need of each pilot; Pilot 1: Athens (Greece), Pilot 2: Milan (Italy), and Pilot 3: London (UK). In the proposed collaborative models it was assumed that different retailers / farmers / companies work as a single decision maker, acting to minimise the joint objectives.

The next steps of the overall assessment methodology for the pilots are:

- Compare KPIs between As-Is and To-Be cases;
- Through the comparisons, measure the impact of U-TURN ideas, on the environment, the society, and the total supply chain costs;
- Perform cross comparisons among the pilots;
- Apply tools and measure benefits from collaboration to identify new opportunities for the stakeholders.

Furthermore, a cross comparison among the pilots was made to sum-up pilot results and compare the respective main outcomes in terms of potential improvements in freight transport in cities.

## 2.3 Process evaluation activities

There were no activities identified.

## 2.4 Appraisal of evaluation approach

Based on the evaluation work in this project, the following observations and recommendations concerning the evaluation approach seem important for other projects (including specific interesting elements in the approach):

- Lack of primary data from the stakeholders.

- There are many KPIs that are used in real environments and there are many differences from case to case. Comparisons among different models are not an easy task.

## 2.5 Annexes and reference documents

Further details are available on project's website: http://www.u-turn-project.eu/ and on U-TURN deliverables.

# 3 Evaluation findings

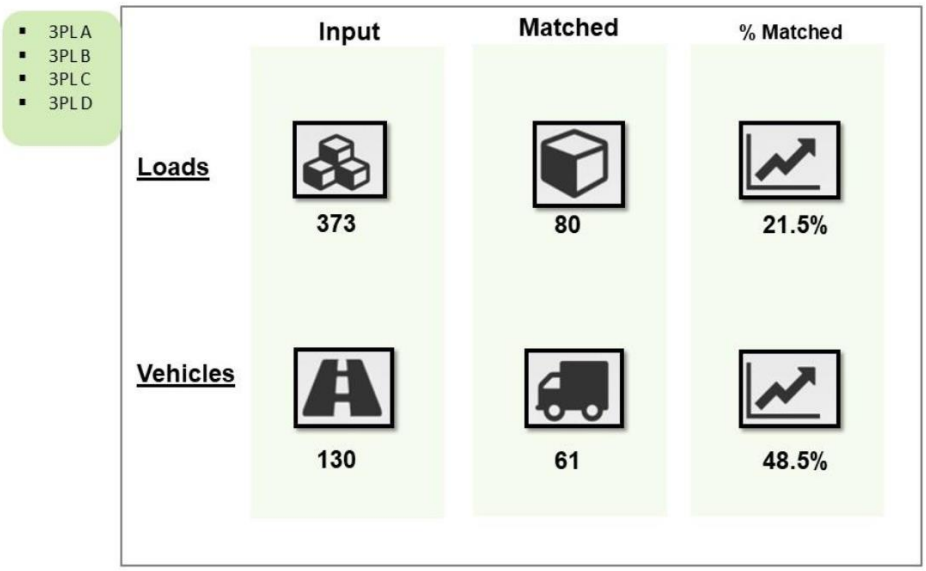
## 3.1 Impact of the measure

### 3.1.1 Results in the CIVITAS impact categories

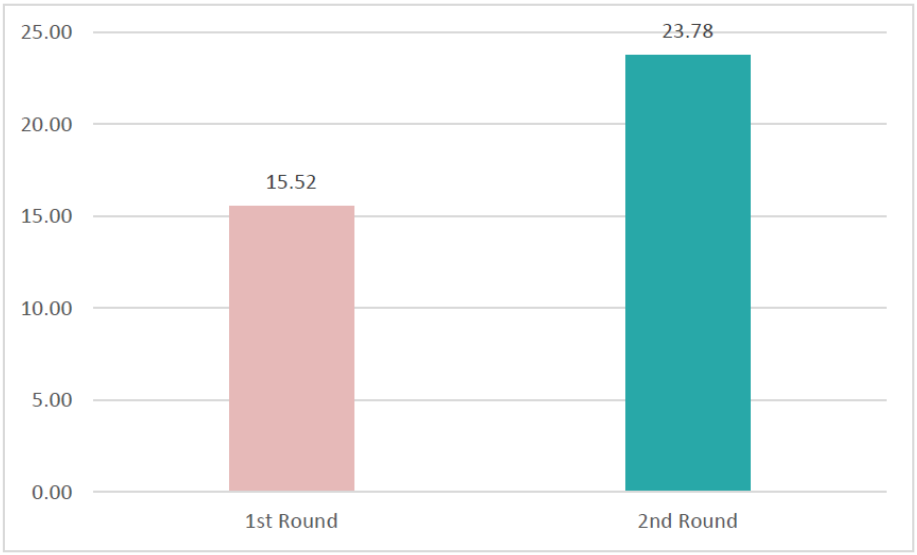
**Pilot 1 - Scenario A. Sharing a common vehicle for delivering goods**

The main results are:

- 33-44% reduction in distance
- 22% of the total loads and 49% of the total vehicles trips were matched
  The following figure presents an overview of the data inserted in the U-TURN platform and the matches arisen during the second round of the pilot scenario execution. More specifically, the 3PL companies inserted 373 loads and 130 vehicles. After the run of the algorithm, 80 loads and 61 vehicles were matched, which corresponds to 21.5% and 48.5% of the total loads and vehicles uploaded, respectively.




- 8% increase in the sectors (i.e. post codes) served per vehicle




- 11% increase in the vehicle loading factor

**Pilot 1 - Scenario B. Sharing Urban Consolidation Centres for collaboratively distributing goods in the 'last mile'**

The main results are:

- 48% reduction in distance
- 5% reduction in the total costs
- 7% reduction in CO2 emissions within the city centre
- 10% reduction in vehicles used
- 19% reduction in total distance travelled
- 11% increase in total number of delivery points visited per trip

Table 33 Total results of the retailers' distribution with a UCC

| | Tours | Cost | $CO_2$ | Distance | Loading factor |
|---|---|---|---|---|---|
| As-Is | 71,924 | 8,992,689 | 2,732,338 | 3,921,554 | 84% |
| To-Be | 54,103 | 6,918,199 | 2,814,308 | 2,028,421 | 94% |

**Pilot 2: Distribution of fresh food from local producers and online retailers to consumers in urban areas**

The main results are:

- more than 80% of collaborative deliveries
- about 20% overall reduction in travel distance
- 20% reduction in total emissions

Table 37 Main KPIs related to the To-Be scenario, based on one week

| KPI | As-Is | To-Be | As-Is vs To-Be | % of reduction |
|---|---|---|---|---|
| **Individual deliveries** | 57 | 22 | | |
| **Collaborative deliveries** | 0 | 35 (61%) | | |
| **Access Distance** | 2,027 | 1,511 | **- 517 km** | **-25%** |
| **In-route Distance (km)** | 869 | 813 | **- 55 km** | **-6%** |
| **Tot distance (km)** | 2,896 | 2,324 | **- 572 km** | **-20%** |
| **Travel time (h)** | 63 | 50 | **- 12h** | **-20%** |

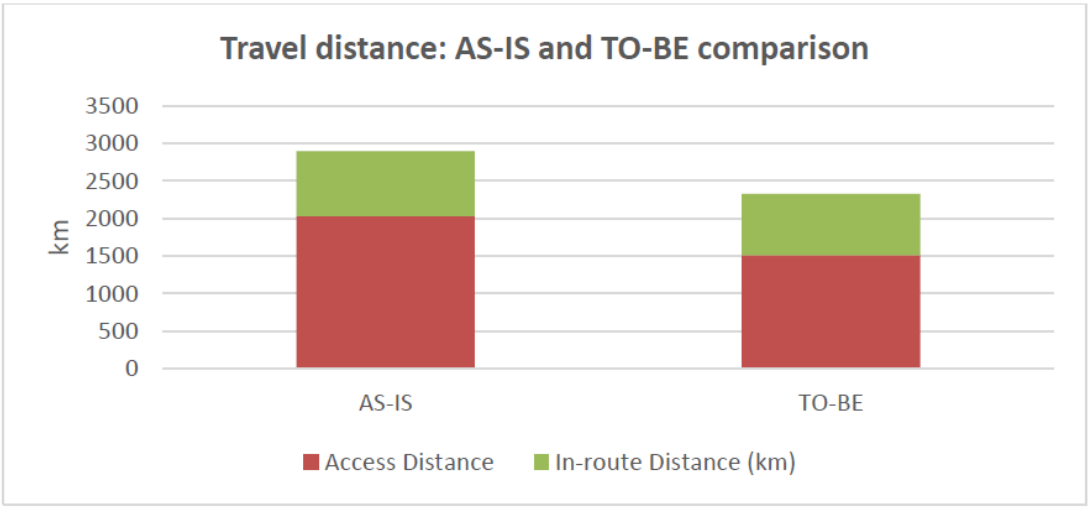



Figure 55 Travel distance: As-Is and To-Be comparison, based on one week

**Pilot 3: Food delivery from online retailers to consumers in urban areas**

The main results are:

- 25% reduction in travel distance
- 40% reduction in number of trucks
- 50% increase in fleet utilisation

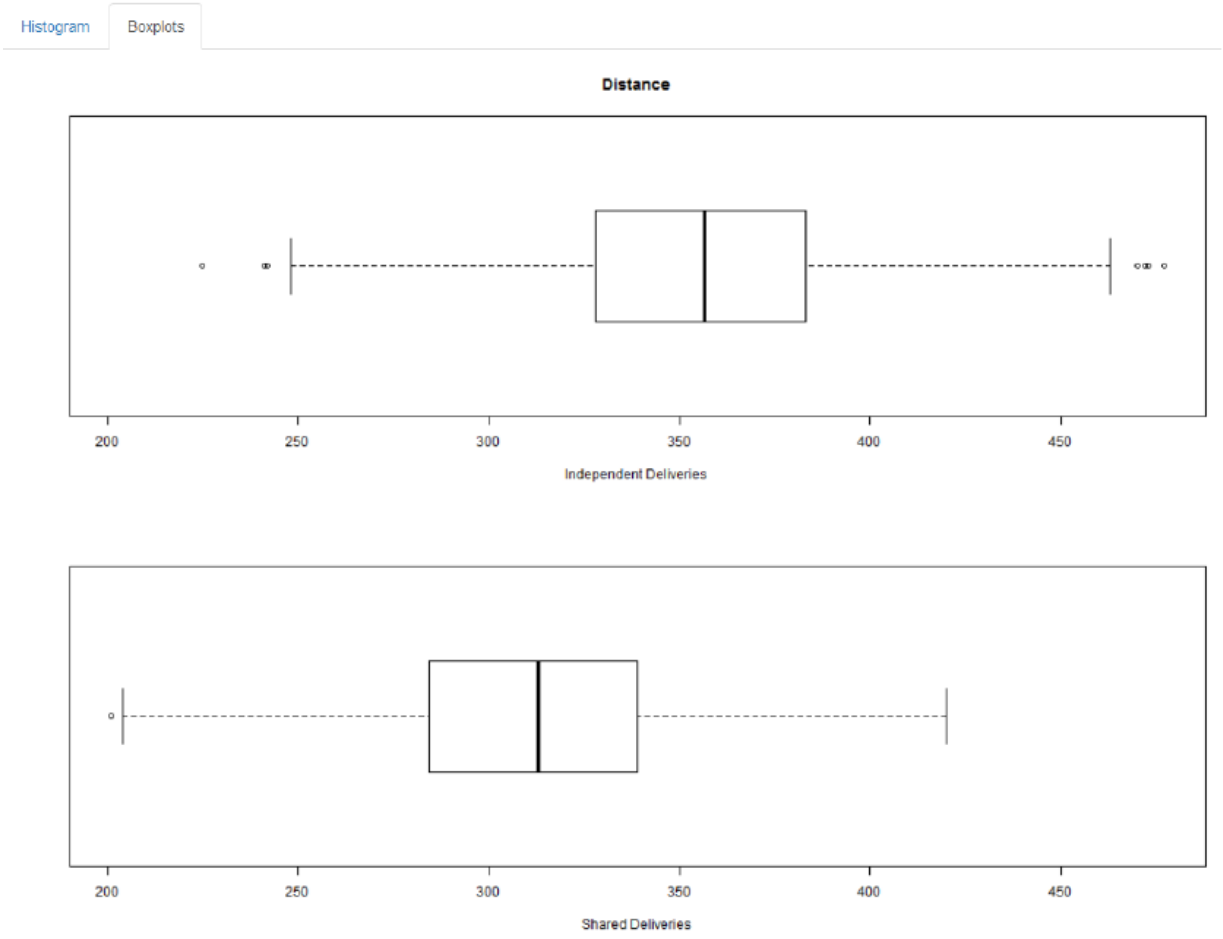



Figure 65 Boxplots of independent and shared deliveries

### 3.1.2 Key impact results

To have uniformity of assessment across Pilots, the results were compared by using distance reduction, and to summarise some of the key findings:

- **Key result – Pilot 1 –** In Pilot 1 it is possible to achieve 9 to 48 per cent distance. The reason for such a wide range is due to the variety of scenarios investigated. The reduction range is smaller in Scenario A: Collaborative Distribution of two 3PL companies: 33% to 44%. The effect of Urban Consolidation Centre on distance reduction is striking in Scenario B: 48%. During the project other scenarios were assessed, achieving other results such as 9% and 19% reduction in distance travelled.
- **Key result – Pilot 2 –** In Pilot 2 figures for distance reduction from collaboration ranged from 25% in access distance, 6% in inroute distance, and 20% in total distance. In this Pilot, the concept of Access Distance is relevant as it refers to the distance from the rural area to Milan City Centre that remains outside Milan. In-route distance as can be anticipated is the distance travelled within the

municipality of Milan. The operating conditions differ on both distance categories in terms of speed limits and engine utilisation, which in turn affect vehicle emissions.

- **Key result – Pilot 3 –** Finally in Pilot 3, collaboration benefits are estimated at 8% to 35% in Business Model 1, 9% to 10% in Business Model 2 and 7% to 14% in Business Model 3 The reason for the wide range of benefits from collaboration in Business Model 1 is due to the last mile delivery aspect, where collaboration has the greatest impact on sparsely distributed consumer orders over 18 time-windows.

## 3.2 Process Evaluation Findings

### 3.2.1 Supporting activities

The following conclusions concerning the supporting activities are drawn:

- **Observation 1** – The U-TURN platform represents a very useful tool in different environments, from 3PLs to local food producers. It basically helps market stakeholders to find collaborative opportunities to enable logistics sharing. These platform actors would also find potential partners with similar needs to work with, like in the case of local farmers and 3PLs.
- **Observation 2** – Further improvements may be required to make the platform usable and fully functional and these could be developed following the conclusion of the project by interested businesses. One of the main objectives of the U-TURN Project was indeed to stimulate the interest in collaborative logistics practices of a wide range of private and public stakeholders and establish a sound methodological basis for new sustainable collaborative logistics platforms for urban distribution of goods in European cities.

## 3.3 Evaluation Conclusions

### 3.3.1 Main lessons learned

Implementing this measure, this are the main lesson learnt, important for future sustainable mobility strategies:

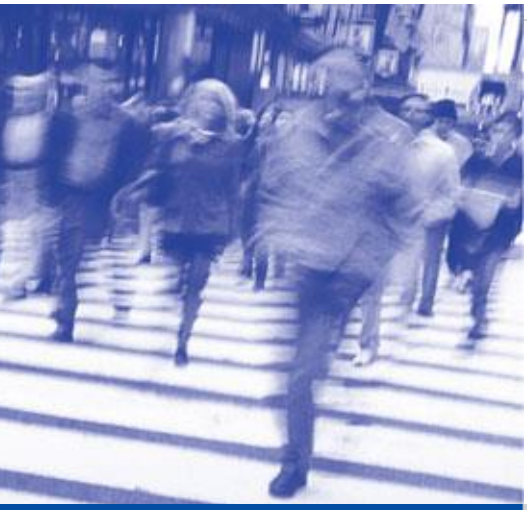
- **Key lesson** – Comparing all three pilots, it can be concluded that we have theoretical and practical evidence to support the hypothesis that U-TURN set out to investigate: collaboration helps improve economic, environmental, and social sustainability of food distribution in cities. The improvements achieved by collaboration depends on the operating conditions and distribution parameters examined in line with model assumptions put forward for each pilot.

### 3.3.2 Long term impact

### 3.3.3 Potentials for transferability in other cities

## 3.4 Annexes and reference documents

The following documents present further details on the evaluation findings:
D5.2 – Pilots overall assessment



2020 CiViTAS
Cleaner and better transport in cities

SATELLITE

# Measure reporting on evaluation approach and evaluation findings

## - RIA projects

| | |
|---|---|
| Measure | Positive incentives |
| Short description | Giving transport users incentives, delivered through an app with tracking and modal detection capability, to cycle, walk or use PT. |
| | |
| **Report developed by** | |
| Project: | EMPOWER |
| City/cities | Enschede, NL |
| Author(s) | Gitte Van Den Bergh, Kain Glensor, Benjamin Groenewolt |
| Mail address | Kain.glensor@wupperinst.org |
| Version | Final |
| Date | 5/07/2018 |
| | |
| ***Template** by* | *CIVITAS SATELLITE* |
| *Review:* | *Dirk Engels* |

EMPOWER
Rewarding Change

2020 CiViTAS
Cleaner and better transport in cities
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# 1 Measure description

## 1.1 Objectives of the measure (or type of measure) ? Why ?

| Ranking | Objectives | Target group |
|---|---|---|
| **1** | Entice people to increase their cycling, walking and PT (in that order), and in so doing, hopefully reduce their use of cars. | Any transport users in and around the city of Enschede, NL |

## 1.2 Description of the measure: what is implemented ? How ?

### 1.2.1 General

In EMPOWER, a **Living Lab** is a way of carrying out embedded research in a multi-stakeholder environment. Design choices are made together with different stakeholders, where cooperation with local stakeholder proved to be vital for the success of the Lab. However, end-user input mostly took place during micro-level experiments and was not so much the focus of the Living Labs. In the Labs, the aim was to relate to every day service as much as possible. This means end users where not actively aware of the research context and research towards actual value for the involved stakeholders was an important topic.

**Enschede** worked with the **existing SMART app** as the basis for the Living Lab. Encouraging sustainable travel behaviour has always been the focus of the functionality of the SMART app. In EMPOWER, the three main focal areas of the Living Lab Enschede were: design of (parallel) incentive schemes, collaboration with (new) stakeholders and recruiting new users.

As the SMART app was already in place and being used by the public in Enschede, the basic functions were in place from the start: a helpdesk had been set up, onboarding procedures (e.g user consent forms, manuals, option to login using Facebook) were in place, incentive providers were recruited and answers to most common technical difficulties were known.

The Enschede Living Lab had a broad range of activities. As a result, users could join multiple challenges at the same time. Therefore, planning of incentives (and there potential interdependency) was a key element in the Living Lab operation. We worked with a base layer of incentives and specific challenges on top of that.

**Base layer of incentives**

There were several challenges for anyone at any time, in order to keep people motivated to join and use SMART. In order not to limit the interaction between the base layer and the more experimental challenges on top of this, the base layer excluded dedicated cycle challenges. The base layer included:

- Introduction challenges – challenges to get to know the SMART app and its functions.
- Event challenges – go to an event in a sustainable way. Partially used as promotion for these events, partially used to create awareness of sustainable travel.
- Bus challenges – to promote the use of bus in Enschede. As bus services are not that prominent in the travel system, these challenges typically have lower response rates.
- Walking challenges – focussing on health benefits of walking.
- Peak avoidance challenges – asking people not to use their car in peak hours.

- Fun challenges – Some gimmicks in the system to reward for instance the first trip with modes like metro and boat and to celebrate people staying with SMART for 3/6/12/24/... months.

**Madeira experiment**

The Madeira experiment (named after the main participatory price to be won) aimed to personalise the incentive experience for a newly recruited sample of commuters. A before questionnaire was used to collect baseline data and based on this data, we've set up a series of challenges. This included three consecutive weeks of challenges, where people could choose to increase the number of days per week they cycled to work. As this was not automatically supported, this lead to over 100 separate challenges to be defined, 50 pro-active push messages and 120 experience sampling questions.

This set up prove to be too complex, with several problems occurring along the way:

- Getting people to onboard on time in the app after filling in the pre-questionnaire
- Some human errors in the definition of incentive
- Insufficient overview of the progress to adapt things along the way

Therefore, we sought a manner of personalisation which was less complex and more flexible: the monthly choice challenge.

**Monthly choice challenges**

The monthly choice challenges introduced a simpler concept of personalisation of incentives. Rather than the operator setting the bar for the challenge, users themselves had the option to choose one out of five options. With this level of personalisation, we were able to have equal opportunities for everyone and at the same time personalise the challenge level.

This resulted in a series of incentive designs, where each month a different approach was taken. Options included a choice in:

- the number of trips to be made within 14 days;
- the number of kilometre to be ridden within 14 days;
- the number of days to ride at least 10 kilometres;
- the number of kilometres to be ridden on at least 10 out of 14 days.

This series of incentives was follow up with experience sampling questions, asking users experiences with the challenges and whether they changed their behaviour to achieve this challenge.

**Enschede Cycle City**

The collaboration with Enschede Cycle City introduced a reward scheme with cash prices. The challenges set up in the collaboration were all aimed at the promotion of infrastructure upgrades. People were challenged to use the SMART app to discover new routes, aiming at a change in either mode-choice of route-choice. Users could earn a €12,50 voucher by exploring these new routes 10 times.

This approach was a great way to recruit new people. However, using municipal channels for recruitments has its complications. People expect to be able to join instantly, so there was no option to have people track their trips before the join the incentive scheme. Also, the public approach made caused the challenge to be rather general and probably too easy for regular cyclist on those routes.

After several campaigns related to new infrastructure (September 2016 – December 2017), three other campaigns from Enschede Cycle City sparked quite an increase in user numbers:

- 'Healthy transport', where we used people's new year resolutions to motivate to walk or cycle more, giving 1 point per kilometre. (Starting January 1st 2018, ongoing.)
- Bike2Sport, where 10 sports associations could earn some money by having their members cycle to trainings. (Running February 2018 – May 2018)
- SMART Green, where traffic lights are being connected to the SMART app and cyclists. (Starting March 7th 2018, ongoing.)

### 1.2.2 Outputs

There are no direct outputs.

### 1.2.3 Supporting activities

#### 1.2.3.1 Multi-stakeholder participation

During the life time of the Enschede Living Lab, several **external stakeholders have been involved** in the EMPOWER work. We list all interesting partnerships, although they didn't all mature during the lifetime of the project.

**Elderly in the bus**

A main objective in the municipality was to increase ridership amongst elderly, thereby increasing their sense of accessibility and limiting their vulnerability. Different strategies to lower barriers to the bus were explored together with the local operator. However, all opportunities they saw did not match our mission of positive incentives via ICT. Therefore, after several meetings it was decided to shift focus away from bus.

**Enschede Cycling City**

During the Living Lab, the municipality introduced the campaign Enschede Cycling City 2020 (Enschede Fietsstad 2020). The aim of this campaign is to become a cycling city by investing both in infrastructure as well as in communication. The infrastructure plans were well laid out, as this has always been a municipal task. For the communications campaign, teaming up with EMPOWER made a nice synergy. The Cycling City campaign learned from the experience and knowledge of the EMPOWER team. This turned out to be a great opportunity, as recruitment efforts from the Cycling City resulted in more SMART users to be part of EMPOWER work as well.

We could use the Cycling City campaign to test some of our concepts in an even more real-life situation. This gave some good insights in how to run an incentive scheme outside the scientific setting. For instance, when using mass outdoor advertisement to all public, people expect challenges to be available directly after installing the app. This made it impossible to have a before measurement using the app. Also, the use of control groups (excluding people from rewards) and the differentiation between segments (creating inequality) is something a municipality rather not does.

**Twente Mobiel**

Together with employer network Twente Mobiel, we proactively approached employers to set up a dedicated reward scheme using the SMART app in a business context. This resulted in several visits by Twente Mobiel, but none of the employers was eager to join. Reasons can be found in the fact that Twente Mobiel typically offers services which take away all burden by the employer, whereas we were looking for active involvement. Another reason was probably the lack of evidence up front, so when someone was

willing to invest their time, the (potential) effect was not clear enough. A third reason can be found in the support of such schemes by the SMART app at that time. A lot of manual work was needed by both the operator and the employer, making it less attractive to join.

**Incentive providers**

The Broodbode was one of the already recruited incentive providers of the SMART app. As they had various offers in store, they were approached to see whether a more one-on-one incentive design with a provider could cause them to give higher rewards in the app.

Together with the Broodbode, a specific challenge was set up where users had to visit several of their stores by foot or bicycle. When doing this, a free muffin (level 1) and sandwich (level 2) was provided. This are better offers then their general offers which gave something for free with another order.

These challenges were picked up by high percentages of the public (20% of users), although the number of people completing them was only another 20% of these (4% of the total). The Broodbode was enthusiastic and we aimed for another run. However, as it is not their core business and a busy Christmas time was upcoming, SMART did not get the necessary priority to get things going again. But SMART will continue approaching incentive providers to set up similar schemes.

**Charities**

Based on results from the Gothenburg Living Lab, a collaboration with four regional charities was set up to support a new wave of recruitment. During a four-month period, SMART users could donate their points to these charities. Each month, the charities were rewarded based on their ranking in the donation statistics. The idea was to use the charities as a proxy- organisation for recruitment, using their channels to motivate people to start using SMART.

The cooperation with the charities was done based on a mutual understanding, rather than a formal contract. This made it easier to arrange as well as less time consuming. Some of the charities really invested in engaging with their followers and consequently got high numbers of donations, where other were less active and did not deliver the expected recruitment effort. Hindsight it might have been better to formalise the relationship in order to get the less committed partners to put more effort in the project as well.

### 1.2.3.2 Real life setting

Given the design of incentives and the collaboration with partners, the final focal area was the recruitment and retention of users. This has been done in and around Enschede, with a series of activities.

**Recruitment**

Looking at the number of users over time, several (main) waves of recruitment have led to more SMART users. In total 7.600 new users joined SMART during the Enschede Living Lab, as shown in Figure 1.

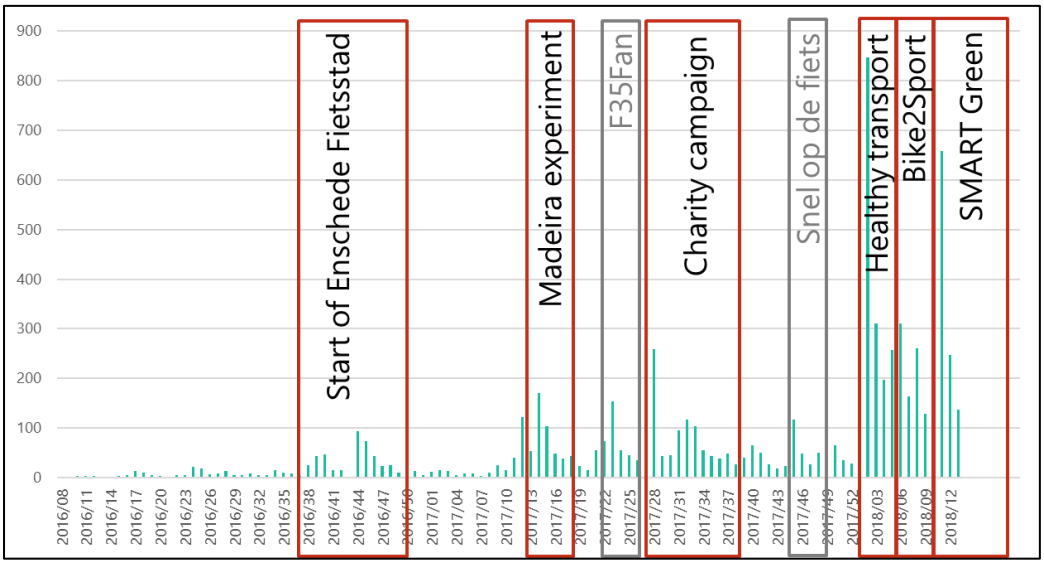



**Figure 1 – New users in the Enschede Living Lab per week**

1. People already using SMART before EMPOWER activity began (± 200 users).
2. Employees from several local companies recruited for the Madeira experiment (± 650 users).
3. People triggered by different media from the Enschede Cycle City campaign (± 2.000 users).
4. Users recruited by Facebook advertisement and Google display banners related to the charity campaign (± 750 users).
5. General inflow of users due to various media outings, just stumbling upon and recommendation by friends. (± 1.200 users).
6. A Facebook post suggesting a new year's resolution to walk and cycle more. (± 1.500 users)
7. Bike2Sport direct recruitment via sports associations (± 500 users)
8. General publicity about SMART Green (± 800 users)
9. Two other projects (F35Fan and Snelopdefiets) recruited their own users (± 200 users)

When asking people how they've heard about SMART, via friends and digital advertisement are the two most mentioned channels, as depicted in Figure 2.

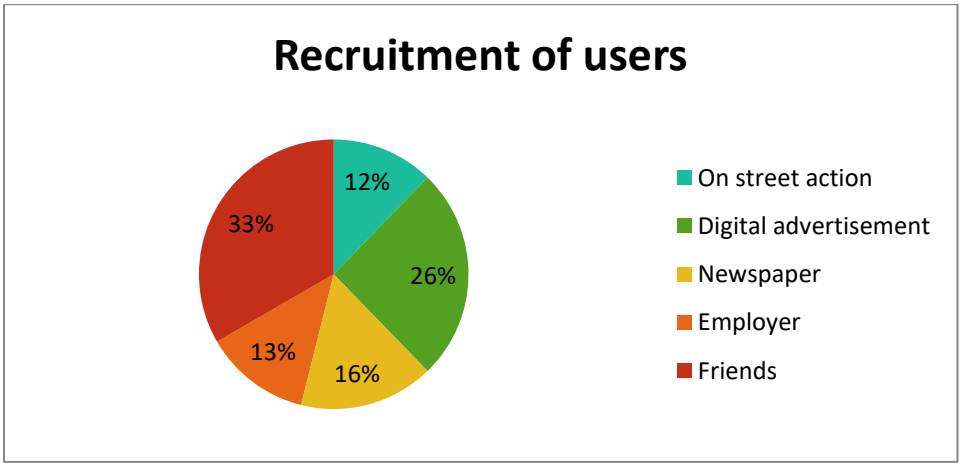



**Figure 2 – Origin of SMART users**

### Retention

Once new users have installed SMART, the challenge was to keep people motivated to use the system. This was monitored by the number of active users: people who have at least made one trip. Figure 3 gives

an overview of the number of active users per month, where the recent success of the Cycling City campaigns can be seen.

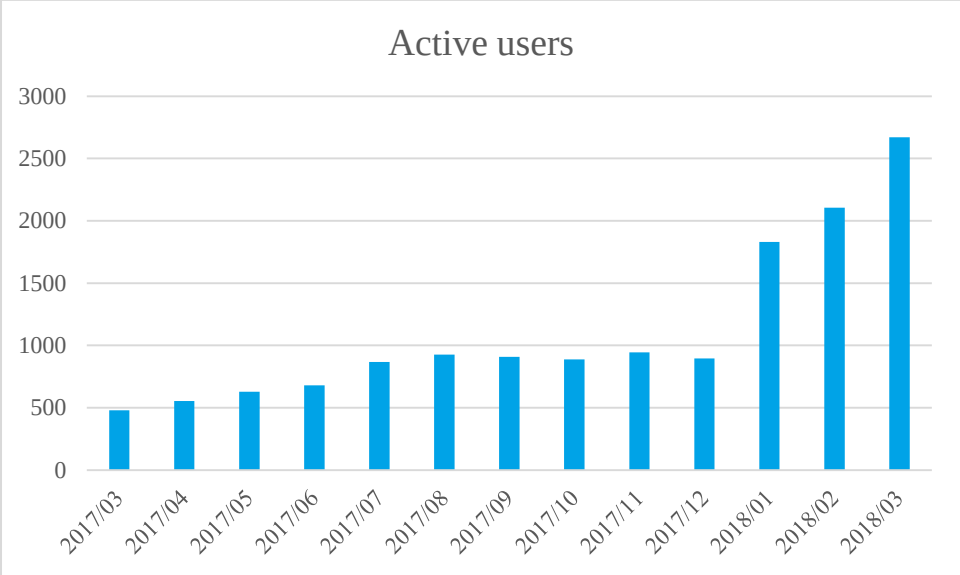



**Figure 3 - Monthly active SMART users**

### 1.2.4 Interaction with other measures/factors

Transport evaluation in a 'real life' setting is challenging because of external factors that are difficult or impossible to measure. This could be changes in the environment, such as infrastructural changes, or other extraneous factors, such as the weather, drastic changes in fuel of public transport prices and holidays.

We have tried to isolate the effect of the incentive schemes, and control the external factors as much as possible, in order to provide high quality evaluation results.

# 2 Evaluation approach

## 2.1 Impacts and indicators

The primary indicators for the EMPOWER evaluation are the Key Performance Indicators (KPIs) as, listed below.

| Impact category / aspects | Expected impacts - Indicators | Data collection methods | Observed groups/areas |
|---|---|---|---|
| **Society-people** | *30% increase in travellers' self-reported positive evaluation of urban accessibility and attractiveness* | Surveys | All users, disaggregated to establish impact on vulnerable groups and gendered effects |
| | *75% Customer/user satisfaction with the EMPOWER mobility service* | Surveys | All users, disaggregated to establish impact on vulnerable groups and gendered effects |
| | *10% response rate for vulnerable travel groups* | Surveys<br>- new accessibility-related definition of vulnerability<br>- specially developed index for assessing the multi-dimensional aspects of vulnerability | Vulnerable groups |
| **Society-governance** | | | |
| **Transport system** | 15%-50% reduction in the use of conventionally fuelled vehicles in cities, using packaging and synergies. | App tracking data<br>Surveys | All users |
| **Economy** | None directly, but implicitly through the aspired to shift to sustainable modes | | |
| **Energy** | None directly, but implicitly through the aspired to shift to sustainable modes | | |
| **Environment** | None directly, but implicitly through the aspired to shift to sustainable modes | | |

Additionally the project identified second order effects, which are benefits for stakeholders, and are unrelated to the direct influencing of people's travel behaviour, so can be considered to be somewhat parallel to primary indicators. They can represent considerable added value, even if, for example a scheme does not come to fruition for some external reason, the discussions around it may prepare the ground for subsequent action. Some examples of these are listed in the table below.

| Category | Aspect |
|---|---|
| Instrumental | Influencing development of policy |
| | Influencing practice |
| | Influencing service provision |
| | Shaping legislation |
| | Altering behaviour |
| Conceptual | Contributing to the understanding of policy issues |
| | Reframing debates |
| | Introduction of new concepts |
| Capacity Building | Technical development |
| | Skill development |
| | Partnership building |

**Figure 4 Impact and legacy aspects**

These ‘impact and legacy aspects’ were not assessed during the lifetime of the project.

## 2.2 Process evaluation activities

The following activities are set in place to understand and assess the implementation process:

- The Living Lab Operators gave their feedback on the process, and all Living Labs had a responsible partner in the consortium who was actively involved in the Living Lab work and who contributed actively in writing the deliverable on lessons learned. For Enschede the responsible partner was actually the operator himself.
- The EMPOWER Living Lab design cycle (see Figure 5) was used to report on the operational lessons learnt in the work carried out. Using the nine steps of the cycle, this gives insights in how we managed the Living Lab operation and gives guidance for future Living Lab work.
- In a second step the project looked for parallels between cities, bringing together all experiences into the ‘lessons learned’ as written into Deliverable 5.2.

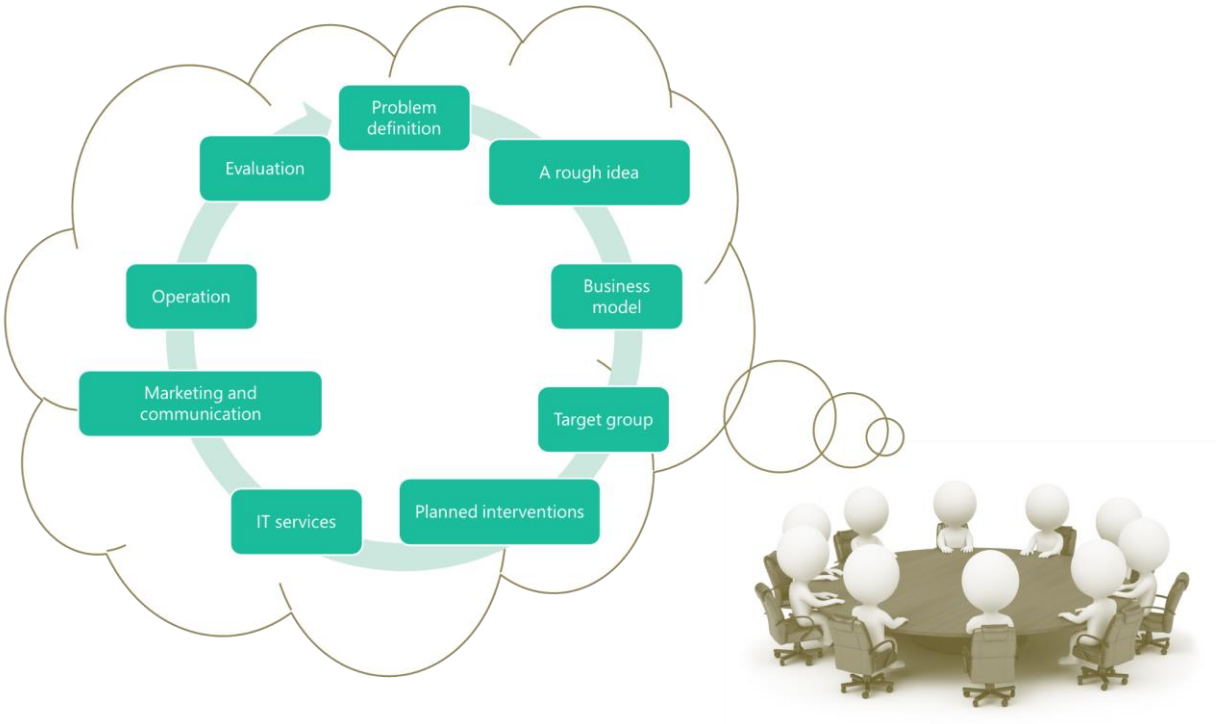



**Figure 5 Design cycle**

## 2.3 Appraisal of evaluation approach

Based on the evaluation work in this project, the following observations and recommendations concerning the evaluation approach seem important for other projects (including specific interesting elements in the approach):

- **Coupling data sources:** Combining the tracking system of an app and data with online questionnaires can be very powerful. However, there is a technical hurdle to take when wanting to merge two as you'd need a common identifier. Some issues arose when manual stating of an e-mail address prove to be error sensitive. A technical more sophisticated manner would be to send individual messages using the userID as a token to enter the questionnaire. However, this might also bring new privacy risks aboard. Ideally, the questionnaire would take place within the app.
- **Data sources model**: All of the schemes in EMPOWER are different and they all have different information available to evaluate them, whether gathered by and for the scheme itself or from other sources within the city. Given this diversity, and that one size does not fill all, a typology of the different scheme types is useful to organise the recommended ways of evaluating the schemes (or indicators within the evaluation). The typology can be very useful for other projects, and is described in D6.3 (see 2.4 Annexes and reference documents).
- **Natural variation in behaviour:** When working in a real-life setting, controlling for external variability is nearly impossible. Using trip data there are high levels of variation from week to week as well as between different days of the week. Given those, there still is a 10% fluctuation in bicycle distance from day to day due to other external factors amongst which weather is a major one.
- **Baseline:** When offering a service to the wider public, it's hard to work with control groups. As well as very difficult to work with a personal baseline. As users expect to get the offer from day one

when they install an (tracking) app, all the tracking data concerns the incentive period or post-incentive period. When users are in the system over a longer period with different waves on incentives, the periods between the ways might be used as control data.

- **Vulnerability index**: A definition of vulnerability has been formulated based on vulnerability regarding transport accessibility, and from that an index has been developed to measure the overall vulnerability of respondents to questionnaires. Based on individuals' responses to questions regarding their income, mobility budget, physical mobility, age, gender, living situation, nation of birth and education, respondents are allocated a vulnerability score. This index could be useful for other projects, especially as it allows cross-referencing vulnerability with other aspects, such as the impact of a measure.

## 2.4 Annexes and reference documents

The following documents present further details on the evaluation approach (e.g. the evaluation plan, a presentation, ..) or are used as a reference document for the development of the evaluation approach:

- Deliverable D6.3: Report of ex-ante and ex-post assessments of incentive schemes in the EMPOWER cities.

# 3 Evaluation findings

## 3.1 Impact of the measure

### 3.1.1 Results in the CIVITAS impact categories

The impact evaluation results in the following changes and interpretations in the relevant impact categories:

- **Society – people:**
  - **11% increase in travellers' perception of urban accessibility**

    In Enschede two groups have answered the post questionnaire: participants in the Madeira experiment and a sample of the general SMART population. In total there are 249 completed questionnaires, answering the KPI's for urban accessibility, user satisfaction and vulnerable people.

    For urban accessibility the average score is that 11% of users experience an increased accessibility due to SMART. This Madeira group scores only 6% on this KPI, whereas the general groups scores 37%. This is probably due to a strong self-selection bias in the second group. Even though people's self-perceived accessibility has increased, it does raise the question whether something has changed as the SMART app does not offer any actual service to increase the objective accessibility. Interesting to see that a relatively high fraction of vulnerable travellers reported an increase in perceived accessibility.

  - **55% neutral or positive on a series of questions regarding usability**

    Based on the post questionnaire, on average 55% of the users answers neutral or positive on a series of questions regarding usability. More than 75% is satisfied with the trip detection and with one or several features of the app. Users were less content about battery usage. About 25% said it was higher than expected. However, after the survey, battery consumption has improved considerably with fewer complaints. Regarding the different features there are some notable differences. About 80% found Travel statistics "fun" & informative, while this was only around 50% for the challenges and the web shop. So clearly travel statistics and information are more attractive. These are passive features that indirectly may encourage behaviour change. They appear however less effective in causing behavioural change. Only 25% of the respondents indicated they would change behaviour due to travel statistics and information, while almost 40% indicated they would change their behaviour using challenges & web shop.

    Challenges enforce a more pro-active attitude, which may be less attractive, but probably is more effective in ensuring positive behavioural change. It can also be concluded that these features are complementary; information is attractive and may attract extra users, challenges and targets are effective and may lead to substantial behavioural change.

  - **For Enschede, the number of vulnerable people is quite high with 23 to 31%.** This suggests the SMART app is not the typical app for white middle-aged men with a 9-5 job but does include vulnerable parts of society in its userbase. In Enschede, 8 criteria were used to identify vulnerable groups using the vulnerability index. Scores are presented in the table below:

| Question | Response | Vulnerability factor | Response |
|---|---|---|---|
| Mobility budget | Tight | 2 | 27% |
| | Very tight | 4 | 6% |
| Disability | Yes | 5 | 8% |
| Gender | Female | 2 | 54% |
| Age | 55-64 | 1 | 12% |
| | 65-74 | 3 | 0% |
| | 75+ | 5 | 0% |
| Education | Vocational/Trade | 2 | 7% |
| | Secondary | 3 | 10% |
| Living Situation | Couple with children | 2 | 43% |
| | Single with children | 4 | 1% |
| Monthly net income | €2k-€3k | 1 | 14% |
| | €1k-€2k | 3 | 27% |
| | <€1k | 5 | 14% |
| Country of birth | Non-Dutch | 1 | 6% |
| Max. possible score | | 29 | |

**Figure 6 Enschede vulnerability scores**

- **Society – governance:**
  - Not assessed

- **Society – transport System:**
  - Monthly choice challenges: **10% reduction during challenge periods.**

    In the evaluation of the monthly choice challenges, we distinguish between participants and non-participants, and for the participants we distinguish between the trips made within the challenge period and outside the challenge period. It is important to note here that every month one monthly choice challenge was offered, but that the duration of the challenge was only two weeks (and that in practice this challenge period was even shorter when participants completed their challenge early). Therefore, a comparison during the challenge and outside the challenge period (between completion of previous challenge and acceptance of next challenge) is possible.

    In Figure 7, we compare the mode share of participants of the monthly choice challenges with other SMART users. The figure shows that there is clearly less car use and more bike use among users that accept the monthly choice challenge. However, we should be careful in interpreting these results as there are no before measurements to control for a possible bias between both groups. It is therefore not completely clear if the difference can be attributed to the challenges or to the fact that users that participated in the monthly choice challenges are more motivated to cycle from the start.

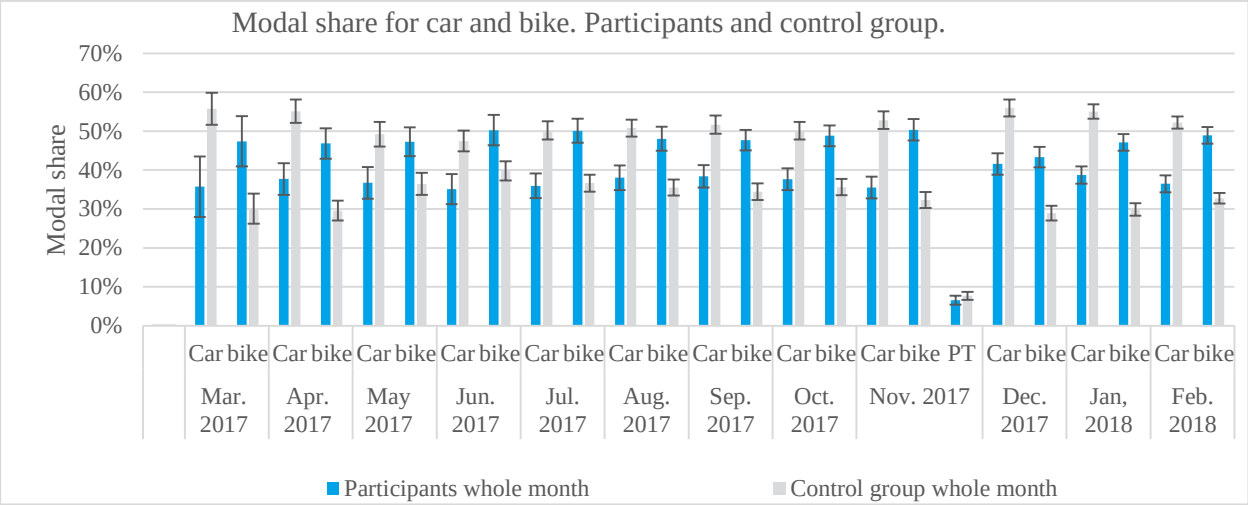



**Figure 7 - Modal share: Participants of challenge versus other SMART users. Error bars indicate 95% confidence levels (CL)**

In Figure 8, we compare between the challenge period and the outside challenge period. The figure clearly shows a significant increase in the bike share and reduction in the car share for trips shorter than 20 kilometres. Also, in absolute number of kilometres (all trips), there is in general a decrease in car kilometres and an increase in bicycle kilometres during challenges (Figure 9). The figures also show differences between challenges. Challenges with higher completion rates are not less effective (when comparing Figure 9 and Figure 10). This results is promising as it does not support the fear that participants (only) choose easy challenges they can fulfil without changing behaviour.

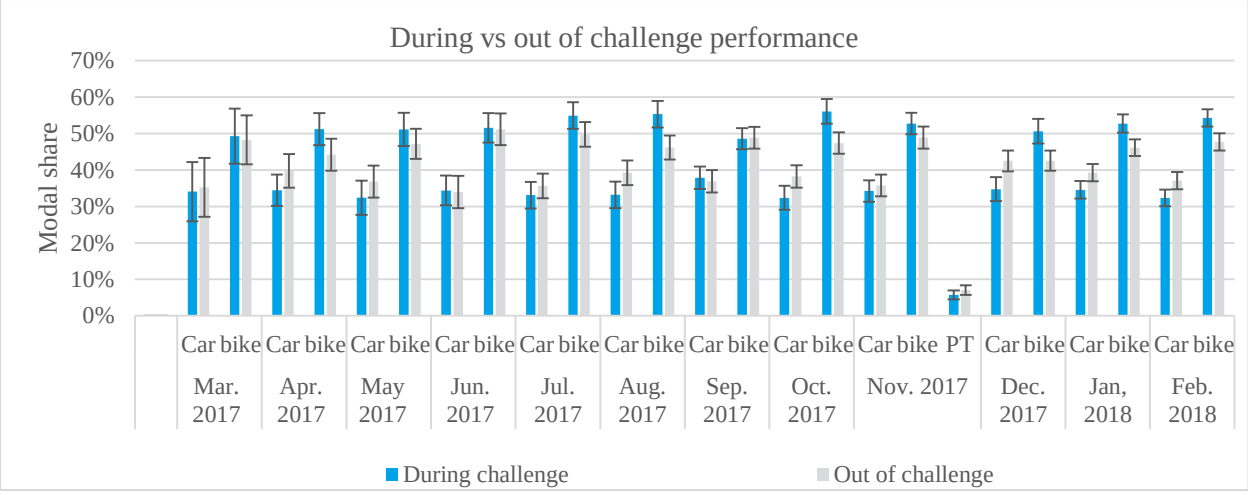



**Figure 8 - Mode share: During and outside the challenge period. Error bars indicate 95% CL**

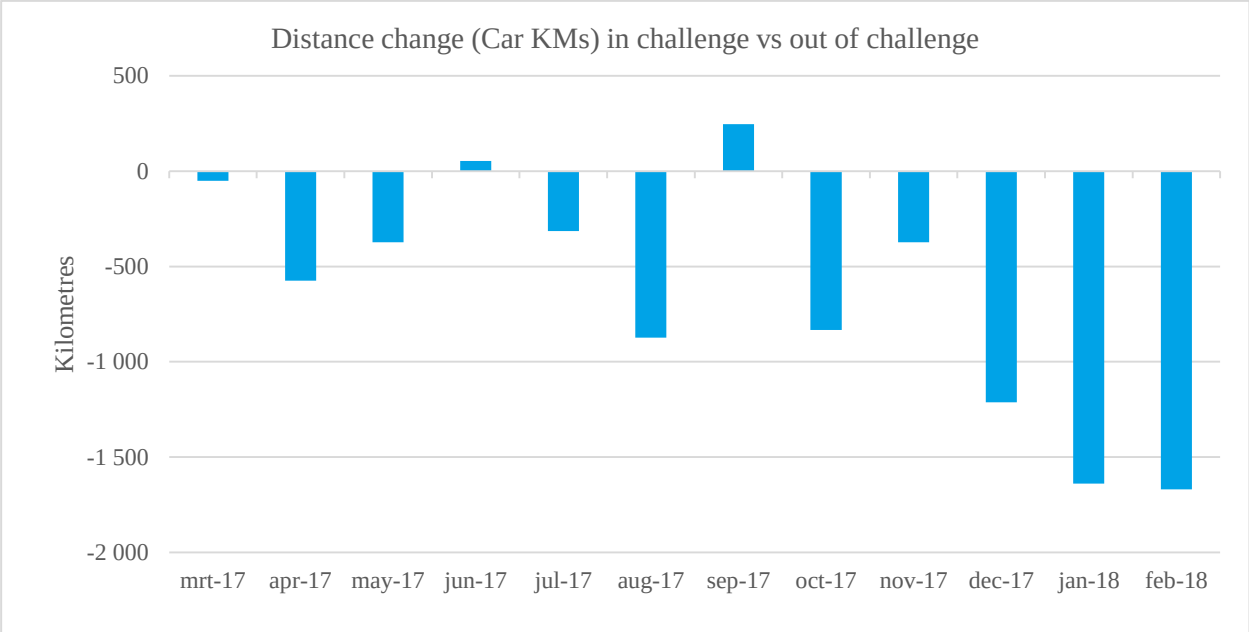



**Figure 9 - Absolute change in kilometres travelled in and off challenge**

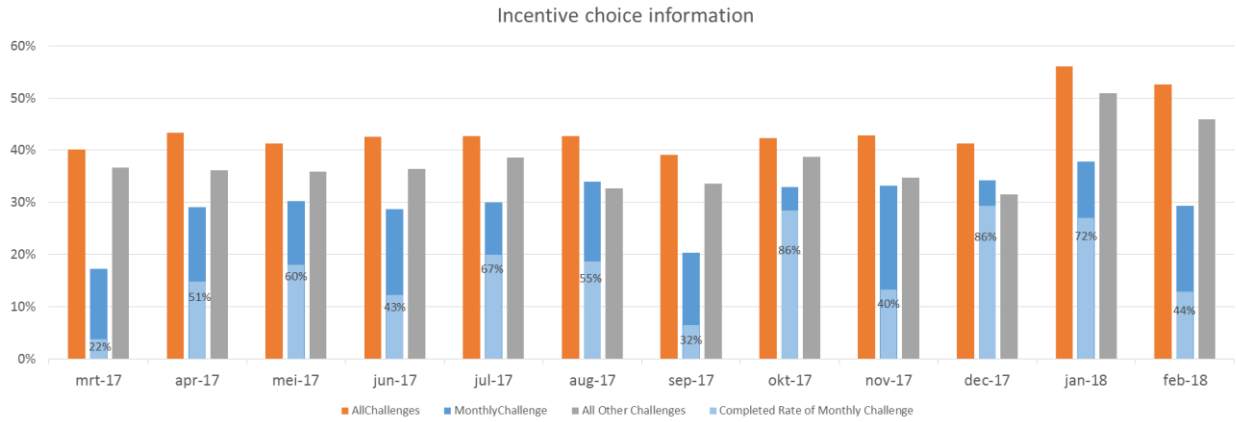



**Figure 10 – Percentage of users with challenges, including completion rates from Monthly choice challenges.**

On the contrary, Figure 11 clearly shows that challenges with the highest completion rates also yield most of the behavioural change. Challenges in which participants need to visit a specified location (left panel) score poorly on both accounts, while challenges in which participants can choose the total cycling distance (centre panel) score best. The more difficult challenges to cycle a certain distance per day or a certain number of trips (right panel) have an effect in line with the easier challenges in the middle but are less popular and slightly less effective.

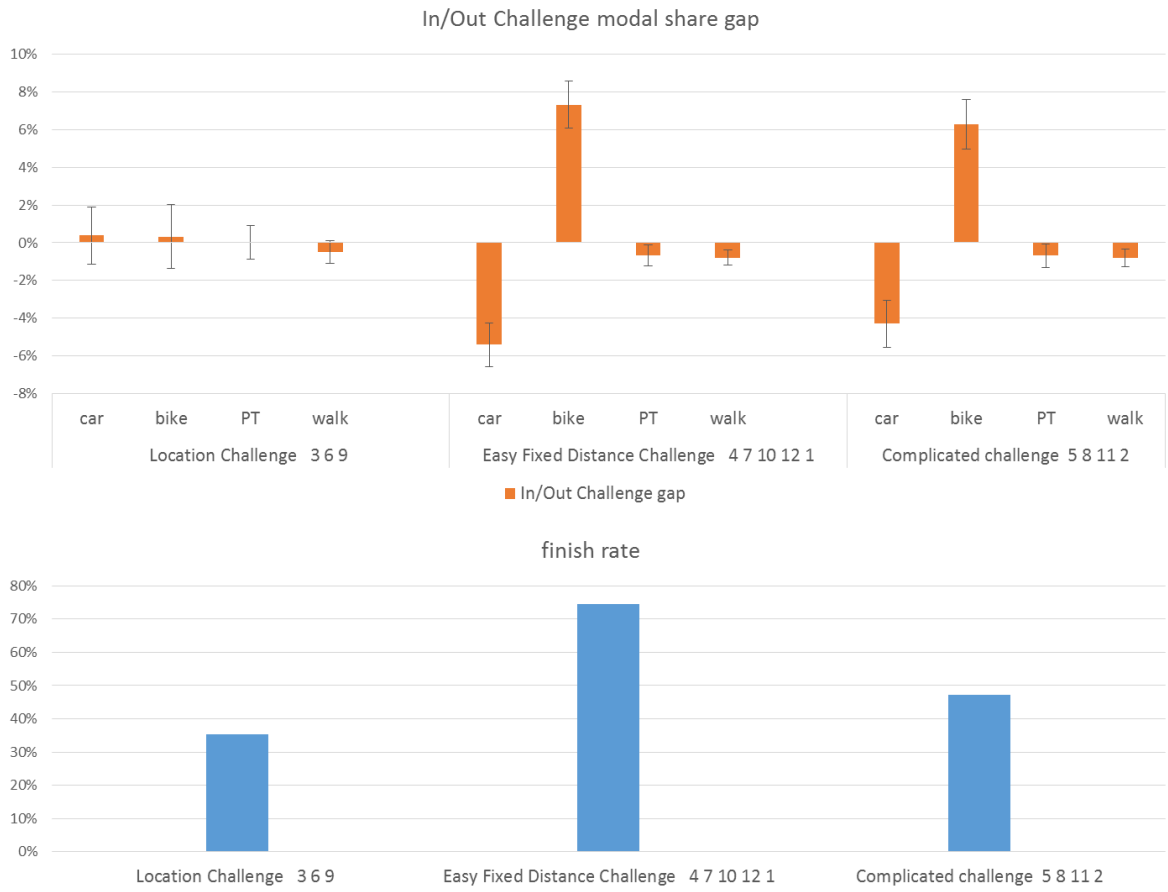



**Figure 11 – Above: Mode share difference (During minus outside challenge period; upper panel) and completion rate (lower panel). Error bars indicate 95% CL. Below: completion rates.**

Figure 11 shows that the difference in car share is slightly more than 5 percent points for the most effective challenges. With slightly more than 50% of the urban trip kilometres being covered by car, this would imply a reduction in car use of 10%. And if we only would consider the SMART users, car use is reduced even more in relative terms; close to 15% (using a 30 – 40% car share for the urban trip kilometres).

Most respondents stated external circumstances (such as bad weather) as reason when they failed to complete the challenge. When they completed the challenge about 40% indicated they had cycled more. Almost half of these people state they substituted car trips to achieve this. More than 50% also indicated that the SMART challenge was the reason for this. About 80% of the cyclists that indicated they had cycled more, also stated they would do this in the future. This result suggests that this behavioural change may be sustained.

Reward vouchers / new infrastructure: Too little data with too much variation.
About half of the participants completed the challenge to cycle at least 10 times along a new cycle route. This has probably led to an increase of cycling trips among those participants, as their surplus of cycling trips (compared to the group that did not complete the challenge) of about 25% of all cycling trips can be attributed to cycling trips related to the challenge. However, the external effects (more than 10% weekly variation in car and bike use) were too large and the sample too small to detect real changes based on the trip data.

For participants that completed the challenge, almost 50% of them indicated they cycled more via in-app questions. In almost all these cases they shifted from car to bike. In all cases, SMART played a role, although in half of the cases, the fact there was a new route also played an important role. In this case, it seems therefore justified to provide this challenge (as extra encouragement), even if it is not suited for everyone. Almost 80% of them indicated to cycle more in the future, but mostly along the new route.

One point per km for active modes: No intended effect
In Figure 3.8, we show the effects of the unconditional reward of one point per km by active mode (walking or cycling). The figure shows the mode share before and during the (start of the) campaign. According to the figure there is no significant change in car and bike use. The success of this campaign is the recruitment of new users rather than a behavioural change.

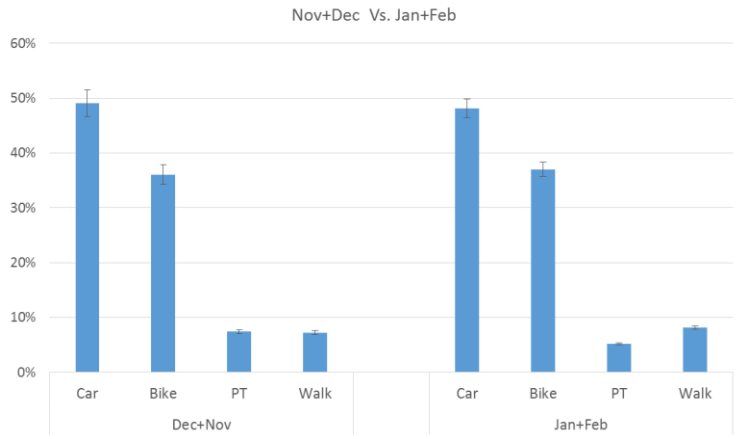



**Figure 12 - Modal share: Before (2017) and during (2018) the points per km by active mode scheme**

- **Society – economy:**
  - Not assessed

- **Society – energy:**
  - Not assessed

- **Society – environment:**
  - Not assessed

### 3.1.2 Key impact results

- Society – people:
  - 11% increase in travellers' perception of urban accessibility
  - 55% neutral or positive on a series of questions regarding usability
  - For Enschede, the number of vulnerable people is quite high with 23 to 31%.
- Society – transport System:
  - Monthly choice challenges: 10% reduction during challenge periods.

## 3.2 Process Evaluation Findings

Using the design cycle, as described in Figure 5, we summarise the most important lessons learnt for each of the steps over all Living Labs.

### 3.2.1 Problem definition

Although problems are plentiful, there are several things to keep in mind in this step of the process:

**Problem owner**

A policy, scheme or system needs an owner, a legal entity that can procure, buy, and develop functionality, etc. Even in a co-creation setting where different stakeholder together build up a system, there need to be contracts between actors on cost and revenue sharing. The overall goal of CFV-reduction, and sustainability goals in general, need a sense of urgency for stakeholder to start acting. When there is no one in the Living Lab ecosystem who acts as the problem owner, it is difficult to convince partners to join. Some cases where there is a problem owner include the following:

- An employer who has a sustainability ambition
- An employer who has a parking problem
- A city authority seeking innovative solutions to meet policy objective
- A public transit operator seeking to improve financial performance

Without a clear project sponsor an incentive scheme cannot become successful. If one organisation judges that they can only take partial ownership or responsibility for an incentive scheme seeking a co-creation process with other stakeholder to match capabilities could be a good way forward. This requires the development of clear joined and separate business models to identify the joined view of the resulting incentive scheme as well as the impact on individual organisations contributing to the incentive scheme.

**Objective formulations**

Transport and traffic in cities is a multidimensional issue that a variety of public agencies, private actors and citizens have a stake in. Reducing congestion, emissions, increase health, quality of urban space,

affordable housing in relation to travel distance, etc. In setting up an incentive scheme, the project sponsors and users need to be able to identify with the project objectives and goals. On the other hand, the objectives need to be precise and measurable to achieve continued (political) support for the scheme.

**Identify the user groups and their motivations**

Before taking a first step into creating rough ideas for an incentive scheme or development of a more detailed business model, it is important to understand how the formulated objectives relate to user groups and their motivations. This step may require some data collection, like focus groups to identify where the barriers lie for people in changing their current travel behaviour and what role incentives can play in overcoming those barriers and creating new travel behavioural patterns.

### 3.2.2 A rough idea

The rough idea describes how an incentive scheme can contribute to achieving the outlined objectives. It is a document that helps communicate with other partners, internally, and with external stakeholder what the project will be about. A useful way to formulate the rough idea is the use personas of users, mock-ups of apps, and graphics on how the back-office and marketing could be handled. Involving different levels within an organisation as well as important partners or potential suppliers early in the development process helps to identify issues and potential before choices become more permanent and costly to change.

For example, we typically see that with employers, higher management might be in favour of incentives at a strategic level. But when it comes down to the details with HR-departments and staff, difficulties start to arise. We've found that working with smaller companies is easiest, as they are typically more flexible and the distance between higher management and the work floor is smaller.

### 3.2.3 Business Models

Developing the business model involves making explicit choices on the value proposition for potential uses, how these values are created and how users will be attracted to the incentive scheme. When involving external stakeholders, the business model become more complicated and each stakeholder should create their own business model. EMPOWER Deliverable 3.4: Generic Business cases gives more generic lessons on this topic.

**An existing user base and services**

One key lesson is that attracting users to new apps and schemes is extremely expensive. To get attention from many users to even consider new services requires a significant effort. To achieve visible effects on congestion, air quality, health however a significant number of users are needed. Often government agencies do not have an existing service, a client based in which they regularly have contact and open (payment and communication) channels with users. Public transit agencies are a good example of where a large client base is already in place, as well as payment channels. Therefore, public transit agencies (like in Singapore and San Francisco) have been successful in attracting large user numbers. That does not mean, as well be described in the next section, that public transit implementation is always successful.

**Public transport involvement**

Our experiences from the UK, led to the following three observations regarding introducing innovation and change within a highly deregulated public transport market.

<u>Small profit margins</u>

We observed that within the bus industry profit margins are devolved to small operational units. This level of accountancy for the profit margin can be at the a very low scale of operation such as the level of the city

garage or route. Which means the stakeholders involved in implementing change range from top level management and executives through to the individual garage managers. Our observations are that this low level of accountancy unit responsibility for the profit margin means that there is a hesitancy to implement change (i) without consensus throughout the management structure; and (ii) without assurances about the impact on the profit margin. Initiating change from the senior management level, i.e. having a senior manager as a champion for the implementing change would probably still require support from other levels of management and particularly from those responsible for the garage level of profit. The implications of which are that implementing change requires endorsement and support for any possible impacts on the profit margin from all levels of management – the organisational structure forces the requirement for a consensus for change rather than for a 'torch-bearing' champion.

Lean organisations

We also observed organisational structures within the bus industry that are very 'lean'. By this we mean bus companies which have 'out-sourced' many of the technical areas, for example, marketing and publicity campaigning, and distilled the company to the 'core' functions and the professional management of that. One implications of this is that the technical expertise to oversee and supervise technically driven change and innovation, such as mobile app-based innovation, is lacking again leading to hesitation, delay and risk aversion. There are delays as the organisation develops 'trust' in either the expertise within the organisation, recruiting additional technical personnel or the external service provider.

Long planning horizons

In addition, we observed that the organisation usually has a programme of change with a schedule ranging from one year to a five-year horizon, although there also seems to be an implicit understanding that this programme of change and schedule is contingent on the profit margin and eventual shareholder dividend. One implication of this is that bringing in innovation and implementing change must be embedded into the existing programme of changes and schedule. It must be self-sufficient or draw on existing budget and resource allocations or there will be impacts for the costs and eventual profit margin.

**Flexibility of technical partners or procured services**

A major decision in developing the business model is to identify how the value can best be delivered to users. Services can be developed in-house, procured or buy in on existing platforms. Each of these has their pros and cons. Buying on an existing platform can be quick, cheap, but with loss of flexibility. New development takes longer time but gives full flexibility. Data ownership and sharing will also be an important issue to address in this. Making sure that data becomes available immediate, in a useable format so that necessary management information and business intelligence can be taken out.

**New partnerships**

During all the Living Lab activities, a lot of effort has been spent on collaboration with partners. In all the labs, new partnerships have been established based on the work with positive incentive schemes. For instance, increased in popularity of an app, attracts new incentives providers to the system. Using these providers and their brands in communication, helps to even further increase popularity due to the endorsement by these organisations.

We've seen that many stakeholders (employers, incentive providers, service providers) believe positive incentives can make a difference for sustainable travel and are in a proactive mood during initial interaction. This speeds up the process, even though it's tough to get an organisation fully aboard. As long as agreements are on a pro bono basis, partnerships can be very successful. However, this suggests there is

the need for a stakeholder to pay for operation of the system. During EMPOWER this was taken care of by the project, but it has proven to be difficult to engage other stakeholders in this work.

In a part of the Gothenburg Living Lab a value network was created in which public and private actors would both benefit from the deployment of an incentive scheme and could bear the cost of the system operations. For the benefits to materialise however a large user group is needed, and to get a large user group (without an existing user base) a large upfront investment in user recruitment would have been necessary. In the end, no partner was willing to co-share the initial costs, fearing that external partners would get a freeride from their investment.

**Circular economy**

Ideally, an incentive scheme would mature into a scheme where there is a circular economy in the Living Lab Ecosystem. Finding stakeholders who profit from the scheme and conveying them to use the profit to pay for the operation is the key challenge. Two cases where we have seen things can work out this way:

Saving on employee parking

A hospital which offers a bicycle incentives scheme to its employees. Given their profession in health care, the health aspect of cycling is very important in promotion of the scheme. However, the key trigger here is that there is a direct, short term financial saving as more cyclist means the hospital must pay less for employee parking spaces which they rent on an individual basis from the municipality.

Saving on employee travel

Another case is a company where an incentive scheme is used in such a way that the employer uses the actual savings on travel to pay for the incentive for their employees to travel more sustainable. Half of the savings is spent on incentives, meaning the employee gets a decent reward and the employer still benefits from the system.

**Cooperation with employers**

For some companies the driving force for incentive scheme is making sure their employees stay healthy and happy. And this trend may be growing as we speak. There are obvious potential savings for the company via e.g. less absences and sick leaves, less early retirements. And positive incentive schemes are very good for company image.

Although it’s an interesting way of providing rewards, it seems that in most companies’ HR departments there is hesitance towards extra salary as rewards. This is mostly due to lack of knowledge what can be done, and consequently lack of will to push forward in fear of additional burden. Another reason is equality; money is seen as a reward that everyone should have the same equal chance to reach for, no matter how small the amount is. With indirect incentives the sentiment is not as steep.

Company spending on employee wellbeing can be written off as an investment at least in Finland, meaning that companies are able to get tax deductions on that spending. While this is meant for company subsidized gym tickets, it opens an opportunity to utilize this measure for incentive scheme rewards. Although according to HR directors’ society Henry, this hasn’t been utilised much.

That said, still seemingly some companies tend to consider this more as an ideological effort rather than strictly company efficiency. Now if those two could be combined in an easy, clever way, we could see breakthrough in employer-based incentive schemes.

### 3.2.4 Target Groups

There are four main lessons to learn in selecting target groups:

**Focus on the changers**

Even though one can make an incentive scheme open to all, to comply with (for instance) municipal constraints on equity, you can still focus all your efforts to make the scheme most attractive for those users who can contribute to the desired impact.

As an example: teaming up with cyclist unions seems like a logical step when introducing a bicycle incentive scheme. However, they probably have mostly cycle fanatics in their network who already perform very well.

**Origin or destination**

Using a geographically focussed target groups makes recruitment a lot easier. This can either be a origin focus (allowing to go door to door or have a stand at a neighbourhood market) or a destination focus (where employers and event organisers can play a vital role in recruitment).

**Control groups**

When working with an open target group, allowing everyone to join the scheme, it is impossible to work with a control group. As outings throughout the city explain the scheme, all people who join expect to get the incentives as advertised. Also, when two users in the scheme know each other and talk about their experiences, we've found it very undesirable to give some of the people no incentives. Also, differentiation in levels of reward should be used with caution, although it might be very useful in personalisation of the service.

**Many small steps**

As small steps are easier to achieve in behavioural change, an incentive scheme can best target many users who can contribute a little towards the goal. The very outliers on both sides (those who never use sustainable modes and those who always use sustainable modes) should not be the focus of your target group if you want to make many small steps.

### 3.2.5 Planned intervention

In planning your interventions, there is a lot to consider. The highlights are the following five lessons.

**Successful incentives**

The most successful incentives (in term of participation rather than behavioural change) have two things in common:

1. They are very easy to explain
2. The behaviour to perform is achievable

<u>Some examples:</u>

Altruism – Changing behaviour for the benefit of a charity one supports has proven to be very effective in campaigning.

Choice challenges – Allowing users to set their own target makes challenges achievable and gives the user a rationale behind the height of the bar.

Relative change – Using relative changes (based on past behaviour) makes challenges comparable for all users. This way there is a level of personalisation even though everyone gets the same message.

One point per kilometre for active modes – The ease of the game together with users eager to collect points make this a very attractive offer.

**Budgeting**

We found that budgeting incentives for individuals is rather complex. You typically want to limit your spending and base rewards on the maximum case where all users get the maximum rewards. However, even in the best cases we see achievement rates of challenges not exceed 90%. And even though the shops might offer suitable prices for everyone, still not all users spend the points they earn. In cases where people could get vouchers worth €12,50, we've seen on average a spend rate of only 70%. So the sum of prices can normally be higher than the maximum budget, as long as there is a back-up plan for the (unexpected) case where everyone scores the maximum and claims their rewards.

**Automation of rewards**

When working with big target groups, one should work with digital reward systems. This allows you to give a reward to a user directly with low effort. Handling postal rewards is time consuming and means there is quite a delay between the behaviour(al change) and the moment a user gets his reward.

**Legislative issues towards handing out positive incentives**

When it comes to incentivising people with money or tangible goods with an explicit economic value, all the Living Labs had issues with legislation and tax regulations.

Particularly in Helsinki, at lot of experience has been gained with this issue. Though it seems there are not any blocking issues, just the uncertainty that there might be issues, is enough to at least slow the progress. From the Finnish legislative perspective incentives are a form of company bonus schemes, and companies are free to choose the model how they wish to provide bonuses to their staff. Because of our discussion with companies, a simple and clear guideline with a legislative focus will be written.

Legislation aside, taxation is an issue. For money it is rather clear: bonuses on top of salary have a clear model how this will be taxed. Indirect bonuses are a bit trickier. Most countries have set levels of the value of gifts that one can receive over a month or a year. And indirect bonuses often are considered as gifts. Applied to an incentive scheme this means there must be a cap on the value of the reward. Depending on the cap level, this may or may not be an aspect to address.

This issue is addressed in the H2020 call MG-4-1-2018 'New regulatory frameworks to enable effective deployment of emerging technologies and business/operating models for all transport modes'. This call for a Coordination and Support Action identifies the lack of coherent and common regulatory framework as a possible obstacle to innovation.

**Incentive fatigue**

A potential challenge in the design of incentives is a matter of incentive fatigue. With current time lines in the Living Labs, we have not encountered concrete cases of this effect. However, the topic has popped up several times. With incentive fatigue we mean that people might get tired from the constant presence of challenges and the need to choose these challenges every time. Also, boredom towards the campaign may turn out to be an issue.

**Incentive formulation**

Experience from the Gothenburg Living Lab is that the challenges that were directly formulated towards reducing car kilometres also were most successful in achieving that objective. So rather than incentivizing an alternative to car use, incentivising user to use the car less and giving them complete freedom in how to achieve that, was most effective.

### 3.2.6 IT Services

Within the Living Lab, a range of IT services were used to distribute incentives. Enschede and Gothenburg used the SMART-app. Milton Keynes worked with both *zwitch and Love to ride. Scotland worked with several dedicated tools to provide information to their users. Lessons learnt in this step can be divided into three categories.

**Commercial products and flexible research tools**

Even though we started off with IT services already developed and ready to be deployed in the different Living Labs, they were not fully flexible research tools which could support all experiments possible. As development was not a key part of the project, living lab operators had to balance between the experimental set-up and the IT provided. This meant some systems functions were (mis)used in a way they were not designed for. It proves to be challenging to give guidance to developers in a situation where you'd need several development cycles to get to a well-functioning new feature. Also, development of the IT service was not the goal of the research in the EMPOWER project.

**Privacy considerations**

A true balancing act is the collection of personal data. From a commercial service point of view, privacy would be most important and one should not collect more data than needed. Form the research point of view, we want to use personal data as explaining variables and see effectiveness of incentives. Especially when to the KPI on vulnerability, the sensitivity of the data collected was the reason we could not ask the exact same questions in each of the labs.

**Personalisation of the service**

During the living lab experiments, personalisation of incentives became more and more a key feature for success. There are three main components to focus future incentive work on:

- Use past behaviour to define incentives;
- Add sociographic data via a user profile in the app;
- Automated the incentive design process.

### 3.2.7 Marketing and communication

Marketing and communication is the most complex part of the design cycle, as you have limited control over the way people will get in touch with your scheme. Also, any efforts and best practices can differ largely from location to location.

**Recruitment strategies**

When aiming for impact, you probably aim for a lot of users. And in broadening your communication channels, you'll attract a lot of people who like initiatives on sustainability and who travel rather sustainable already.

Even though this is not necessarily a weakness, one can better make the strategic choice to focus on those people who can have an impact (see 4.4.1 as well) and adapt your message accordingly. Probably more focussing on individual benefits (costs, health, travel time) rather than communal benefits (the environment).

**What's in it for the user**

To engage with people, there needs to be a clear benefit. No one is actively looking for a app that can change their behaviour, so people need to know what your app can do for them.

This can be as easy as saying that people can from now on earn rewards by travelling sustainably, but other examples include:

- the support in changing to a more active lifestyle;
- supporting charity;
- access to (personalised) travel information;
- fun / games.

Whatever your message is, make sure it is as simple as one sentence.

**Building on top of existing brands**

Once you have a clear value for the user, it is still a matter of getting peoples interest in your service. Building on top of existing brands can really improve your effect of marketing efforts. This can be done in various ways:

- Using an existing brand to market your incentive scheme ('This app is a service of your local municipality');
- Align your actions with other (relevant) brands like the European mobility week, local climate initiatives, etc;
- Use the brand of an incentive provider (see 4.7.4) to promote yourself;
- Getting well known partners to function as a proxy in your recruitment efforts.

**Role of incentives in marketing**

Incentives can not only be used to change travel behaviour, they can also be used to ease recruitment. We saw two effective ways you can work with incentives in recruitment.

First, we clearly saw an impact of the use of the (future) incentive in communication messages. People trigger easily on high value incentives or incentives provided by trusted/well know providers. The prospect of the incentive to be earned, makes people likelier to join the incentives scheme.

Second, rewarding people to recruit for you helps as well. We've found high numbers of users joining the scheme by worth of mouth. This is mostly done by people who already like the system and motivate friends to join as well. This way of introduction of new users can be enlarged by rewarding users when they bring in new user.

**Equity considerations**

There are two aspects to consider when working with rewards in real life. The first is the difficulty in communication with personalised incentive schemes. The second is the use of control groups.

Mass communication about personal offers

To be effective, personalisation of incentives is a desirable strategy. Using the EMPOWER apps, the distribution of personal offers is catered for as a digital service. However, central communication outside of the app is far more difficult to personalise. Let alone the communication between users themselves. So, in personalising the incentives, one should very much consider whether it is fair to distribute a personal incentive to only a subgroup of the users.

Control groups

The same goes for control groups in experiments. Even though all users in the experiment got an equal chance in the reward draw at the end, people were upset when they found out that a colleague got an incentive treatment (without monetary value) which they didn't. One way to overcome this issue would be to work with different companies, where one of the companies serves as a reference case.

**Recruitment best practices**

There are two ways of recruitment where we see most potential:

Social media

The use of social media networks to work with highly personalised digital advertisements has proven as a cost-effective method to recruit new users. This way reach is high and the time spent by the operator is low. One side note is that you'll need large numbers here, as the conversion from initial interest to full participation is low in this case.

On street activity

The other effective recruitment action is on street presence. Even though one-on-one interaction with the public is time consuming, numbers reached are high as well as conversion. Another benefit of this strategy is the direct dialogue with end-user, which forces you to have a crisp and clear message about the value incentive scheme (see 4.7.2).

### 3.2.8 Operation

The operation of a Living Lab involves task like the final design of incentives, providing a helpdesk for users and operational cooperation with partners.

**Operation of the services**

The main lesson in the operation of the service is to take into account sufficient resources for the operation. Working with users can be very time consuming, especially with complex services like SMART where technical issues (eg. malfunctioning of the interface, errors in modality detection, excessive battery drain) need an in-depth analysis to find the cause and take time to resolve with the technical partners.

Also, the design of incentives is time consuming. Even with a certain degree of automation (see 4.6.3), the human readable text must be written. This includes at least a technical description of the incentive rules, but ideally is tailored for the local context, personalised to trigger users to take the challenge.

**Running a commercial like service**

EMPOWER tried not to be a research project toward the end users. This means we aimed in not focussing too much on telling people they were part of a research project. Also, the user experience should be like

any other (non-research driven) app in the store. This means the role of the user goes beyond a simple test-subjects and we had a more customer like relationship with the users.

This strategy was chosen in other to not influence the behaviour of people beforehand. It also meant that users had a higher expectation of the service and were less forgiving towards any glitches in technology.

We think this is the best strategy when running a Living Lab like the ones in EMPOWER. However, this asks for an operator of the Living Lab who has little research interest and is solely focussed on operation and the 'wellbeing' of the users.

**Management tools**

A lot of focus has been on the front end of IT services: look and feel, services, ease of use, etc. However, from the operational perspective the back-end of the system plays a vital role. Having insights in users (numbers, activity, ways of travel), incentives (target group numbers, behavioural responses) and messages (sent, read) largely benefits the operator of the incentive scheme.

### 3.2.9 Evaluation

This is already described in chapter 2.4.

## 3.3 Evaluation Conclusions

### 3.3.1 Main lessons learned

Using the results of all the Living Labs, following recommendations can be made:

**1. The design of mobility services**

Based on the responses on questionnaires, some functionality of the apps is very appealing to users:

- Traffic information
- Travel statistics based on tracked trips
- Basis incentive schemes like the points per kilometre for charity and points per kilometre for active modes.

These incentive schemes are not effective in terms of behavioural change but are very appealing and very useful in attracting new users.

Next to this, the basics of the service must be flawless. People are easily bothered by little bugs, malfunctioning of trip detection and functions not working properly. Once people leave the scheme because of such issues, it's nearly impossible to get them back. To the end user, the system must compete with other commercial apps which have a high expectation in user satisfaction.

**2. The use of social networks for enrolment of new users**

There are two mains ways to use social networks in recruitment

- Using online social networks, we have had a lot of benefit of targeted advertisement. By directing targeting your (potential) users, can spend your marketing money effectively.
- Offline social networks are maybe even more successful, as many users are tipped by friends to join the incentive scheme. Incentivising recruitment is an effective way to stimulate these mouth-to-mouth enrolment efforts.

**3. The most effective and efficient incentives**

Personalisation of incentives is a key aspect in the effectiveness of incentives. There are several ways forward based on our Living Lab work:

**Choice challenges**

These are challenges where people have the flexibility to choose their own goal. This way, the goal is always near enough to the own behaviour. However, people might not be ambitious in their goals to change.

**Relative change challenges**

Designing challenges where you base the challenge on previous travel behaviour. Technically a bit more complex, but this way all users have a challenge which is suitable for themselves.

**Challenge automation**

The next step in researching positive incentive schemes, where you further automate the incentive process and base challenges on past travel behaviour as well as on past challenge effectiveness. Artificial intelligence and automated learning systems probably play an important role in this next step.

**4. The improvement of incentive personalisation**

As stated in before in 3, personalisation is a key aspect. Using social media data would mean we target people based on sociodemographic characteristics which has its limits due to ethical considerations. Using past mobility behaviour seems a more fruitful path to discover. Although we've seen rather large variations over time without incentives, which means is will be hard to predict how difficult next week's challenge should be to still be relevant.

**5. The embedding in existing organisations**

This kind of innovations in public services is very disruptive to the day to day business of an organisation. Therefore, we need champions in different expertise groups within organisations to make sure the embedding will sustain. We've found this to be the case in almost all partners: incentive providers, public transport operators and employers.

**6. The factors influencing to uptake**

We've defined three most prominent factors which influence the uptake of new mobility services:

**Proof of concept**

As we're introducing innovative schemes, one of the major risks is stakeholders who don't oversee the conceptual idea fully and are therefore reluctant to proceed in a collaboration. Having a proof of concept available helps a lot to have stakeholders trust the concept. Such a proof of concept can be something like an early demo-version or a full working system in another city. At least something where the full system is technically operational. Ideally, some (test) users should be involved in the proof of concept as well.

**Trustworthy partners**

Next to trust in the technology, trust in the partners is another important factor. In cases where a government was actively involved, other stakeholders joined more easily. The participation of such a major stakeholder gave other partners the confidence that a scheme was worth joining and not just another innovation passing by.

**Ease**

For most stakeholders, incentive schemes are not their core business. This is clearly the case for local shopkeepers who act as incentive provider, but also for more transport-oriented partners like public transport operators. To motivate people to be involved in the scheme, ease is therefore an important factor. This can be expressed in two ways: the ease of understanding the added value and the ease of participating.

### 3.3.2 Long term impact

Based on the conclusions of the evaluation of this measure in the lifetime of the CIVITAS project, we can conclude the following concerning the long term impact of this measure:

- Incentive schemes can be very helpful to nudge persons to test a new and more sustainable transport mode. However, it is necessary that the transport experience itself is practical and enjoyable, in order that the changed travel behaviour will remain after the incentive stops. Therefor the supporting infrastructure for a shift towards active travel or towards public transport should be in place in order to achieve long term impact results.

### 3.3.3 Potentials for transferability in other cities

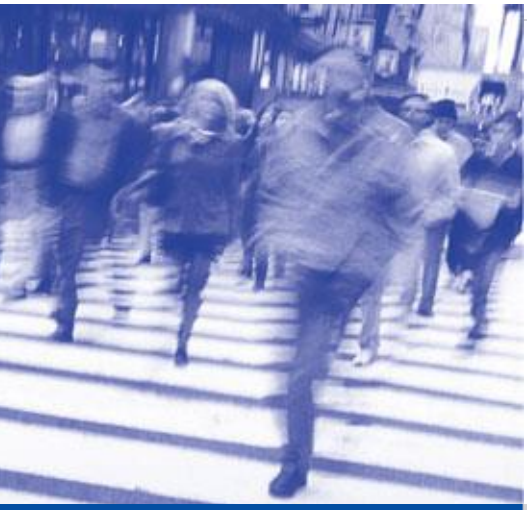
Based on the conclusions of the evaluation of this measure and the available knowledge on the context and challenges of other cities, the following conclusions on the transferability potential of the measure can be made:

- The measure is transferrable to other cities
- For long term effectiveness of the measure, good quality infrastructure and services for sustainable transport modes must be in place (see 3.3.2 Long term impact)

## 3.4 Annexes and reference documents

The following documents present further details on the evaluation findings (e.g. the evaluation report, a presentation, ..):

- Deliverable D5 2 Living Lab Report



CIVITAS 2020
Cleaner and better transport in cities

SATELLITE

# Measure reporting on evaluation approach and evaluation findings

## - RIA projects

| | |
|---|---|
| Measure | Positive Drive (App) |
| Short description | App based on making and rewarding the right transport choices. Right choices are those that are less harmful to the environment, i.e. active modes, but also public transport. As soon as the user turns on the app it starts measuring and rewarding good behaviour and giving direct feedback. |
| | |
| **Report developed by** | |
| Project: | TRACE |
| City/cities | n/a |
| Author(s) | Stephanie Keßler |
| Mail address | s.kessler@luxmobility.eu |
| Version | Final |
| Date | 16 June 2018 |
| | |
| ***Template** by* | *CIVITAS SATELLITE* |
| *Review:* | *Dirk Engels, Gitte Van Den Bergh* |

TRACE
WALKING AND CYCLING TRACKING SERVICES

CIVITAS 2020
Cleaner and better transport in cities
SATELLITE

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# 1 Measure description

## 1.1 Objectives of the measure

| Ranking | Objectives | Target group |
|---|---|---|
| 1 | Influencing people's transport mode choice towards more sustainable modes (reduce car use) | All |
| 2 | Raising awareness for different modes and for flexible decisions | All (primarily car drivers) |
| 3 | Informing about health impact (coaching) | All (primarily car drivers) |
| 4 | Improving quality of living in the city | All |
| 5 | Collecting tracking data for further processing and planning decisions (TAToo) and improving the app (mode recognition) | n/a |

## 1.2 Description of the measure: what is implemented ? How ?

### 1.2.1 General

The measure involves the implementation of the following:

- The app is based on making and rewarding the right transport choices. Right choices are those that are less harmful to the environment, i.e. active modes, but also public transport. As soon as the user turns on the app it starts measuring and rewarding good behaviour and giving direct feedback. Positive Drive only uses positive incentives, such as coaching, prizes, social status and achievements. The user can see all rewards gained, share the achievements through social media and play for prizes in the virtual game room. The coaching program is driven by the achievements and is tailored to each individual user. TRACE extended and improved the already existing Positive Drive app to offer users better feedback on walking and the use public transport, in addition to cycling and using a car.

### 1.2.2 Outputs

Direct results of the measure:

- Six different campaigns in European cities (Águeda PT, Belgrade RS, Breda NL, Hasselt BE, Luxembourg LU, Southend-on-Sea UK) using the app.
- More than 80,000 trips tracked (data collection for feeding into the tracking analysis tool TAToo)
- More than 1,400 app users (over all six campaigns)

### 1.2.3 **Supporting activities** *(if applicable)*

| Supporting activity | Target group(s) | Main objectives |
|---|---|---|
| Local events, social media campaigns | Different in the respective campaigns (students, commuters, users of a specific road etc.) | Promotion of the campaign/app |
| Incentives, lottery | All users of the app | Making application more attractive, motivating sustainable mode choice |
| [Stakeholders (sponsors) are automatically involved as they provide the prizes.] | Different in the respective campaigns (shops, cafés etc.) | Higher degree of acceptance |
| The campaigns as such are citizen engagement activities | All inhabitants | Increasing the use of sustainable transport modes<br>Collecting data through tracking |

### 1.2.4 **Interaction with other measures**

This measure has a significant interaction with the following measures (including the possible influence on impact and implementation process):

- In Southend-on-Sea two similar campaigns ran parallel (timely and geographically) which led to some confusion among users.

# 2 Evaluation approach

## 2.1 Impacts and indicators

| Impact category / aspects | Expected impacts - Indicators | Data collection methods | Observed groups/areas |
|---|---|---|---|
| **Society-people** | Behavior change (mode choice) | Survey | Different in respective campaigns |
| **Society-governance** | n/a | | |
| **Transport system** | Better planning – data collection for tracking analysis | | Local authority |
| **Economy** | n/a | | |
| **Energy** | n/a | | |
| **Environment** | Less car-use, more walking, cycling and public transport | Survey | See above |

Comments to the table:

*none*

**Additional comments:**

- none

## 2.2 Further analysis of data

The following additional analyses are done to optimise and complete the evaluation findings:

- The indicators vary between the six different campaigns. Each campaign included a survey, asking the users about their transport behaviour, their satisfaction with the app/campaign and its impact on their mode choice.

## 2.3 Process evaluation activities

The following activities are set in place to understand and assess the implementation process:

- There has not been a strict boundary between process and impact evaluation. Through focus groups and stakeholder interviews the campaigns have been evaluated with regard to their impact as well as their setting-up.

## 2.4 Appraisal of evaluation approach

Based on the evaluation work in this project, the following observations and recommendations concerning the evaluation approach seem important for other projects (including specific interesting elements in the approach):

- Running a campaign for behaviour change towards more sustainable modes, using incentives, and at the same time collecting tracking data for planning to optimise infrastructure according to user needs means that the tracked data is biased and does not necessarily represent average behaviour.
- For seriously measuring behaviour change the approach was not suitable. It is generally questionable whether or not short-term campaigns can induce behaviour change. Moreover, the survey data collection would have to be sounder, i.e. reliable baseline and ex post data.
- Focus groups are difficult to set up and may need some incentive too. Interviews are easier to carry out (e.g. via telephone), but are more expensive if they are to be transcribed and lack the element of group discussion.

## 2.5 Annexes and reference documents

The following documents present further details on the evaluation approach (e.g. the evaluation plan, a presentation, ..) or are used as a reference document for the development of the evaluation approach:

- TRACE D7.1 (Evaluation Plan)

# 3 Evaluation findings

## 3.1 Impact of the measure

### 3.1.1 Results in the CIVITAS impact categories

The impact evaluation results in the following before and after scores of the indicators, changes and interpretations in the relevant impact categories (including figures, graphs and tables):

*As the objectives of the evaluation in TRACE were rather to validate the use of tracking apps and their potential than actually changing people's behaviour, it is difficult to answer in CIVITAS impact categories. Moreover, most of the impact evaluation was qualitative and not quantitative.*

- **Society – people:**
  - The Positive Drive app is supposed to have an impact on people's mobility behavior. Measuring behavior change and attributing it to one measure is very difficult. The effect of the app in the context of a campaign is limited, but can be considered as initiation of a new behavior (operant conditioning). Other influencing factors are needed.

- **Society – governance:**
  - In TRACE the Positive Drive app has collected data on nearly 80,000 trips. This indicates that it is effectively collecting data that can be used by municipalities or any other public institution.

- **Society – transport System:**
  - At pilot level, data have been collected and fed into a tracking analysis tool (TAToo) developed in the framework of TRACE too. The quality of data tracked by Positive Drive was considered usable, but with room for improvement.

- **Society – economy:**
  n/a

- **Society – energy:**
  n/a

- **Society – environment:**
  - The Positive Drive app is supposed to have an impact on people's mobility behavior, encouraging environmentally friendly modes (walking and cycling). The effect of the app in the context of a campaign is limited, but can be considered as initiation of a new behavior (operant conditioning). Other influencing factors are needed. Measuring behavior change and attributing it to one measure is very difficult.

## 3.2 Process Evaluation Findings

### 3.2.1 Barriers

The following barriers were observed (including actions to overcome these barrier)

- **Barrier 1** – It has been observed that it is particularly difficult to set up a campaign involving a number of stakeholders when the app is not ready or has severe bugs.
- **Barrier 2** – A separate registration process after downloading the app was an extra effort for users.
- **Barrier 3** – "Virtual robbery" as it happened in the campaign in Southend-On-Sea, where two users managed to "win" 50% of all available prizes in one night. This was obviously frustrating for the other users.
- **Barrier 4** – Rating car driving higher than cycling (more 'smiles' based on the bigger number of kilometres)

### 3.2.2 Drivers

The following drivers were observed (including actions to make use of these drivers):

- **Driver 1** – Positive Drive campaigns are inclusive, i.e. everyone can participate, not only those who already use active modes of transport.
- **Driver 2** – Positive Drive has an important gamification component making it a valuable tool using operant conditioning[1].
- **Driver 3** – High level of flexibility of the tool (customization for individual campaign).

### 3.2.3 Supporting activities

The following conclusions concerning the supporting activities are drawn:

n/a – as a campaign is already a bunch of activities including PR activities etc.

### 3.2.4 Recommendations on the implementation process

The following recommendations can be given:

- **Recommendation 1** – Many users and stakeholders stated that the possibility to share individuals' positive achievements via social media would be a great way to stimulate emulation between participants.
- **Recommendation 2** – Prizes in the lottery need to be reasonable, i.e. not too small, but not too big either, depending on local conditions and campaign specific target group.
- **Recommendation 3** – Due to the specific nature of the evaluation in TRACE (validating the app as product and at the same time assessing its potential for data collection) there is an immanent contradiction: When a campaign using the app promotes walking and cycling and provides incentives

[1] Operant conditioning, which is used in Positive Drive, is pairing behaviour with a consequence (positive or negative) in order to encourage or discourage certain behaviour.

for favorable transport choices, then the data generated and collected by the app is biased and only to a limited degree usable for planning purposes as it does not represent average behavior.

## 3.3 Evaluation Conclusions

### 3.3.1 **Interaction with other measures** (only if relevant)

Concerning the interaction with other measures, the following key conclusions can be drawn:

- **Key conclusion 1** – Quality and reliability of tracking data collected by the app for planning could be improved. However, if quality and reliability are good, the output information of a Positive Drive campaign is valuable input for tracking analysis.

### 3.3.2 **Main lessons learned**

Implementing this measure, this are the main lesson learnt, important for future sustainable mobility strategies:

- **Key lesson 1** – Incentives and rewarding are important features for a campaign. Though, often discussed in relation to bias incentives and rewards can highly influence the number of active users which is positive with regard to initiating behavior change through operant conditioning and even more important with regard to tracking data collection.
- **Key lesson 2** – Rating car driving higher than cycling (more 'smiles' based on the bigger number of kilometres) is obviously not what was originally intended; therefore, the ratio between smiles given to bike trips needs to be at least ten times bigger than for car use (e.g. if a user commutes 120km back and forth to work every day, he or she should certainly not collect more smiles than someone cycling to work 12km every day)
- **Key lesson 3** – The number of downloads of the app exceeds the number of active users by far. Apparently, people are initially interested in what the app does, but lose interest before actually using it (→ barrier).

### 3.3.3 **Long term impact**

Based on the conclusions of the evaluation of this measure in the lifetime of the CIVITAS project, we can conclude the following concerning the long term impact of this measure:

- **n/a**

### 3.3.4 **Potentials for transferability to other cities**

Based on the conclusions of the evaluation of this measure and the available knowledge on the context and challenges of other cities, the following conclusions on the transferability potential of the measure can be made:

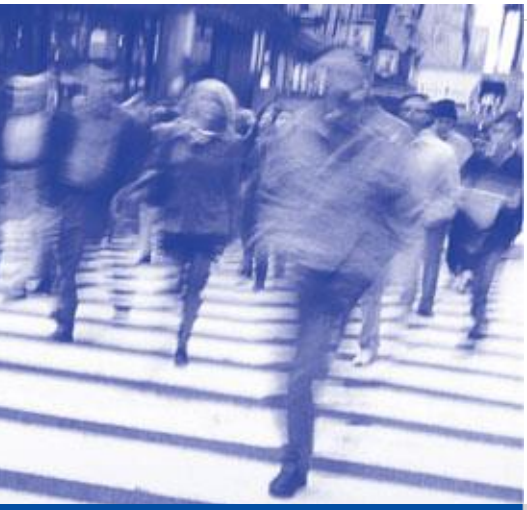
- **Key conclusion 1** – The app is suitable and sufficiently flexible to implement Positive Drive campaigns in other cities. Campaign managers should adapt their campaign to the local needs and

settings in order to make it a success for data collection, awareness raising, stakeholder involvement or behavior change.

## 3.4 Annexes and reference documents

The following documents present further details on the evaluation findings (e.g. the evaluation report, a presentation, ..):

- TRACE D7.2 (Final Evaluation Plan)



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# Measure reporting on evaluation approach and evaluation findings

## - RIA projects

| | |
|---|---|
| Measure | Biklio (mobile application) |
| Short description | Biklio gathers local businesses in a network to reward customers who come by bike. |
| | |
| **Report developed by** | |
| Project: | TRACE |
| City/cities | Breda (NL), Luxembourg (LU), Plovdiv (BG), Bologna (IT), Southend-on-Sea (UK) |
| Author(s) | Stephanie Keßler (LuxMobility) |
| Mail address | s.kessler@luxmobility.eu |
| Version | Final |
| Date | 30 June 2018 |
| | |
| ***Template** by* | *CIVITAS SATELLITE* |
| *Review:* | *Dirk Engels, Gitte Van Den Bergh* |

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# 1 Measure description

## 1.1 Objectives of the measure

| Ranking | Objectives | Target group |
|---|---|---|
| 1 | Influencing people's transport mode choice towards using the bicycle more often. | Primarily cyclists (and secondly other transport user groups) |
| 2 | Creating a sense of community, cycling as a lifestyle | Cyclists, local shops, cafes etc. |
| 3 | | |

## 1.2 Description of the measure: what is implemented? How?

### 1.2.1 General

The measure involves the implementation of the following:

- The app creates a link between retail stores, cafes and other consumer business and customers who cycle. When customers arrive by bike they earn a reward – as the citizen rides, the app detects if he/she is using the bicycle. When he/she arrives and stays at the location of a participating business, a notification congratulates him/her for using the bike and announces a reward. The user then shows the shopkeeper the app notification to claim the reward, normally a discount on the items purchased.
- The app has been promoted in local campaigns run as pilots during TRACE project lifetime. In the different pilot cities the campaigns were different too, e.g. in Bologna the rewarding businesses were mostly cinemas and some small restaurants and bars in their vicinity. In Breda the app was used to support a campaign in connection with implementing the city's first bicycle street (Boschstraat).

### 1.2.2 Outputs

Direct results of the measure *(e.g. buying 10 buses, ..)*:

- Five different campaigns in European cities (Bologna IT, Breda NL, Luxembourg LU, Plovdiv BG, Southend-On-Sea UK) using the app.
- More than 1,000 trips tracked (data collection for feeding into the tracking analysis tool TAToo.
- Approximately 180 active app users (over all five campaigns)

### 1.2.3 **Supporting activities** *(if applicable)*

| Supporting activity | Target group(s) | Main objectives |
|---|---|---|
| Local events, social media campaigns | Cyclists and others | Promotion of the campaign/app |
| Stakeholder involvement through involving local businesses as sponsors (providers of discounts for cyclists) | Local businesses (different focus in the respective campaigns) | Creating a sense of community between cyclists and businesses |
| Citizen engagement (the campaign as such) | Primarily cyclists, but other citizens too | Encouraging cycling and local shopping, cycling as a lifestyle |

### 1.2.4 **Interaction with other measures**

This measure has a significant interaction with the following measures (including the possible influence on impact and implementation process):

- In Plovdiv the BIKLIO pilot campaign ran during the European Mobility Week in September in order to mutually benefit from publicity and to create synergies; however, the campaign was considered as much too short (one week) to really show effect.
- In Breda the BIKLIO campaign was used to introduce the city's first bicycle street (Boschstraat). The implementation of the new infrastructure and traffic rules may be seen as other measure with which the campaign interacted.
- In Southend-on-Sea two similar campaigns (BIKLIO and Positive Drive) ran parallel (timely and geographically) which led to some confusion among users.

# 2 Evaluation approach

## 2.1 Impacts and indicators

| Impact category / aspects | Expected impacts - Indicators | Data collection methods | Observed groups/areas |
|---|---|---|---|
| **Society-people** | Creating a sense of community and a 'cycling lifestyle', eventually leading to a changed behavior with regard to transport mode choice in favor of cycling | Ex post survey | Mostly cyclists, slightly different focus in each campaign (e.g. customers of cinemas or cafes) |
| **Society-governance** | n/a | | |
| **Transport system** | Better planning – data collection for tracking analysis | | Local authority |
| **Economy** | Supporting specific local businesses | Ex post survey | Businesses involved in the campaigns |
| **Energy** | n/a | | |
| **Environment** | Less car-use, more cycling | Survey | App users |

Comments to the table:

*none*

**Additional comments:**

*none*

## 2.2 Further analysis of data

The following additional analyses are done to optimise and complete the evaluation findings:

- The indicators vary between the five different campaigns. Each campaign included a survey, asking the users about their transport behaviour, their satisfaction with the app/campaign and its impact on their mode choice.
- Local businesses who participated as providers of discounts have been interviewed in order to assess their satisfaction with the campaign/app for their own benefit (recruiting new customers, encouraging existing customers to pass by etc.)

## 2.3 Process evaluation activities

The following activities are set in place to understand and assess the implementation process:

- There has not been a strict boundary between process and impact evaluation. Through focus groups and stakeholder interviews the campaigns have been evaluated with regard to their impact as well as their setting-up.

## 2.4 Appraisal of evaluation approach

Based on the evaluation work in this project, the following observations and recommendations concerning the evaluation approach seem important for other projects (including specific interesting elements in the approach):

- Running a campaign for behaviour change towards more sustainable modes, using incentives, and at the same time collecting tracking data for planning to optimise infrastructure according to user needs means that the tracked data is biased and does not necessarily represent average behaviour.
- For seriously measuring behaviour change the approach was not suitable. It is generally questionable whether or not short-term campaigns can induce behaviour change. Moreover, the survey data collection would have to be sounder, i.e. reliable baseline and ex post data.
- Focus groups are difficult to set up and may need some incentive too. Interviews are easier to carry out (e.g. via telephone), but are more expensive if they are to be transcribed and lack the element of group discussion.

## 2.5 Annexes and reference documents

The following documents present further details on the evaluation approach (e.g. the evaluation plan, a presentation, ..) or are used as a reference document for the development of the evaluation approach:

- TRACE D7.1 (Evaluation Plan)

# 3 Evaluation findings

## 3.1 Impact of the measure

### 3.1.1 Results in the CIVITAS impact categories

The impact evaluation results in the following before and after scores of the indicators, changes and interpretations in the relevant impact categories (including figures, graphs and tables):

*As the objectives of the evaluation in TRACE were rather to validate the use of tracking apps and their potential than actually changing people's behaviour, it is difficult to answer in CIVITAS impact categories. Moreover, most of the impact evaluation was qualitative and not quantitative.*

- **Society – people:**
  - The BIKLIO app is supposed to create a network/community of cyclists and local businesses for the good of their city. Measuring the feeling for this community and its effects is very difficult.

- **Society – governance:**
  - In TRACE the BIKLIO app has collected data on nearly 700 cycling trips. However, with only very small numbers of tracked trips in some cities the data cannot be effectively used by municipalities or any other public institution.

- **Society – transport System:**
  - At pilot level, data have been collected and fed into a tracking analysis tool (TAToo) developed in the framework of TRACE too. The quantity of data tracked by Biklio during the campaigns is considered too low to be effectively used to improve the transport infrastructure.

- **Society – economy:**
  n/a

- **Society – energy:**
  n/a

- **Society – environment:**
  - The Biklio app is supposed to have an impact on people's mobility behavior, encouraging cycling (cycling as a lifestyle). The effect of the app in the context of a campaign is limited, but can be considered as initiation. Biklio addresses mostly people who already use their bike frequently. The TRACE campaign was a pilot, but Biklio is supposed to run and create effects on a longer term, i.e. not in a short campaign, but continuously. Biklio is then expected to have a growing effect with more and more people joining (snowball), eventually attracting non-cyclists too.

## 3.2 Process Evaluation Findings

### 3.2.1 **Barriers**

The following barriers were observed (including actions to overcome these barrier)

- **Barrier 1** – Finding local partners: While for Biklio, the incentive for the app users was clear, the benefit for the local partner was not always obvious. Indeed, some local partners have expressed their concerns regarding the lack of added value for them. In cities with low bike use the promise to attract a bunch of cyclist is simply not enough. Of course, communication about benefits such as customer loyalty increase or customer acquisition among cyclist is essential, but developing or highlighting added value for local shops could be interesting. For instance, gamification elements at the level of the local shops could be interesting to increase their interest and involvement for the campaign. A kind of ranking among shops or special challenges (the most Biklio users in a single day, hour, etc.) will create emulation among local partners and contribute to an efficient implementation.
- **Barrier 2** – Download and registration process too complex, i.e. high drop-out rate of users
- **Barrier 3** – Duration of the campaign: For instance, the implementation of the Biklio campaign in Plovdiv lasted 4 days, which is considered as insufficient considering the preparation time. In Luxembourg, where the implementation period lasted 2 months, one local shop indicated he did not understand why the campaign was “so short”. It is also true that once the preparation and organisation work has been done and the campaign is starting to run smoothly the biggest part of the work is behind. Consequently, the requested minimum running time should be at least 4 weeks.
- **Barrier 4** – Parallel campaigns: There are various reasons why there should not be more than one campaign at a time in one site, e.g. difficulty to recruit local partners as sponsors, overlapping communication, confusion amongst users.

### 3.2.2 **Drivers**

The following barriers were observed (including actions to make use of these drivers):

- **Driver 1** – Positive image of the campaign created interest of users
- **Driver 2** – Flexibility of the app to adapt: Choice for the focus of the campaign, e.g. cinemas or cafes as local partners, this allows targeting specific user groups.
- **Driver 3** – Cooperation with the local cyclists association: Effective communication and near to no costs.
- **Driver 4** – Direct contact to the (potential) users worked better than social media campaigning (in Bologna e.g. when people queued for the cinema). For collecting feedback on user experience though social media seemed to be a suitable communication channel.

### 3.2.3 **Supporting activities**

The following conclusions concerning the supporting activities are drawn:

n/a – as a campaign is already a bunch of activities including PR activities etc.

### 3.2.4 **Recommendations on the implementation process**

The following recommendations can be given:

- **Recommendation 1** – Benefits for biking need to be reasonable, i.e. not too small, but not too big either, depending on local conditions and campaign specific target group.
- **Recommendation 2** – Due to the specific nature of the evaluation in TRACE (validating the app as product and at the same time assessing its potential for data collection) there is an immanent contradiction: When a campaign using the app promotes cycling and provides incentives, then the data generated and collected by the app is biased and only to a limited degree usable for planning purposes as it does not represent average behavior.
- **Recommendation 3** – It seems important to have a reasonable number of local partners (shops etc.) in order to make use of the app attractive for users. Thus, it could be good to provide some sort of incentive to local partners too. The campaign as such is not enough to make them want to contribute.

## 3.3 Evaluation Conclusions

### 3.3.1 **Interaction with other measures** (only if relevant)

Concerning the interaction with other measures, the following key conclusions can be drawn:

n/a

### 3.3.2 **Main lessons learned**

Implementing this measure, this are the main lesson learnt, important for future sustainable mobility strategies:

- **Key lesson 1** – Good communication and roll-out is key.
- **Key lesson 2** – Direct contact with potential users is easier and less costly than social media campaigns and at the same time more effective.
- **Key lesson 3** – The number of downloads of the app exceeds the number of active users by far. Apparently, people are initially interested in what the app does, but lose interest before actually using it (→ barrier).
- **Key lesson 4** – A sufficiently high number of local partners is important for the success of the campaign. When contacting them, make sure you talk to the right person in charge.

### 3.3.3 **Long term impact**

Based on the conclusions of the evaluation of this measure in the lifetime of the CIVITAS project, we can conclude the following concerning the long term impact of this measure:

n/a

### 3.3.4 Potentials for transferability in other cities

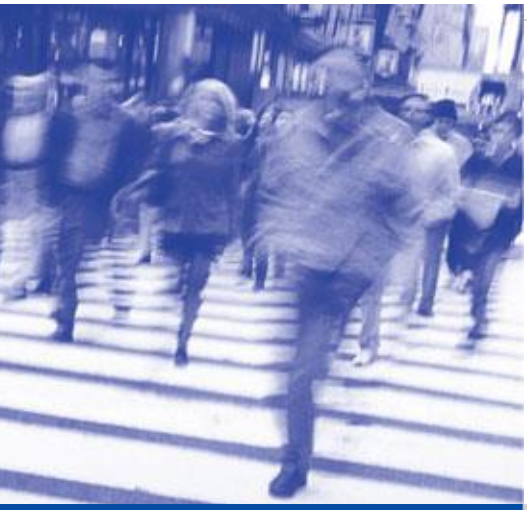
Based on the conclusions of the evaluation of this measure and the available knowledge on the context and challenges of other cities, the following conclusions on the transferability potential of the measure can be made:

- **Key conclusion 1** – The app is suitable and sufficiently flexible to implement Biklio campaigns in other cities. Campaign managers should adapt their campaign to the local needs and settings in order to make it a success in creating a cycling lifestyle, collecting tracking data, raising awareness for sustainable transportation, attracting new customers and increasing customer loyalty or in involving stakeholders.

## 3.4 Annexes and reference documents

The following documents present further details on the evaluation findings (e.g. the evaluation report, a presentation, ..):

- TRACE D7.2 (Final Evaluation Plan)



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# Measure reporting on evaluation approach and evaluation findings

## - RIA projects

| | |
|---|---|
| Measure | Traffic-Snake-Game-Tracker (TSG-T) |
| Short description | Add-on to the classic Traffic Snake Game; tracking the home-school-trip of primary school children |
| | |
| **Report developed by** | |
| Project: | TRACE |
| City/cities | Flanders (BE), Belgrade (RS), Águeda (PT), Sofia (BG), Bologna (IT), Southend-on-Sea (UK) |
| Author(s) | Stephanie Keßler (LuxMobility) |
| Mail address | s.kessler@luxmobility.eu |
| Version | Final |
| Date | 20 July 2018 |
| | |
| ***Template** by* | *CIVITAS SATELLITE* |
| *Review:* | *Dirk Engels, Gitte Van Den Bergh* |

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# 1 Measure description

## 1.1 Objectives of the measure

| Ranking | Objectives | Target group |
|---|---|---|
| 1 | Tracking home-school trips | Primary school children |
| 2 | Assessing the possibility of automatic mode detection | Primary school children |
| 3 | Assessing the value of tracking information for the school | Schools |

## 1.2 Description of the measure: what is implemented ? How ?

### 1.2.1 General

The measure involves the implementation of the following *(ev. in different stages):*

- The aim of the Traffic Snake Game is to encourage primary school children to travel more sustainably to school. The campaign originates from Belgium and is developed by Mobiel 21. Traffic Snake Game is now played in 19 European countries and is typically played for one or two weeks. During the campaign week(s), children that travel sustainably to school receive a small sticker in the form of a dot. All children that receive a sticker paste it onto a large green rectangular sticker and all rectangular stickers are pasted onto the school banner. At the end of the campaign period, the children are rewarded for their efforts to travel sustainably to school with a day without homework, extra playtime or free ice cream.
- In TRACE, tracking was added to the traditional Traffic Snake Game. Based on an extensive stakeholder investigation, Mobiel 21 developed tracking hardware that was suitable for tracking primary school children. The trackers were shock and water resistant, they had a long battery life (20 hours) and the system was plug-and-play. The tracking hardware consisted of ninety trackers and four receivers. The trackers were carried by the children and measured their home-school travels. The receiver was used to read out the data from the trackers and get the data on a server. On the server, a travel mode was added to the GPS tracks. The tracking data were presented on a website trace.trafficsnakegame.eu and each school had a login to consult their data, which consisted of a heat map and a modal split for the school and for each class.
- Each school received the trackers for the children and one receiver. The receiver was plugged in with an Ethernet cable and showed a green light if it made connection with the server. The trackers had to be placed near the receiver every day (at least within 300m of the receiver). The trackers were passed on from one class to the next.

### 1.2.2 **Outputs**

Direct results of the measure *(e.g. buying 10 buses, ..)*:

- Six cities/regions used the TSG-T during their Traffic Snake Game: Flanders (BE), Belgrade (RS), Águeda (PT), Sofia (BG), Bologna (IT), Southend-on-Sea (UK) with a total of 18 schools involved, 1,058 children tracked on their way to or from school.
- The participation rate (number of consent forms sent out to parents divided by the number of forms returned) was 0,55.
- The mode detection performance of the tracker (number of correct mode detections divided by number of children tracked) was 0,60.

### 1.2.3 **Supporting activities** *(if applicable)*

| Supporting activity | Target group(s) | Main objectives |
|---|---|---|
| The tracking took place during the Traffic Snake Game – this is support and bias at the same time! | Primary school children | Influencing the travel behavior for the way to school and back towards more sustainable mode choices |
| | | |

### 1.2.4 **Interaction with other measures**

This measure has a significant interaction with the following measures (including the possible influence on impact and implementation process):

- The tracker was used in the context of the Traffic Snake Game the objective of which is to influence the travel behaviour of children (and their parents) for the way to school. As the game is an incentive/motivation to use another than the usual mode, the tracked data is biased and does not necessarily represent average behaviour. The benefit of the data for the schools can be questioned.

# 2 Evaluation approach

## 2.1 Impacts and indicators

| Impact category / aspects | Expected impacts - Indicators | Data collection methods | Observed groups/areas |
|---|---|---|---|
| **Society-people** | Influence on mode choice, behavior change to more sustainable transport | Tracking and mode detection (normally, hands-up survey) | Primary school children and their parents |
| | | | |
| **Society-governance** | | | |
| | | | |
| **Transport system** | Potentially, the tracked data could be used to visualize the paths used, helping schools to argue for improved infrastructure and safety features | n/a | Schools<br>Local authorities |
| | | | |
| **Economy** | | | |
| | | | |
| **Energy** | | | |
| | | | |
| **Environment** | Less emissions from cars used to drive children to school or pick them up | n/a | Pilot sites |
| | More livable and less dangerous school environments due to less cars | n/a | Pilot sites |
| | | | |

Comments to the table:

(1) The TSG-T pilots run during the TRACE project were done in order to test the functionality and practicability of the tracker and assess the usability of the data collected. Thus, none of the impact categories really applies.

**Additional comments:**

none

## 2.2 Further analysis of data

The following additional analyses are done to optimise and complete the evaluation findings:

- To investigate whether tracking of such a young target group was possible and delivered interesting results for the school, additional measurements were added to the campaign: (a) to check whether automatic travel mode detection was possible, the teacher measured the travel mode of the children carrying a tracker by asking the child how he/she came to school, (b) to check whether the home-school route was accurately tracked, the parent received an email with the route of their child and indicated on a short questionnaire whether the route was accurate, and (c) to check whether the obtained data were useful to the school and whether the workload of a tracking campaign was not too high, interviews with the school were conducted.

## 2.3 Process evaluation activities

The following activities are set in place to understand and assess the implementation process:

- none

## 2.4 Appraisal of evaluation approach

Based on the evaluation work in this project, the following observations and recommendations concerning the evaluation approach seem important for other projects (including specific interesting elements in the approach):

- n/a

## 2.5 Annexes and reference documents

The following documents present further details on the evaluation approach (e.g. the evaluation plan, a presentation, ..) or are used as a reference document for the development of the evaluation approach:

- TRACE D7.1 (Evaluation Plan)

# 3 Evaluation findings

## 3.1 Impact of the measure

### 3.1.1 Results in the CIVITAS impact categories

The impact evaluation results in the following before and after scores of the indicators, changes and interpretations in the relevant impact categories (including figures, graphs and tables):

*These CIVITAS impact categories are not applicable to the TSG-T pilots in TRACE as their objective was to test the device. The later application of the trackers (e.g. in other projects) does in fact aim at having an impact in these categories.*

- **Society – people:**
  n/a

- **Society – governance:**
  n/a

- **Society – transport System:**
  - While the heat maps are powerful tools to improve road safety for instance, the usefulness of the maps can be reduced if the information is not shared. Indeed, the usefulness of the entire approach will be drastically reduced if the school has no contact with other public or private institutions to discuss the outcome and a possible follow-up. Obtaining data is key, but making the best use of the data is important too; it requires an extra step that not all the schools might take.

- **Society – economy:**
  n/a

- **Society – energy:**
  n/a

- **Society – environment:**
  n/a

### 3.1.2 Key impact results

- **Key result 1 – Incompatibility of TSG (classic) and TSG-T** – One important finding concerning the implementation of TSG is the potential incompatibility between the two versions – the classical behaviour change version and the tracking version – as they have different output objectives. The objective of the classical version is to induce a change in mode choice towards more respecting travelling modes for the home-school trip. An important objective of the tracking version is to collect information (GPS location, speed, and mode) on the habitual trip of the pupils. If the two campaigns are combined, the data collected might not be representative of the usual behaviour.

- **Key result 2** – An important aim of TSG-T is the delivery of route information. Thus, **providing high quality data is essential** and some campaign managers have questioned efficiency of the data collection approach. While the vast majority of the parents have indicated that the route taken by the children was correct, some parents have reported incorrect tracking.

- **Key result 3** – Sending **heat maps by mode to schools was appreciated**. This form of output was described as interesting and useful. The campaign managers should provide basic information on the meaning of these maps. For instance, red means more points (high point density) and not more safety risk.

- **Key result 4** – The **accuracy of the automatic mode recognition is not 100%.** This automatic mode detection was clearly a very positive added value of the TSG-T tool. However, because one use of this automatic mode detection tool is to improve the survey data (hands up survey) provided by pupils, accuracy is important. If the accuracy of the automatic mode detection is not better than the accuracy of the hands up survey (which remains unknown) then the benefit of this feature is questionable.

- **Key result 5** – Another remark made by several campaign managers is with regard to **long data delivery time.** While it has to be noted that the delivery time and the data quality are not related at all, it is understandable that receiving data several months after the implementation can be frustrating for both the campaigns managers and the teachers in charge of this project. According to Mobiel 21 this was possibly due to different internet protocols in the different pilot countries, but also to national regulations for plugging in the receivers.

- **Key result 6** – Some campaign managers have questioned the **necessity to provide the trackers to pupils.** Primary school children do usually not decide for themselves how they go to school. In addition, up to a certain age their parents will most likely go with them. Thus, developing a smartphone application could work as well. This would probably simplify the consent process. However, for older children who travel alone, but do not have a smartphone yet, using a tracking device seems mandatory.

## 3.2 Process Evaluation Findings

### 3.2.1 **Barriers**

The following barriers were observed (including actions to overcome these barrier)

- **Barrier 1 –** The data privacy statement partially decreases the participation rate and creates a workload for teachers. Clearly, there is no solution to do without this data privacy statement. It means that extra care should be taken regarding this additional process. Supporting teachers, providing enough time etc. are examples of measures that can help easing the process.
- **Barrier 2 –** The campaign managers have reported some technical issues.
- **Barrier 3 –** In Belgrade three face-to-face meetings per school (twelve in total) were necessary to convince them and provide all the information needed for the campaign.

### 3.2.2 **Drivers**

The following barriers were observed (including actions to make use of these drivers):

- **Driver 1** – The municipality of Águeda was already active in term of sustainable mobility educational activities. This was clearly an asset for the TSG implementation.

### 3.2.3 **Supporting activities**

The following conclusions concerning the supporting activities are drawn:

- In Águeda awareness about TSG was raised via a walking event where 40 pupils from “os Pioneiros” walked a distance of 2600m. Such activity is seen as a great initiative to introduce students to sustainable mobility.
- The final TSG closing event implemented in the 4 schools in Belgrade is an excellent idea to make pupils talk and think about sustainable behaviour. This is a very good educational opportunity. The increase, in terms of percentages, for sustainable mode usage by the pupils increased impressively. In 3 schools out of 4, the original modal split targets have been over performed.
- SRM (Bologna) collaborators and the concerned schools organised parties in each of the institutions to celebrate the end of the campaign. This event that was also attended by the deputy mayor for traffic issues in Bologna is an excellent way to promote sustainable mobility through education and awareness.

### 3.2.4 **Recommendations on the implementation process**

The following recommendations can be given:

- **Recommendation 1** – Patience and anticipations are two essential elements that SRM (Bologna) collaborators took well into consideration. Indeed, the first communication regarding the implementation of the TSG campaign took place 7 months before the implementation. This permitted to solve issues (communication issues with the schools for instance) without influencing the entire implementation process.

## 3.3 Evaluation Conclusions

### 3.3.1 **Interaction with other measures** (only if relevant)

Concerning the interaction with other measures, the following key conclusions can be drawn:

- n/a

### 3.3.2 **Main lessons learned**

Implementing this measure, this are the main lesson learnt, important for future sustainable mobility strategies:

- **Key lesson 1** – TSG-T generates a much higher workload than the classic version of TSG.
- **Key lesson 2** – The tracker should have some sort of display or status LED and an on/off and a reset button; further, the device is considered too big and needs too many cables.

### 3.3.3 Long term impact

Based on the conclusions of the evaluation of this measure in the lifetime of the CIVITAS project, we can conclude the following concerning the long term impact of this measure:

- n/a

### 3.3.4 Potentials for transferability in other cities

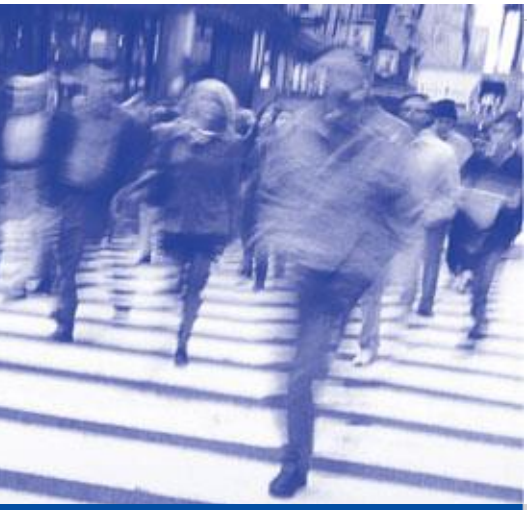
Based on the conclusions of the evaluation of this measure and the available knowledge on the context and challenges of other cities, the following conclusions on the transferability potential of the measure can be made:

- **Key conclusion 1** – Basically, the TSG-T is transferable to other cities/schools. However, the added-value of tracking the pupils' home-school-trips does not outweigh the extra workload for campaign managers and teachers. Take-up cities/schools should be well aware of the difference in objective and output of the tracking version compared to the classic version of TSG. Only if the school is interested in obtaining data on the mobility behavior of the children they should opt for the tracker. With regard to the promotion of sustainable mobility through education and awareness both versions have their role.

## 3.4 Annexes and reference documents

The following documents present further details on the evaluation findings (e.g. the evaluation report, a presentation, ..):

- TRACE D7.2 (Final Evaluation Plan)



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# Measure reporting on evaluation approach and evaluation findings

## - RIA projects

| | |
|---|---|
| Measure | TATtoo (Tracking Analysis Tool) |
| Short description | A tool to analyse tracking data for urban mobility planning and policy making, using the data produced by the other TRACE apps (Biklio, Positive Drive), but also by any other commercial app that tracks people's trips. |
| | |
| **Report developed by** | |
| Project: | TRACE |
| City/cities | n/a |
| Author(s) | Stephanie Keßler (LuxMobility) |
| Mail address | s.kessler@luxmobility.eu |
| Version | Final |
| Date | 1 August 2018 |
| | |
| ***Template** by* | *CIVITAS SATELLITE* |
| *Review:* | *Dirk Engels, Gitte Van Den Bergh* |

TRACE
WALKING AND CYCLING TRACKING SERVICES

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# 1 Measure description

## 1.1 Objectives of the measure

| Ranking | Objectives | Target group |
|---|---|---|
| 1 | Support for decision makers at local level (urban planning) by turning data into valuable information, i.e. informed decision making by offering stakeholders relevant information on the use of their walking and cycling infrastructure, enabling them to identify needs and problems, prioritize actions and evaluate measures. | Urban planners, city representatives, politicians |
| 2 | | |
| 3 | | |

## 1.2 Description of the measure: what is implemented ? How ?

### 1.2.1 General

The measure involves the implementation of the following *(ev. in different stages):*

- Based on the GPS trajectories collected not only by the TRACE apps (like Biklio and Positive Drive) but also by any other commercial apps that track people's trips, TAToo performs a "map matching" operation that allows the characterization of the flows over the mobility network.
- This "map matching" operation consists in the allocation of the recorded trajectories into the nodes, links and zones of the network, creating the possibility of allocating location trajectories given by points into concrete links and nodes where each person/vehicle has passed. Map matching is more widely developed for car traffic, for which there is a higher demand of congestion information and data availability. Since pedestrians and cyclists have different characteristics of behaviour, the challenge of map matching is different, thus it was a challenge associated to the development of the tool to develop an appropriate map matching algorithm.

### 1.2.2 Outputs

Direct results of the measure *(e.g. buying 10 buses, ..)*:

- The tool has been tested with data sets from different apps and different cities in the framework of TRACE.
- The tool works on OSM format maps; a conversion tool for other formats comes with the tool.
- A trajectory conversion tool is available for data from other sources.

- Another auxiliary tool is related to the desire of each city to use its own zoning system. This means that the indicators related to the starting and ending zone of each trip and to the characteristics of trips between two zones are calculated considering the polygons that each user understands to be more useful.

### 1.2.3 **Supporting activities** *(if applicable)*

| | Supporting activity | Target group(s) | Main objectives |
|---|---|---|---|
| | none | | |
| | | | |
| | | | |

### 1.2.4 **Interaction with other measures**

This measure has a significant interaction with the following measures (including the possible influence on impact and implementation process):

- n/a

# 2 Evaluation approach

## 2.1 Impacts and indicators

| Impact category / aspects | Expected impacts - Indicators | Data collection methods | Observed groups/areas |
|---|---|---|---|
| **Society-people** | | | |
| | | | |
| | | | |
| **Society-governance** | Better (informed) decision making on cycling and walking infrastructure | Stakeholder interviews at city level | Urban planners, politicians etc. |
| | Usability | Stakeholder interviews at city level<br>Online questionnaire | Urban planners, civil engineers |
| | | | |
| | | | |
| **Transport system** | At strategic level (and in the long run): Walking and cycling (infrastructure development etc.) will benefit from better informed decision making; thus, improve the conditions for pedestrians and cyclists | (theoretically) User satisfaction | |
| | | | |
| | | | |
| **Economy** | | | |
| | | | |
| | | | |
| **Energy** | | | |
| | | | |
| | | | |
| **Environment** | At strategic level (and in the long run): Walking and cycling (infrastructure development etc.) will benefit from better informed decision making; thus, improve the conditions for pedestrians and cyclists and promoting these modes | (theoretically) Modal split | |
| | | | |

Comments to the table:

(1) The tool development in TRACE has been evaluated through stakeholder interviews. Whether the tool can successfully contribute to better infrastructure planning could potentially be evaluated at a later point. At the moment it is too early.

## 2.2 Further analysis of data

The following additional analyses are done to optimise and complete the evaluation findings:

- Naturally, the outputs have been tested for plausibility and their value for urban planning (technical evaluation).

## 2.3 Process evaluation activities

The following activities are set in place to understand and assess the implementation process:

- There was no process evaluation. However, the project partners were involved in the development process of the software tool. They have been asked to test the tool at various stages and provide feedback and report any bugs.

## 2.4 Appraisal of evaluation approach

Based on the evaluation work in this project, the following observations and recommendations concerning the evaluation approach seem important for other projects (including specific interesting elements in the approach):

- The expectation of the user were very high, leading to disappointment and negative evaluation although the objectives of the development set beforehand have mostly been met.

## 2.5 Annexes and reference documents

The following documents present further details on the evaluation approach (e.g. the evaluation plan, a presentation, ..) or are used as a reference document for the development of the evaluation approach:

- TRACE D7.1 (Evaluation Plan)

# 3 Evaluation findings

## 3.1 Impact of the measure

### 3.1.1 Results in the CIVITAS impact categories

The impact evaluation results in the following before and after scores of the indicators, changes and interpretations in the relevant impact categories (including figures, graphs and tables):

- **Society – people:**
  - n/a

- **Society – governance:**
  USER SATISFACTION
  - **Installation and usage**
    - The number of steps to install and run TATOO was one of the biggest throwbacks that threatened the successful usage of the tool. Only two out of the six pilot cities that tried to use TATOO managed to install it correctly, run the engines and extract results from it. Indeed, the number of additional software needed for those who aren't familiar with these kinds of programs is considerable. Some partners described the installation process as easy, but time demanding.
    - TATOO (VBA language) does not run in non-Microsoft, open access environments.
    - TATOO needs a 64-bit version of MS Windows, no chance to run it in a 32-bit version.
    - The average score for the user manual was 5,25 (from 1 to 10).
    - Users found that additional IT knowledge (database and GIS) was needed to install and use the tool.
    - The trajectory conversion tool needs some time for processing during which it is not responding.
  - **Running data and results**
    - Most questions of the partners that they wanted the tool to answer could be answered.
    - Most partners reported the results to be representative.
    - Some partners reported erroneous results basically due to "some extreme customization of OpenStreetMap" and to wrong mode recognition by the apps.
  - **Overall analysis and further improvements**
    - Overall, TATOO is recognized as potentially useful to communication with the responsible decision-makers of each city.
    - The different partners clearly believe in the future influence of a tool like TATOO in planning and policy processes in the future
    - Success would depend on data quality and quantity, as well as on privacy issues.
    - One partner stated the need of "a proper tool", since it will allow "to plan small and concrete projects with a citizen participative approach" and "facilitate the dialog between all involved stakeholders".
    - List of required improvements: Handling and usability, user-friendliness and intuitiveness, easier installation and improved manual (with improved "error section"), adaptation for another programming language (independent of Microsoft and

allowing bigger data sets), less experienced stakeholders would rather pay for the analyses than buying a stand-alone tool, the experienced ones prefer a stand-alone software to run their big data sets and make their own analyses.

- **Society – transport System:**
  - No evaluation done for the potential impact the TATOO has on the transport system.
- **Society – economy:**
  - n/a
- **Society – energy:**
  - n/a
- **Society – environment:**
  - n/a

### 3.1.2 Key impact results

- **n/a**

## 3.2 Process Evaluation Findings

### 3.2.1 Barriers

The following barriers were observed (including actions to overcome these barrier)

- **n/a**

### 3.2.2 Drivers

The following barriers were observed (including actions to make use of these drivers):

- **n/a**

### 3.2.3 Supporting activities

The following conclusions concerning the supporting activities are drawn:

- **n/a**

### 3.2.4 Recommendations on the implementation process

The following recommendations can be given:

- **n/a**

## 3.3 Evaluation Conclusions

### 3.3.1 **Interaction with other measures** (only if relevant)

Concerning the interaction with other measures, the following key conclusions can be drawn:

- n/a

### 3.3.2 **Main lessons learned**

Implementing this measure, this are the main lesson learnt, important for future sustainable mobility strategies:

- **Key lesson 1** – The objectives of the tool development have been met. Not surprisingly, the most difficult and less accomplished objective is related to the user-friendliness and usability of the tool individually by local stakeholders

### 3.3.3 **Long term impact**

Based on the conclusions of the evaluation of this measure in the lifetime of the CIVITAS project, we can conclude the following concerning the long term impact of this measure:

- **Key expectation 1** – The tool is available in the CIVITAS toolbox (http://civitas.eu/tool-inventory/tatoo-tracking-planning-tool). If others are using it and provide feedback to the developers, it can be further improved.
- **Key expectation 2** – The local use of the tool can lead to better infrastructure planning for walking and cycling.

### 3.3.4 **Potentials for transferability in other cities**

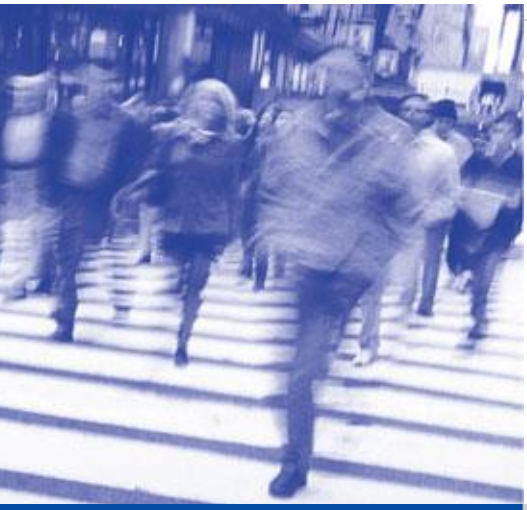
Based on the conclusions of the evaluation of this measure and the available knowledge on the context and challenges of other cities, the following conclusions on the transferability potential of the measure can be made:

- **Key conclusion 1** – The TAToo can be used by any city using OpenStreetMap data and making use of the trajectory conversion tool to feed in tracked data from any tool.

## 3.4 Annexes and reference documents

The following documents present further details on the evaluation findings (e.g. the evaluation report, a presentation, ..):

- TRACE D7.2 (Final Evaluation Plan)



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# Measure reporting on evaluation approach and evaluation findings

## - RIA projects

| | |
|---|---|
| Measures | Reallocation of public space (Munich) |
| Short description | Feasibility study of the Arcisstrasse Art Boulevard. The FLOW modelling and assessment activities in Munich focused on pedestrian crossing measures. |
| | |
| **Report developed by** | |
| Project: | FLOW |
| City/cities | Munich |
| Author(s) | Gitte Van Den Bergh, Kristin Tovaas |
| Mail address | k.tovaas@rupprecht-consult.eu |
| Version | Final |
| Date | 16/07/2018 |
| | |
| ***Template** by* | *CIVITAS SATELLITE* |
| *Review:* | *Dirk Engels, Gitte Van Den Bergh* |

flow

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# 1 Measure description

## 1.1 Objectives of the measure ? Why ?

| Ranking | Objectives | Target group |
|---|---|---|
| 1 | Improving walkability and urban qualities of the *Kunstareal* | Pedestrians crossing the site |
| 2 | | |
| 3 | | |

## 1.2 Description of the measure: what is implemented ? How ?

### 1.2.1 General

Munich chose Arcisstrasse, located within the city's Kunstareal (art district) as its FLOW study area. The Kunstareal is the home of various universities, museums, monuments, memorial sites and art galleries. It is located approximately 1 km northwest of the city centre.

In the Kunstareal, FLOW tied in to an ongoing development process (http://projekt.kunstareal.de) which aims to improve the public appearance, urban qualities and external and internal accessibility of the Kunstareal and to strengthen cooperation between the institutions located in the district.

An idea developed early in the Kunstareal process and documented in the overall strategy is the creation of an “Arcisstrasse Art Boulevard”. This measure is intended to create an attractive walking axis with a high urban quality that directly connects several of the most prominent institutions and landmarks within the art district as well as the district as a whole towards the main railway station, thereby improving walkability and orientation within the Kunstareal. As these goals fit very well with Munich's aims for the FLOW project, Arcisstrasse was selected as the FLOW study area.

Apart from the overall strategy, a further milestone of the Kunstareal project was the Bürgergutachten (citizen panel), carried out in 2013. During a four-day moderated working process, 100 randomly selected citizens developed guidelines for the further development of the Kunstareal. Transportation was a major issue in this process. Accordingly, the guidelines in the context of FLOW and the Arcisstrasse Art Boulevard are:

- traffic calming,
- priority for pedestrians and cyclists,
- improved crossings of the major roads.

Independent of the FLOW project, Munich's city council approved the implementation of a new traffic scheme for the major roads of the Kunstareal. According to this scheme, two parallel roads, Gabelsberger Strasse and Theresienstrasse, which cross Arcisstrasse and currently operate as two-lane one-way roads, are to be partially converted to bidirectional traffic. In addition, Gabelsberger Strasse will gain cycle lanes in both directions (currently there are none). This traffic scheme was finalised during the FLOW project period by Munich's construction department and will be implemented after final approval by the city council.

One expected side effect of this new traffic scheme (calculated within a traffic impact study by means of a macroscopic transport model in 2012, before the beginning of FLOW in which walking and cycling were not

modelled) is an increase of traffic on Arcisstrasse between Gabelsberger and Theresienstrasse from approximately 6,500 to 9,500 cars/day.

Another issue – probably the most critical one, with regard to a final vote in favour of the scheme – is parking: the new traffic scheme might lead to a loss of a large number of parking spaces mainly along Theresien- and Gabelsberger Strasse. It is not clear, yet, whether this side effect will be politically accepted or whether implementation will be postponed until a solution for compensating these parking spaces is found.

In this context, the scope of FLOW was to contribute to a **feasibility study** of the Arcisstrasse Art Boulevard. Concrete measures were suggested, visualised, communicated and tested with regard to their impacts on the local traffic conditions and compatibility with ongoing projects.

In a first step, **example measures were developed** within FLOW **based on established German planning guidelines** by the German Road and Transport Research Association (FGSV). Key measures suggested and assessed within FLOW were:

- crossing median between Technical University main entrance and Alte Pinakothek museum (see Figure 62),
- additional pedestrian crossings between Brienner and Gabelsberger Strasse,
- on-street cycle lanes and widened sidewalks
- improved safety and comfort for pedestrians and cyclists,
- reduced road space (thereby contributing to traffic calming)

Figure 62: Crossing median in front of TUM and a pedestrian crossing between Brienner and Gabelsberger. Strasse

**Use the FLOW modelling tools**

The FLOW modelling and assessment activities in Munich focused on pedestrian crossing measures in the section of Arcisstrasse between Gabelsberger and Theresienstrasse, where the main entrance of Munich's Technical University is located.

Specifically, PTV Vissim/Viswalk was used in order to model **several design scenarios** for the relevant segment of Arcisstrasse, compare different solutions of designing pedestrian crossings and focus on the

evaluation of travel time balances over all affected modes. The scenarios differ with regard to right-of-way (pedestrian or car), type of crossing aid, and car speed (30 km/h or 50 km/h).

In accordance with the FLOW project scheme, Munich used the Vissim/Viswalk modelling software for the FLOW project. Munich's transport planning unit did not own this software before FLOW and thus did not have prior experience or existing models; therefore, a new Vissim/Viswalk model of the study area around Arcisstrasse was developed and the measures described below were implemented in this model. In the development of the model the new traffic scheme was used as the modelling baseline, as it is expected that this scheme will soon become the status quo for any further planning for the Arcisstrasse Art Boulevard. This means that the situation as it exists today with Gabelsberger and Theresienstrasse as two-lane one-wayroads was not modelled.

| | **Right-of-way** | **Type of crossing aid** | **Car speed** |
|---|---|---|---|
| **Scenario 1** | car | Punctual kerb extension (baseline) | 50 |
| **Scenario 2** | car | Extended kerb extension | 50 |
| **Scenario 3** | car | Divided kerb extension | 50 |
| **Scenario 4** | car | Punctual median refuge | 50 |
| **Scenario 5** | car | Extended median refuge | 50 |
| **Scenario 6** | car | Extended median refuge | 30 |
| **Scenario 7** | pedestrian (zebra crossing) | Punctual kerb extension | 50 |

### 1.2.2 Outputs

Direct results of the measure:

A Vissim/Viswalk multimodal model that includes cars, cyclists and pedestrians.

### 1.2.3 Supporting activities

| Supporting activity | Target group(s) | Main objectives |
|---|---|---|
| Local Forum: inform about and discuss the FLOW measures for the Arcisstrasse Art Boulevard with local stakeholders at an early stage of the process | targeted group of invited stakeholders: technical representatives from the departments of the city administration and the State of Bavaria that are involved; local politicians as well as representatives of institutions and citizens' groups involved in the Art District Project | opportunity to present and discuss the developed measures to/with selected stakeholders<br><br>stimulating dialogue and networking between various stakeholders |

### 1.2.4 Interaction with other measures

No interaction with other measures.

# 2 Evaluation approach

## 2.1 Impacts and indicators

With regard to the FLOW conceptual framework, the assessment of the crossing measures focused mainly on the aspect of transport network performance with an additional eye on traffic safety. This approach is due to the local political discussion which circles mostly around the conflicting interests of (car) transport performance vs. pedestrianisation and urban design; this discussion needed custom-fit evidence from the model.

The key questions were whether these measures result in significant travel time benefits for pedestrians and whether magnitudes of benefits can be achieved (balanced over all modes) that justify the implementation of the measures. Therefor a Cost-Benefit Analysis (CBA) was carried out.

| Impact category / aspects | Expected impacts - Indicators | Data collection methods | Observed groups/areas |
|---|---|---|---|
| **Society-people** | | | |
| | | | |
| | | | |
| **Society-governance** | | | |
| | | | |
| | | | |
| | | | |
| **Transport system** | Delay (travel time) | Output transport model | Pedestrians |
| | Safety (Reduction of injured and killed persons) | Estimation | |
| | | | |
| **Economy** | Investment costs | | |
| | | | |
| | | | |
| **Energy** | | | |
| | | | |
| | | | |
| **Environment** | | | |
| | | | |
| | | | |
| | | | |
| | | | |

## 2.2 Further analysis of data

The following tools were used for evaluation:

- **FLOW's Multimodal Transport Analysis Methodology of Urban Road Transport Network Performance (MTAT)** is a tool for evaluating the impacts of cycling and walking measures on transport network performance and congestion.

  The FLOW Multimodal Transport Analysis Methodology uses key performance indicators to operationalise its multimodal definition of transport network performance and congestion in terms of

travel time and the relationship between the demand for and supply of road space. The KPIs describe the state of traffic flow for all traffic participants, thereby enabling the analysis of transport network performance for all modes. The KPIs are (based on FGSV 2015 - German Road and Transport Research Association):

- **Delay** – the additional travel time experienced by a traffic participant compared to the minimum travel time from origin to destination.
- **Density** – a measure of the number of persons or vehicles using a given space.
- **Level of service (LOS)** – a measure reflecting the quality of service experienced by traffic participants at different levels of infrastructure use (i.e. more or fewer people travelling).

These indicators can be used for local (e.g. a road segment or a junction) or network level analysis and can be calculated for each transport mode separately.

For Munich's FLOW study area, it turned out that the application of the multimodal transport analysis tool in the context of the pedestrian crossing situation across Arcisstrasse was not yielding useful results.

According to the FLOW methodology, a transport facility can be assessed as either a road segment or a junction. In the first case, **density** should be used as a performance indicator, in the latter case, **travel time**. In the Munich study case, the focus was on a pedestrian crossing. It was not clear whether such a facility should be treated as a segment or a junction. In traditional traffic engineering language, it is not a junction but treating it as a road segment seemed misleading as well because functionally it is a kind of junction where a pedestrian and a vehicle link intersect. The additional problem in the real world is that vehicle traffic on the segment is mainly influenced by the neighbouring signalised intersections which are only 250 m apart.

In the model, these intersections may have been neutralised in order to be able separate the effects of the pedestrian crossing from the effects from the signalised junctions.

In the application of the FLOW multimodal transport analysis tool, both approaches were tested. It turned out that levels of service (LOS) for both cars and pedestrians were always “A” for all scenarios, meaning that neither the density-based nor the travel-time-based analysis approach provided useful evidence for the planning task because differences between the scenarios did not become visible.

While we concluded that the FLOW Multimodal Transport Analysis Tool is not a suitable method for the particular problem at Arcisstrasse, the City of Munich performed some additional tests of the methodology based on “dummy” data to evaluate its usefulness for planning purposes.

- **FLOW Impact Assessment Tool** reflects the mobility impacts (traffic performance, green row in Table 3), the environmental, societal and economic effects of a measure (orange, blue and yellow rows), and the impacts of the measure on public financing (grey). The first column represents the focus area, while the second represents the scope of what is to be assessed and the third shows the indicator and the unit which is measured. Currently, transport project assessments vary greatly from city to city and many cities have no predefined guidelines or regulations at all. Qualitative data that arises from measures is often neglected due to the difficulties in assessing it. However, such data could significantly influence the value of some policies and measures – particularly walking and/or cycling measures. Depending on the local political objectives and data accessibility, FLOW

offers different approaches to analyse the socio-economic impact indicators. For the Munich measure a Cost-benefit analysis (CBA) was applied.

| Target System | Scope | Indicator | Transport mode | |
|---|---|---|---|---|
| | | | MT | NMT |
| Public Financing | **costs** of (new) infrastructure | **investment costs** [EUR/year - annuity] | | |
| | | **operating & maintenance costs** [EUR/year] | | |
| Traffic Performance | travel time related | **total travel time** [person-h/year; ton-h/year] | X | X |
| Environment | GHG emission & local air pollution | total direct **$CO_2$ emission** [t/year] | X | |
| | | total direct **$NO_x$ emission** [t/year] | X | |
| | | total direct **PM emission** [t/year] | X | |
| | *noise pollution* | *noise level in the daytime [dB/day]** | *X* | |
| | land consumption | sealed surface: **total new / deconstructed traffic area** [-] | X | X |
| Society | traffic safety | number of **persons killed** [no./year] | X | X |
| | | number of (seriously & slightly) **injured persons** [no./year] | X | X |
| | health | **health benefits** based on a reduced probability of death for people who cycle/walk [no./year] | | X |
| | increased access | **accessibility** - increased access of non-motorized residents' to amenities (e.g. jobs) [-] | | X |
| | social interaction | **separation effect** [-] | | X |
| Private Business | vehicle operating costs | **vehicle operating costs** [EUR/year] | X | X |
| | energy consumption | total final **energy consumption** [kWh/year] | X | X |
| | (monetary) attractiveness | commercial attractiveness: **increased retail rents** [EUR/year] | | X |
| | | residential attractiveness: **increased residential rents** [EUR/year] | | X |

**Table 3:** Indicators used in FLOW's impact assessment tool.[5] Source: FLOW project

Experience from various kinds of transport infrastructure measures (mostly road and railway projects) shows that **travel time** gains in many cases are the main driver of positive benefit cost ratios.

The key question for the application of the FLOW impact assessment tool in Munich was whether this logic could also be applied to pedestrian projects. More precisely, we wondered to what extent monetised travel time benefits caused by pedestrian measures (e.g. crossing aids) can economically justify the financial investments required for their implementation.

It was assumed that wider costs and benefits of crossing measures in Arcisstrasse would play a minor role (e.g. there is no residential or commercial use in the immediate surroundings) and that their model-based determination and monetisation is linked with high uncertainties. Therefore, the assessment used only traveltime related benefits for the assessment, with one exception: in a second assessment step, **traffic safety** was added as an assessment criterion, because the

economic cost rates attributed to injuries and deaths are high enough to have a substantial impact on cost-benefit analysis, and traffic safety is a major aspect of both technical and political debates on pedestrian measures.

## 2.3 Process evaluation activities

Not applicable to FLOW; we did not conduct process evaluation

## 2.4 Appraisal of evaluation approach

Based on the evaluation work in this project, the following observations and recommendations concerning the evaluation approach seem important for other projects (including specific interesting elements in the approach):

- While a full-scale model-based multimodal analysis, as carried out in the FLOW cities, may be more appropriate for larger scale projects than individual pedestrian crossings, an **economic assessment with the FLOW Impact Assessment Tool** can also be performed in an explorative manner without extensive data requirements by testing scenarios based on assumptions and rough estimates.
- In Munich, we concluded that micro-models can and should be used where
  1. very complex non-routine planning problems are tackled,
  2. planners want to test different planning parameters and play with input variables and assumptions in a virtual environment,
  3. where a high-quality visualisation of traffic and movement is needed.

## 2.5 Annexes and reference documents

The following documents present further details on the evaluation approach (e.g. the evaluation plan, a presentation, ..) or are used as a reference document for the development of the evaluation approach:

- D1.1 Handbook on indicators measuring congestion reduction in the context of walking and cycling, including discussion of methods and sources used for development
- D2.2 Extended versions of PTV Visum and Vissim software
- D2.3 FLOW Impact Assessment Tool
- D2.4 FLOW Congestion Impact Reduction Analysis Tools Guidelines

# 3 Evaluation findings

## 3.1 Impact of the measure

### 3.1.1 Results in the CIVITAS impact categories

The modelling and assessment process focused on the seven scenarios shown above. Scenario 1 was defined as the baseline scenario and served as the reference case to calculate travel time gains or losses which were determined for scenarios 2-7 by means of the VISSIM/VISWALK simulation. The annuities of the investment costs were calculated for a 30-year period with a 3.0% interest rate.

In the first assessment step, only travel time benefits were considered and compared with investment annuities. The assessment produced the following results:

| **Measure** | **Investment cost** [Euro] | **Annuity** [Euro/year] (30 y., 3.0 %) | **Travel time benefit** [Euro/year] | **Yearly surplus** [Euro] | **Benefit-cost-ratio** |
|---|---|---|---|---|---|
| Extended kerb extension | 60,000 | 3,061.16 | 3,175.98 | 114.82 | 1.04 |
| Divided kerb extension | 30,000 | 1,530.58 | 2,061.11 | 530.53 | 1.35 |
| Punctual median refuge | 30,000 | 1,530.58 | 649.74 | -880.83 | 0.42 |
| Extended median refuge | 75,000 | 3,826.44 | 4,646.47 | 820.02 | 1.21 |
| Extended median refuge – speed limit 30 km/h | 75,000 | 3,826.44 | -27,200.80 | -31,027.24 | –- |
| Zebra crossing | 15,000 | 765.29 | -4,194.42 | -4,959.71 | –- |

Referring to the question of whether investments into pedestrian infrastructure can be economically justified by monetised travel time savings caused by this infrastructure, the main findings are:

- Even in environments with moderate pedestrian flows (in this case approx. 100 peds/peak hour), travel time savings enabled by improved pedestrian facilities are able to amortise the investment cost of such facilities (e.g. crossing aids such as median refuges).
- Additional costs for more expensive solutions that better meet pedestrians' needs (in this case extended or divided solutions as opposed to punctual ones) may also be justified by the additional benefits caused by these improved measures.

- If pedestrian facilities have a negative impact on car traffic flow (e.g. zebra crossing), the travel time losses for car drivers/passengers are likely to outweigh the travel time benefits of pedestrian traffic.
- Car travel time losses due to speed limits (in our case from 50 km/h to 30 km/h) have a very large impact. Large numbers of pedestrians with large travel time savings would be needed to justify such a measure on the basis of travel time savings.

It should be noted that both in the modelling and in the assessment process, many parameters had to be estimated that have an impact on the overall calculation results. All given figures are therefore subject to substantial uncertainty. Results should be treated accordingly.

In the second assessment step, the follow-up question on the impact of traffic safety was investigated. The safety impacts of the measures were not modelled but only estimated. The evaluation of available accident data did not show relevant pedestrian accidents for the last three years; therefore, very small safety effects in the range of 1-2 avoided injuries per 10 years were assumed.

With the inclusion of safety effects, the assessment produced the following results:

| **Measure** | **Avoided light injuries** per 10 years | **Avoided severe injuries** per 10 years | **Traffic safety benefits** [Euro/year] | **Yearly surplus** [Euro] | **Benefit-cost-ratio** |
|---|---|---|---|---|---|
| Extended kerb extension | 1 | 0 | 2,697.82 | 2,812.64 | 1.92 |
| Divided kerb extension | 1 | 0 | 2,697.82 | 3,228.36 | 3.11 |
| Punctual median refuge | 1.5 | 0 | 4,046.74 | 3,165.90 | 3.07 |
| Extended median refuge | 1.5 | 0 | 4,046.74 | 4,866.76 | 2.27 |
| Extended median refuge – speed limit 30 km/h | 1 | 1 | 35,970.98 | 4,943.74 | 2.29 |
| Zebra crossing | 2 | 0 | 5,395.65 | 435.94 | 1.57 |

Our conclusion was that safety measures have a tremendous effect: in the FLOW case study, the range of safety benefits (under the assumption of a very low number of avoided light injuries) is very similar to the range of travel time benefits. As soon as avoided severe injuries or even fatalities enter the game, safety benefits far exceeded pedestrian travel time benefits. Such safety benefits can equal or even outweigh travel time losses for cars due to, e.g., speed restrictions.

## 3.2 Process Evaluation Findings

In principle, FLOW-related measures – i.e., measures that promote walking, cycling and neighbourhood mobility – are supported by a large part of Munich's public and politicians. Problems usually arise when particular projects are defined and effects on traffic flow, parking and sometimes public transport become concrete, e.g. a car (or bus) lane needs to be removed or parking spaces taken away. At that stage, the wellknown "not-in-my-backyard" discussions often make the realisation of measures very difficult.

Many such conflicts (e.g. between traffic flow and pedestrian/cycling measures) are at the heart of what FLOW has been aiming to achieve. However, FLOW does not offer "miracle solutions" to such problems of conflicting interests which are usually zero-sum games where one mode has to give up what is given to another (e.g. new bike lane at the cost of parking spaces).

The value of FLOW therefore cannot lie in offering new technical solutions but in fostering the ability of all involved parties to achieve compromise and consensus. Modelling and assessment can be helpful in that respect by providing evidence and – thinking about simulation – in making traffic flow phenomena that can otherwise only be explained by abstract calculations visible and comprehensible in the form of 3D movies.

However, it also needs sensitivity on the part of the planners in order not to give the impression of trying to prove that someone is right and someone else is wrong: stakeholders who have something to lose will usually only be convinced when their subjective interests are reflected in a given solution.

In other words, while the core challenge of achieving political compromise remains unchanged, FLOW offers new or refined technical instruments to analyse and visualise planning problems which may help to neutralise political controversies if used wisely.

Beyond these political struggles, it must be emphasised that – even in advanced cycling cities like Munich – bicycle and pedestrian infrastructure planning is in many (if not most) cases supply-oriented rather than demand-oriented. Even along major cycling/pedestrian routes, the number of cars is in many cases 3-10 times higher than the number of cyclists (assumingly because of the shorter average length of walking and cycling trips). Assessments based on mode-specific traffic volumes therefore tend to marginalise walking and cycling.

More important than demand-oriented engineering methods are binding quality standards for walking and cycling infrastructure which apply regardless of actual traffic volumes and ideally support a shift from the private car to non-motorised modes. This seems particularly important for cities which are at a very early stage of promoting walking or cycling and have low modal shares for these modes. In Germany, the technical guidelines for urban road design of the FGSV (esp. RASt 2006 – *Richtlinien für die Anlage von Stadtstraßen*) provide such standards on a scientific basis.

Nonetheless, there are certain traffic facilities in Munich where congestion of bicycle and walking facilities is becoming an issue and where multi-modal assessments are needed. While the project's instruments may not yet have achieved a standard at which they can be integrated into routine planning processes, FLOW has made an important step in that direction.

## 3.3 Evaluation Conclusions

### 3.3.1 Main lessons learned

Implementing this measure, these are the main lessons learned, important for future sustainable mobility strategies:

- **Key lesson** – The major finding of the application of the FLOW Impact Assessment in Munich is that investments into pedestrian infrastructure are in many cases well spent and promise to have benefit-cost-ratios well above 1.
  In addition:
  - Travel time benefits alone (without wider costs and benefits and even safety effects) often amount to benefits that exceed the required investment.
  - Moderate pedestrian flows may suffice to achieve a benefit-cost-ratio above 1.
  - Positive safety effects on pedestrians have an enormous impact on the assessment and will in many cases marginalise travel time effects.
  - Due to the high benefit rates attributed to avoided injuries and fatalities, safety effects justify enormous investments as well as significant time losses for motorised traffic.

### 3.3.2 Long-term impact

Regarding the further action on implementing the Art Boulevard Arcisstrasse, it must be emphasised that this project is not primarily a transport but an urban development project. Local priority setting and ambitions concerning future spatial functions and design elements still have to be clarified. These issues comprise much more than just transport and are still under debate among the various stakeholders from the political, administrative and private spheres.

Within FLOW, the feasibility and appropriateness of the suggested measures from the *Bürgergutachten* were assessed. It was shown that walking and cycling measures can be implemented which bring substantial improvements for pedestrians and cyclists as well as spatial gains for urban development while not significantly affecting traffic flow. These measures are based on German transport planning guidelines and economic benefit was confirmed by the FLOW Impact Assessment Framework.

These findings have been and will continue to be communicated to partners and stakeholders and will be presented in the relevant panels and committees in order to further the discussion of what the Art Boulevard could and should be like and how the transport-related issues can be addressed. However, at this point of the process it is not clear how the project as a whole will develop and so it is not possible to define a clear action plan with specific scheduled steps.

Furthermore, as noted above, an obstacle for the implementation of measures in the *Kunstareal* is the loss of parking spaces in the course of putting the new traffic scheme into operation. Although the FLOW measures for the Art Boulevard Arcisstrasse bring only minor losses of parking spaces, it will be politically difficult to bring a new project forward before a final decision on the new traffic scheme has been taken.

Beyond the activities around the Art Boulevard Arcisstrasse, the FLOW findings will also play a role for the recently started process of updating Munich's Transport Development Plan. FLOW successfully proved and highlighted the importance and economic feasibility of improving conditions for pedestrians and emphasized the need for a city-wide walkability and neighbourhood mobility strategy.

### 3.3.3 Potentials for transferability in other cities

What can be learned from the Munich experience, by both German and other European cities, is that the economic and safety benefits of walking and cycling are highly significant and justify substantial investment in walking and cycling infrastructure.

From a technical perspective, transferability of Munich's FLOW results to other cities in Germany should not be a problem: all proposed measures are derived from national planning guidelines. The use of a simulation model in combination with the FLOW impact assessment was an interesting experiment indicating the economic value of the measures. This modelling and assessment procedure is transferable, given cities are able and willing to invest the required resources and gather the necessary data. However, it is not a necessary step for the purpose of developing and implementing appropriate measures. As the cost of measures like the ones planned within FLOW for Munich's Arcisstrasse is manageable, most cities should in principle be capable of implementing them.

However, each city is confronted with its own particular political issues and must find ways of navigating through these processes. Even in one city, you never know how a particular discussion may develop.

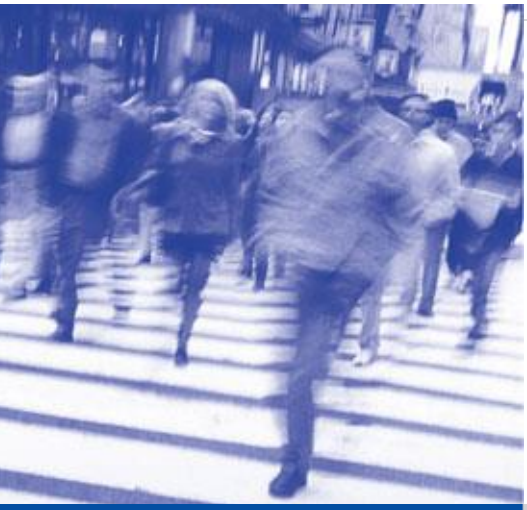
Transferability is therefore always conditional. Taking blueprint solutions from one city and using them in another is not realistic. And the more complex the planning problem, the truer this is.

Nonetheless, planners should communicate and exchange with one another not only about technical aspects but also about processes and successful strategies of persuasion and compromise. It then remains up to the individual planner's judgment, to what extent particular experience gathered elsewhere shows promise of transferability.

## 3.4 Annexes and reference documents

The following documents present further details on the evaluation findings (e.g. the evaluation report, a presentation, ..):

- D3.4 Implementation scenarios and action plans of FLOW partner Cities
- D3.3 Reports on Congestion Busting Forums



CIVITAS 2020
Cleaner and better transport in cities

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# Measure reporting on evaluation approach and evaluation findings

## - RIA projects

| | |
|---|---|
| Measure | Bike to work campaigns (Sofia) |
| Short description | Sofia Urban Mobility Center developed and ran Cycle2Work campaigns in several major companies in Sofia that had a high likelihood that employees would be motivated to try cycling to work. |
| | |
| **Report developed by** | |
| Project: | FLOW |
| City/cities | Munich |
| Author(s) | Gitte Van Den Bergh, Kristin Tovaas |
| Mail address | k.tovaas@rupprecht-consult.eu |
| Version | Final |
| Date | 16/07/2018 |
| | |
| ***Template** by* | *CIVITAS SATELLITE* |
| *Review:* | *Dirk Engels, Gitte Van Den Bergh* |

flow

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# 1 Measure description

## 1.1 Objectives of the measure (or type of measure) ? Why ?

| Ranking | Objectives | Target group |
|---|---|---|
| 1 | **General**: raise the profile of transportation cycling in Sofia through involvement of high profile organisations | |
| 2 | **Short to mid-term**: make cycling more attractive in Sofia | All road users |
| 3 | **Long term**: reduce congestion by increasing cycling | All road users |

## 1.2 Description of the measure: what is implemented ? How ?

### 1.2.1 General

The measure consists of a Cycle2Work campaign that is made up of four steps:


The workplace-based campaigns allow companies to choose from four types of events (see step 3 the schema above) the best ways to promote cycling among their employees:

**Bicycle training**

Bicycle training is targeted at potential new cyclists and is a two-hour cycling training dedicated to safe cycling in urban conditions and learning the best techniques. Gadgets such as reflective ankle straps are distributed to participants with a focus on new cyclists. Trained and certified guides show safe routes to work that avoid busy or congested areas. Participants use their own bikes or bikes rented by the project.

Each participant is required to sign a waiver (common practice for this type of training). The is usually planned in the first week of the campaign.

**Bike tour in the outskirts of Sofia**

This event is customised for each company aiming to gather employees/ teams outdoors. The event can be combined with team-building activities and other company initiatives. Tours are suitable for beginner cyclists and are aimed to offer a short, pleasant cycling journey in the outskirts/suburbs. Group medical insurance is issued as insurers do not issue individual insurance for cyclists. Participants use their own bikes or bikes rented by the project. The event is generally planned in the second week of the campaign on the weekend or at the end of the working day as it takes a few hours.

**Bicycle test rides**

Each company is provided with 10 regular and 1 electrically-supported test bikes for interested employees to try out for:

- Business trips within the city;
- Commuting to work and;
- Riding in their leisure time.

Employees are provided with a cycling manual containing the relevant legal requirements of the Road Traffic Act and cycling tips (e.g. teaching materials provided by a partner NGO). The test bikes, which belong to SUMC, are provided for a period of at least six weeks. Employees signs a waiver in case of damage or theft.

**Cycle2Work competition on cycling kilometres travelled**

In order to add some friendly competition to the campaign and 'gamify' travel behaviour change, a Cycle2Work competition is held throughout the six-week campaign in which teams or individual employees from a company try to cycle the most kilometres or number of days to work. A free smartphone app can be used to register kilometres cycled and compare results within the company. All participants are provided with bike-related incentives and the winners receive a bigger prize (either bike equipment or non-bike related).

The event is generally planned to start in the fourth week of the campaign, after the training for new cyclists has been conducted.

Each campaign runs for six weeks, aiming to inform employees about the available cycling opportunities in Sofia and to improve companies' bicycle-friendliness.

### 1.2.2 Outputs

Direct results of the measure:

Five companies (with in total 7411 employees) participated in the Cycle2Work campaign in 2016 and 2017:

| Company | Employees | Participants in the Cycle2Work campaign | Responses to ex-ante survey | Responses to 1st ex-post survey | Responses to 2nd ex-post survey |
|---|---|---|---|---|---|
| **Bulgarian National Radio** | 1300 | 20 | 71 | 24 | 41 |
| **Telenor Bulgaria** | 2111 | 17 | 21 | 21 | 14 |
| **SAP Bulgaria** | 600 | 20 | 57 | 12 | 17 |
| **DSK EAD** | 2000 | 20 | 9 | 15 | (summer 2018) |
| **SUMC** | 1400 | 25 | 72 | 69 | (summer 2018) |

### 1.2.3 Supporting activities

| Supporting activity | Target group(s) | Main objectives |
|---|---|---|
| Local Forum | Local technical experts in the fields of public space and non-motorised transport – both from the public sector and from NGOs | Provide an opportunity for local practitioners to learn from other FLOW partner cities and to exchange with one another about cycling – and related issues – in Sofia |
| Engaging with local stakeholders | Key stakeholders included the local authority, the project team at the Sofia Urban Mobility Center, local cycling NGOs that promote cycling, the national transport ministry (responsible for transport policy at the national level) and the ministry of regional development (responsible for regional spatial planning) and the participating companies | |

### 1.2.4 Interaction with other measures

There was no interaction with other measures.

# 2 Evaluation approach

## 2.1 Impacts and indicators

| Impact category / aspects | Expected impacts - Indicators | Data collection methods | Observed groups/areas |
|---|---|---|---|
| **Society-people** | | | |
| | | | |
| | | | |
| **Society-governance** | | | |
| | | | |
| | | | |
| | | | |
| **Transport system** | Modal shift | Ex-post and ex-ante surveys | Participants of the programme (employees) |
| | Travel time | Ex-post and ex-ante surveys | Participants of the programme (employees) |
| | | | |
| **Economy** | Investment costs | SUMCs financial data | Participants of the programme (employees) |
| | Operation & maintenance costs | SUMCs financial data | Participants of the programme (employees) |
| | | | |
| **Energy** | | | |
| | | | |
| | | | |
| **Environment** | CO2 emissions over all transport modes | Calculated by using results of ex-post and ex-ante surveys | Participants of the programme (employees) |
| | NOx emissions over all transport modes | Calculated by using results of ex-post and ex-ante surveys | Participants of the programme (employees) |
| | PM emissions over all transport modes | Calculated by using results of ex-post and ex-ante surveys | Participants of the programme (employees) |
| | | | |
| | | | |

**Additional comments:**

- Since the surveys are location specific, no city-wide implications can be assumed. There is also no city-wide information available about potential behaviour changes arising from the campaign because no traffic counts or household surveys were conducted during the campaign.

- In order to evaluate the extent of employees' travel behaviour change and the potential impact on congestion, the ex-ante and ex-post surveys gather data in the following areas:
  - Ex-ante survey: Selected companies' data (number of employees, mobility habits, addresses, age/sex)
  - The first ex-post survey measures participants' short-term travel behaviour change for journeys to work (2 weeks after the campaign ends)
  - The second ex-post survey measures participants' long-term behaviour change. It shows the modal shift as a result of the Cycle2Work campaign.
- The availability of the data needed for the ex-ante survey may vary from company to company, due to their data privacy rules. The data for both ex-post surveys should be readily available but this depends on the proportion of participating employees who complete the surveys. An e-mail is sent to all participants reminding them to fill it out.

## 2.2 Further analysis of data

The following additional analyses are done to optimise and complete the evaluation findings:

- Multi-criteria analysis (MCA) Weighted benefit analysis (WBA)
- Cost-benefit analysis (CBA)
- Qualitative appraisal

In assessing the impact, we had to face the issue of a low response rate to the first ex-post survey. There was a significant drop in responses to the ex-post survey from the ex-ante survey. In order to overcome this, we 1) decreased the number and complexity of questions (meaning a higher completion rate but somewhat less information collected), 2) provided incentives for participants to complete the surveys, 3) used a face-to-face option for completion of the survey at the workplace in addition to the online survey and 4) sent reminders to participants through company-internal contact points to complete the survey.

To extrapolate the behaviour changes from the sample to the whole company, extrapolation factors need to be calculated based on findings 1) for the difference of n between ex ante and ex post survey and 2) for the difference between sample and all employees.

These analyses could also be used to learn about the potential for behaviour change in different groups. It can also be helpful for analysing health aspects. Another option would be to have a control group in other companies that are generally interested in promoting cycling but that do not participate in a specific bike to work campaign in order to better determine the effectiveness of the campaign on mode choice for journeys to work.

## 2.3 Process evaluation activities

Not applicable to FLOW; we did not conduct process evaluation

## 2.4 Appraisal of evaluation approach

Based on the evaluation work in this project, the following observations and recommendations concerning the evaluation approach seem important for other projects (including specific interesting elements in the approach):

- Being able to put figures on the environmental cost-benefit ratio of cycling to work has helped increase the level of importance given to cycling in Sofia.
- **Challenge**: The communication with employees with regard to the follow-up surveys that were necessary for the project's assessment activities was not done well by the companies. There was no follow up and no 'pushing' from the top down. Having received few responses, we altered (shortened, different questions) the ex-post and ex-ante survey mid-way to increase the number of respondents.
- **What we would do differently:** We did not carry out a survey with the employers about their thoughts on the campaign and its results. This would be a good opportunity to learn about the employer's perspective.

## 2.5 Annexes and reference documents

The following documents present further details on the evaluation approach (e.g. the evaluation plan, a presentation, ..) or are used as a reference document for the development of the evaluation approach:

- D1.1 Handbook on indicators measuring congestion reduction in the context of walking and cycling, including discussion of methods and sources used for development
- D2.2 Extended versions of PTV Visum and Vissim software
- D2.3 FLOW Impact Assessment Tool
- D2.4 FLOW Congestion Impact Reduction Analysis Tools Guidelines

# 3 Evaluation findings

## 3.1 Impact of the measure

### 3.1.1 Results in the CIVITAS impact categories

The FLOW impact assessment tool was used to assess the results of the second campaign, i.e. the Cycle2Work campaign which was run at SUMC offices (1400 employees). First the impact was calculated for the people who answered the survey. Then the impact was calculated for all employees of SUMC by extrapolating the data for the whole workforce.

The following input was available:

- Campaign SUMC:
- Total number of employees: 1,400
- Duration campaign (days): 38
- participants:72
- trips/day: 2
- days/year: 200
- Cost of campaign: 23,035 Euro

Data without extrapolation:

| **Before campaign** | Number of people | Total number of single trips/week | % | average travel distance (km) | total travel distance (km)/peak hour[10] | average travel time (min)/peak hour | total travel time (min)/peak hour[11] |
|---|---|---|---|---|---|---|---|
| car users | 18 | 84 | 23.7% | 8.04 | 144.72 | 22.28 | 401.04 |
| cyclists | 3 | 25 | 7.0% | 4.5 | 13.5 | 20 | 60 |
| PT users | 50 | 236 | 66.5% | 7.16 | 358 | 31.2 | 1,560 |
| Pedestrians | 1 | 10 | 2.8% | 2 | 2 | 10 | 10 |

[10] total travel distance (km)/peak hour = Number of people x average travel distance (km)
[11] total travel time (min)/peak hour = Number of people x average travel time (min)

| **During campaign** | Number of people | Total number of single trips/week | % | average travel distance (km) | total travel distance (km)/peak hour | average travel time (min)/peak hour | total travel time (min)/peak hour |
|---|---|---|---|---|---|---|---|
| car users | 11 | 84 | 23.7% | 10.09 | 110.99 | 22.36 | 245.96 |
| cyclists | 18 | 25 | 7.0% | 5.63 | 101.34 | 28.72 | 516.96 |
| PT users | 41 | 236 | 66.5% | 7.58 | 310.78 | 32.8 | 1,344.8 |
| Pedestrians | 2 | 10 | 2.8% | 1.5 | 3 | 15 | 30 |

Data with extrapolation:

| **Before campaign** | Number of people | Total number of single trips/week | % | average travel distance (km) | total travel distance (km)/peak hour[12] | average travel time (min)/peak hour | total travel time (min)/peak hour[13] |
|---|---|---|---|---|---|---|---|
| car users | 350 | 84 | 23.7% | 8.04 | 2814 | 22.28 | 7,798 |
| cyclists | 58 | 25 | 7.0% | 4.5 | 262.5 | 20 | 1,166.6 |
| PT users | 972 | 236 | 66.5% | 7.16 | 6,961.1 | 31.2 | 30,333.3 |
| Pedestrians | 19 | 10 | 2.8% | 2 | 38.9 | 10 | 194.4 |

[12] total travel distance (km)/peak hour = Number of people x average travel distance (km)
[13] total travel time (min)/peak hour = Number of people x average travel time (min)

| **During campaign** | Number of people | Total number of single trips/week | % | average travel distance (km) | total travel distance (km)/peak hour | average travel time (min)/peak hour | total travel time (min)/peak hour |
|---|---|---|---|---|---|---|---|
| car users | 214 | 84 | 23.7% | 10.09 | 2,158.1 | 22.36 | 4,782.5 |
| cyclists | 350 | 25 | 7.0% | 5.63 | 1,970.5 | 28.72 | 10,052 |
| PT users | 797 | 236 | 66.5% | 7.58 | 6,042.9 | 32.8 | 26,148.8 |
| Pedestrians | 39 | 10 | 2.8% | 1.5 | 58.3 | 15 | 583.3 |

## Results of the impact assessment In money

Data without extrapolation:

| | |
|---|---|
| **Sum of all Benefits** | **38.634** |
| **Sum of all Costs** | **11.519** |
| **BCR** | **3,35** |
| **Benefits-Costs [EUR/year]** | **27.115** |

| **Costs** | | | | |
|---|---|---|---|---|
| **Target System** | **Scope** | **Number** | **Indicator** | **Result [EUR/a]** |
| public financing | costs of (new) infrastructure | C1 | Investment costs | 11.519 |
| | | C2 | Operating & maintenance costs | 0 |
| **Sum of Yearly Capitalised Costs** | | | | **11.519** |

| Benefits | | | | | | |
|---|---|---|---|---|---|---|
| **Target System** | **Scope** | **Number** | **Indicator** | **Value without measure [EUR/a]** | **Value with measure [EUR/a]** | **Result - Benefit [EUR/a]** |
| transport network performance | travel time | B1 | total travel time costs over all transport modes per year | 0 | 0 | 0 |
| environment | GHG emission & local air pollution | B2 | total direct $CO_2$ emission costs over all transport modes per year | 38.361 | 33.050 | 5.311 |
| | | B3 | total direct NOx emission costs over all transport modes per year | 11.733 | 10.163 | 1.570 |
| | | B4 | total direct PM emission costs over all transport modes per year | 8.995 | 7.784 | 1.210 |
| society | traffic safety | B5 | total personal costs of fatal accidents over all transport modes per year | 0 | 0 | 0 |
| | | B6 | total personal costs of accidents with injuries over all transport modes per year | 0 | 0 | 0 |
| | health | B7 | health benefits based on a reduced probability of death for people who cycle/walk | 0 | | 0 |
| private business | vehicle operating costs | B8 | total vehicle operating costs over all transport modes per year | 174.075 | 149.986 | 24.089 |
| | energy consumption | B9 | total final fuel/energy consumption costs over all transport modes | 46.487 | 40.032 | 6.454 |
| | (monetary) attractiveness | B10 | Commercial attractiveness: total increased retail rents | 0 | | 0 |
| | | B11 | Residential attractiveness: total increased residential rents | 0 | | 0 |
| **Sum of Benefits** | | | | | | **38.634** |

With extrapolation to the whole company:

| Result | |
|---|---|
| **Sum of all Benefits** | **751.212** |
| **Sum of all Costs** | **11.519** |
| **BCR** | **65,21** |
| **Benefits-Costs [EUR/year]** | **739.692** |

| Costs | | | | |
|---|---|---|---|---|
| **Target System** | **Scope** | **Number** | **Indicator** | **Result [EUR/a]** |
| public financing | costs of (new) infrastructure | C1 | Investment costs | 11.519 |
| | | C2 | Operating & maintenance costs | 0 |
| **Sum of Yearly Capitalised Costs** | | | | **11.519** |

| Benefits | | | | | | |
|---|---|---|---|---|---|---|
| Target System | Scope | Number | Indicator | Value without measure [EUR/a] | Value with measure [EUR/a] | Result - Benefit [EUR/a] |
| transport network performance | travel time | B1 | total travel time costs over all transport modes per year | 0 | 0 | 0 |
| environment | GHG emission & local air pollution | B2 | total direct $CO_2$ emission costs over all transport modes per year | 745.900 | 642.637 | 103.263 |
| | | B3 | total direct NOx emission costs over all transport modes per year | 228.146 | 197.619 | 30.527 |
| | | B4 | total direct PM emission costs over all transport modes per year | 174.896 | 151.364 | 23.531 |
| society | traffic safety | B5 | total personal costs of fatal accidents over all transport modes per year | 0 | 0 | 0 |
| | | B6 | total personal costs of accidents with injuries over all transport modes per year | 0 | 0 | 0 |
| | health | B7 | health benefits based on a reduced probability of death for people who cycle/walk | 0 | | 0 |
| private business | vehicle operating costs | B8 | total vehicle operating costs over all transport modes per year | 3.384.789 | 2.916.396 | 468.393 |
| | energy consumption | B9 | total final fuel/energy consumption costs over all transport modes | 903.906 | 778.409 | 125.498 |
| | (monetary) attractiveness | B10 | Commercial attractiveness: total increased retail rents | 0 | | 0 |
| | | B11 | Residential attractiveness: total increased residential rents | 0 | | 0 |
| Sum of Benefits | | | | | | 751.212 |

The results of both campaigns are very positive according to the cost-benefit analysis. The positive results are mainly due to:

- lower (environment) costs related to $CO_2$ emissions
- the decrease in vehicle operating costs
- reduction in energy consumption

**Conclusion**

At first glance, the results of the FLOW impact assessment appear unrealistically positive, especially when looking at the impact of extrapolated numbers. But in calculating the benefit for each extra cyclist, the figures do indeed seem reasonable, meaning that there is huge potential gain by increasing the number of people who cycle to work in Sofia.

| | |
|---|---|
| cost-benefit/year | 27,115 Euro |
| number of extra cyclists thanks to campaign (=18 cyclists during campaign - 3 before campaign) | 15 |
| Cost-benefit per cyclist/year | 1,807.70 Euro |

## 3.2 Process Evaluation Findings

The following recommendations can be given:

- Offering testing bikes was important. This helped to convince companies to participate, and company bikes convinced employees to take part in the campaign.
- Companies were very open to the idea as “green” ideas improve the image of the company. Because of the campaign, companies found out there is a niche for employees cycling to work.
- The short-term Cycle2Work campaign includes a yearly plan for carrying out the campaigns. The yearly planning is important for optimal usage of the bicycles as some of the campaigns could run in parallel.
- Planning the campaigns in advance can also support activities such as European Mobility Week and other cycling events at a city level. Some maintenance time must always be considered between campaigns.
- Weather influences the campaigns although the experience of the project demonstrated that the influence is not as strong as expected. Six weeks has been an optimal period for a single campaign but if there is a demand for longer campaigns, this can also be accommodated.

## 3.3 Evaluation Conclusions

### 3.3.1 Main lessons learned

Implementing this measure, these are the main lessons learned, important for future sustainable mobility strategies:

- **Key lesson 1** – In general, the Cycle2Work campaigns have been a great success. The companies were interested and still are. There is currently a high demand to continue the Cycle2Work campaigns.
- **Key lesson 2** – The Cycle2Work campaigns really brought cycling to the attention of companies. They now know they can act themselves and influence their employees’ commuting behaviour. Some companies took it a step further after the campaign was finished and bought company bikes. Cycling to work has become a topic of discussion in companies.

### 3.3.2 Long-term impact

There is a high demand from companies who have not yet participated, to take part in a Cylce2Work campaign. As such there is potential to extend the campaigns to more companies (not only those with 1000+ employees). And based on the outcome of our impact assessment and on the reaction of

participants (both companies and employees), we intend to continue carrying out Cycle2Work campaigns in the coming years. These are a popular activity and promise to be an effective means of increasing the number of people who cycle to work in Sofia.

We feel the Cycle2work campaign, which demanded a relatively small investment, could have a large impact in the long term.

Analysing the results and adapting the surveys from the first campaigns improved the response rate. The campaigns could be easily adjusted to meet specific needs and targets. Some follow-up initiatives could be carried out, such as bike-to-work day or bike-to-school day.

The main challenges which Cycle2Work campaigns will face are the lack of cycling infrastructure close to working/residential place and the distant locations of newly established business zones in the city outskirts which are more difficult to reach by bicycle. Here, the Ministry of Regional Development and Public Works is an important stakeholder as it is responsible for conducting a reform of the country's development, the territorial spatial planning, i.e., the zoning that allows businesses to locate far from their workers.

As success factors for the long-term behaviour change, the employers' commitment to continue encouraging cycling among the employees is very important. The e-bikes (pedelecs) used in the campaigns have proven to be a "game changer" by encouraging cycling to more distant locations and streets where dedicated cycling infrastructure is lacking. We will encourage employers to invest in pedelecs for their employees' use – or perhaps as an alternative to a company car.

As a result of the SUMC involvement in the FLOW project, the city included a measure for encouraging cycling (among many others) in its cycling strategy: Campaigns with employers on the territory of Sofia Municipality to encourage the use of bicycle transport by their employees. This is important as educational and promotional activities and creative and positive messages and campaigns are crucial to the uptake of cycling by noncyclists.

We are aware from other European cities that campaigns alone are not enough to encourage large numbers of people to switch from driving to cycling. Safe and attractive infrastructure is also needed. As such, our recommendations for decision makers for upscaling our cycling campaigns in Sofia include a focus on infrastructure. This includes recommendations to:

- Ensure better and safer conditions for bicycling,
- Establish a seamless bicycle network,
- Create safer conditions for cycling,
- Provide better bicycle parking.

Although many of these actions are already being considered in Sofia in the General Plan for Traffic Organisation in Sofia, we hope that the attention gathered by the Cycle2Work campaigns will help to put a focus on the needs of cyclists in the city so that even the challenging measures can be carried out.

### 3.3.3 Potentials for transferability in other cities

Cycle2Work campaign are not new; they have been organised in many other countries and cities across Europe, proving that the method is transferable. But there are still many cities in Europe that have not had the resources – or the interest – to pursue such a campaign. What was important in Sofia, a city that currently has a low rate of cycling, was:

- The ability of the organiser to make the event attractive by providing bicycles to participants – many of whom didn't have their own.
- The offer of related team-building and campaign activities to encourage participants and to make them feel comfortable on their bikes.
- The buy-in of major local employers.

But there are some local factors to take into account, which can influence the success of the campaign:

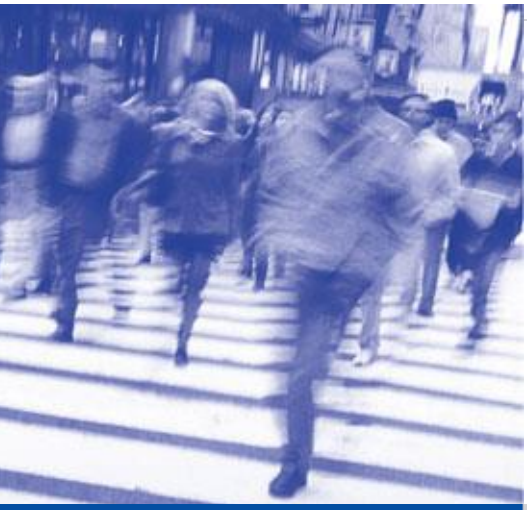
- Implementation methodology: Depending on the available budget, the implementation methodology can be different.
- Topography: Hills can certainly influence travel behaviour. On the other hand, electric bicycles can be at least a partial an answer to this.
- Weather conditions can impact participation in a Cycle2Work campaign. It will be more difficult to realise an increase in cycling when it is cold and rainy (or extremely hot). People are more easily convinced to try out cycling in better weather seasons. On the other hand, the survey carried out in Sofia indicated that weather wasn't as important as some claim it is. It can – but shouldn't – be used as an excuse not to carry out a campaign.
- Spatial planning and road infrastructure have an effect on travel behaviour and the attitude of the road users towards different modes. The better the cycling infrastructure, the easier to convince people to cycle. For this reason, the appropriate ministries and departments need to be included as important stakeholders; they have the capacity to increase cycling significantly. Cycle2Work campaign data can provide them with important information on (potential) cycle routes and the needs of cyclists. This data can be used in future transport models to assess the needs of all modes equally. As these decision-makers become aware of the congestion-reducing potential of cycling, the planning decisions they make may start to change.

Cycle2Work campaigns could easily be implemented successfully in other Bulgarian cities. Offering test bikes is essential to convince companies to participate. In some cities the lack of cycling infrastructure could decrease participation short-term but could make a long-term difference as more local stakeholders begin to appreciate the needs for better cycling infrastructure. For example, some national level regulations concerning 30 km/h zones and contra-flow for cyclists could encourage and attract more employees and companies to participate.

## 3.4 Annexes and reference documents

The following documents present further details on the evaluation findings (e.g. the evaluation report, a presentation, ..):

- D3.4 Implementation scenarios and action plans of FLOW partner Cities
- D3.3 Reports on Congestion Busting Forums



2020 CiViTAS
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# Measure reporting on evaluation approach and evaluation findings

## - ELIPTIC project

| | |
|---|---|
| Measures | 1) Safe integration of e-buses into existing electric public transport infrastructure through recharging them “en route” and upgrading trolleybus networks with battery buses or trolleyhybrids and automatic wiring/de-wiring technology<br>2) Smart energy management upgrade of electric public transport systems for rail<br>3) Multi-purpose use of electric public transport infrastructure |
| Short description | This report describes the evaluation process of three use cases, each associated with one of the three different types of measures (also called Pillars) above reported |
| | |
| **Report developed by** | |
| Project: | ELIPTIC – Electrification of Public Transport in Cities |
| City/cities | Brussels; Oberhausen and Gdynia |
| Author | Maria Vittoria Corazza |
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| Version | Final |
| Date | July 30th 2018 |
| | |
| ***Template** by* | *CIVITAS SATELLITE* |
| *Review:* | *Gitte Van Den Bergh* |

eLIPTIC
electrification of public transport in cities

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# 1. INTRODUCTION

Within ELIPTIC (2015-2018) 20 new concepts were developed to optimise existing electric public transport infrastructure and rolling stock. ELIPTIC deployed such new concepts on 21 use cases in 11 cities across Europe, to demonstrate that the further take-up of electric vehicles can be done in a cost-efficient way, with tangible effects on the urban environment. Evidence was collected via the development of the above mentioned innovative use concepts within 3 Thematic Pillars (Table 1) which represent core technologies for the full up-take of electrification in Europe; these are:

- *Pillar A* - safe integration of electric buses using existing electric public transport infrastructure, through the assessment of potential replacement of diesel buses with trolley-hybrids or electric buses, with a focus on opportunity (re)charging operations (fast or overnight), exploiting tram or metro local infrastructure.
- *Pillar B* - innovative energy storage systems to increase operational efficiency, by the recovery of braking energy from light rail or tram networks, or the conversion of a dismissed rural line into a light rail one
- *Pillar C* - multi-purpose use of electric public transport infrastructure, via the possibility of supplying energy to other types of electric modes (commercial vehicles, passenger cars, taxis).

| ELIPTIC Use Cases | Pillar A<br>Safe integration of electric buses using existing electric public transport infrastructure | Pillar B<br>Innovative energy storage systems to increase operational efficiency | Pillar C<br>Multi – purpose use of electric public transport infrastructure |
|---|---|---|---|
| Bremen (Germany) | Operation-optimized system of opportunity charging at bus depots* / ** | Recuperation of braking energy from trams: Refurbishment of a flywheel energy storage system** | Extension of existing multimodal mobility hub stations** |
| London (United Kingdom) | Opportunity (re)charging of electric buses and/or plug-in hybrid buses (using metro infrastructure)** | | Use of metro sub-station for (re)charging transport operator's electric utility vehicles and zero-emission taxis* |
| Barcelona (Spain) | Optimized braking energy recovery in light rail network* | | Use of metro/tram infrastructure for recharging electric vehicles** |
| Brussels (Belgium) | Progressive electrification of hybrid bus network, using existing tram and metro infrastructure** | Optimised braking energy recovery in light rail network** | |
| Warsaw (Poland) | Use of /tram infrastructure for recharging electric -buses* / ** | | |
| Leipzig (Germany) | Opportunity (re)charging of electric buses (using tram infrastructure) * | | Use of tram network sub-station for (re)charging electric vehicles ** |
| Oberhausen (Germany) | Opportunity (re)charging of electric buses (via tram catenaries and sub-stations) * | | Fast-charging stations for electric vehicles powered from the tram network * |
| Gdynia (Poland) | a) Opportunity (re)charging of electric buses connecting the local agglomeration based on trolleybus infrastructure* | Optimised braking energy recovery in trolleybus network ** | |
| | b) Replacing of diesel bus lines by extending trolleybus network with trolley-hybrids * / ** | | |
| Eberswalde (Germany) | Replacing diesel bus lines by extending trolleybus network with trolley-hybrids (incl. automatic (de)wiring)* | | |
| Szeged (Hungary) | Replacing diesel bus lines by extending trolleybus network with trolley-hybrids* | | Multipurpose use of infrastructure for (re)charging trolley-hybrids and electric vehicles** |
| Lanciano (Italy) | | Conversion of rural line into tram** | |

** demonstrator* *** feasibility study*

*Table 1. The Eliptic Use Cases per Technological Pillar*

## 1.1 The evaluation methodology

The ELIPTIC use cases were demonstrators (with operations tested in real urban scenarios), feasibility studies, or both (Table 1). Such variety of cases called for two specific requirements in the evaluation of results: cross-case comparability of results, and comprehensive analysis including more impact areas. It also called for an assessment of the innovations implementation process itself, given the technological and operational efforts required to carry out the testing activities and feasibility studies. To meet all such requirements, the ELIPTIC assessment methodology was two-pronged: on the one hand, it was aimed at evaluating the performance results achieved (the so-called "Impact Evaluation") and, on the other, the implementation process and the experiences in the different use cases (the "Process Evaluation"). The integrated interpretation of results from both assessments was needed to provide a comprehensive understanding of the effectiveness of the ELIPTIC innovative measures. Evaluation studies on performance variations usually encompass the need to: have an independent assessment of results, develop a set of evaluation criteria and indicators consistent with the performance levels to measure, and eventually coordinate a common procedure to collect data to "feed" the indicators. The ELIPTIC evaluation methodology was no exception: a series of more than 100 Key Performance Indicators – KPIs was issued, divided into five main evaluation categories: *Operations, Energy, Economy, Environment* and *People*, each subdivided into more impact areas. The framework of such methodology was based on previous successful assessment procedures (developed within CIVITAS Initiative, ZeEUS and EBSF) and adapted to have the selected KPIs coherent with the three Pillars gist. Moreover, the methodology had to consider that along with the "conventional" demonstrators', also outcomes from the feasibility studies needed to be assessed. If for the former, a classical "before-vs-during" comparison of results could be performed, for the latter being no actual implementation, a different but comparable assessment was required. The ELIPTIC evaluation process, therefore, relied on two specific tasks: the "Full Conventional Evaluation" for the use cases with demonstrators and the "Technical Viability Evaluation" for the use cases based on feasibility studies. Common to both was the creation of the "NO ELIPTIC", i.e. a reference scenario for each use case, built on the local KPIs values and additional information, to describe the situation prior to the ELIPTIC innovations.

The "Full Conventional Evaluation" also included the creation of an "ELIPTIC scenario" based on the demonstrators' performance of the ELIPTIC innovations, still built on via the local selection of KPIs. Such "before-vs-during" performance comparison also included a Cost Benefit Analysis, to assess the cost effectiveness of the ELIPTIC measures.

The "Technical Viability Evaluation for the feasibility-study use cases, banking on the NO-ELIPTIC scenario as a knowledge base, relied on the development of a SWOT analysis to highlight drivers, barriers and prospects of the ELIPTIC innovative concepts, thus enabling to stress elements of strength and weakness and potential opportunities and threats, useful to assess the possibility of a full uptake of the ELIPTIC innovations.

To conclude a transferability exercise was performed for all the ELIPTIC measures.

Unlike other CIVITAS projects which involve multimodal mobility measures and the enforcement of sustainable-driven policies, ELIPTIC was specifically focused on transit and more specifically on operations linked to the electrification of public transport and the optimization of infrastructure and rolling stock *already in service*, as drivers to reduce costs and save energy. For this reason, the Use Cases local selection of Evaluation Categories, Impact Areas and KPIs, although comprehensive, was affected by that. In average, each measure relied on a set of 20 KPIs.

In this report, the overall extent and the crux of the ELIPTIC Evaluation activities will be reported by describing one use case per each pillar in section 2, and more specifically:

- Pillar A – Gdynia Use Case: Replacing of diesel bus lines by extending trolleybus network with trolley-hybrids
- Pillar B – Brussels Use Case: Optimized braking energy recovery in light rail network

- Pillar C – Oberhausen Use Case: Fast-charging stations for e-cars powered from the tram network

In section 3, to increase the comprehensiveness of the general evaluation findings, results including all the ELIPTIC use cases will be reported.

# 2 MEASURE DESCRIPTION and EVALUATION APPROACH

## *a) Gdynia Use Case - Replacing of diesel bus lines by extending trolleybus network with trolley-hybrids (Pillar A)*

### a.2.1 Objectives of the measure

| Ranking | Objectives | Target group |
|---|---|---|
| 1 | explore the possibilities of further public transport electrification in the area (aka Tricity, including the cities of Gdansk, Sopot and Gdynia) basing on the concept of replacing current diesel bus lines with battery trolley hybrids or e-buses, both charged in motion from a trolleybus infrastructure and going off line to cover former diesel bus routes. | Whole community |
| 2 | investigate technical potential of hybrid trolleybuses (in synergy with the possibility to progress with the outputs already achieved within CIVITAS DYN@MO project, especially for battery-operated supply) | PT Operator |
| 3 | set the requirements for charging trolley hybrid trolleybuses from trolleybus catenary allowing for replacing diesel buses with battery trolley hybrids. | PT Operator |
| 4 | comply with local strategies in the field of sustainability | Whole community |

### a.2.2 Description of the measure: what is implemented?

#### a.2.2.1 General

The measure involves the possibility to improve the local trolleybus network in order to identify potential routes for extending the existing trolleybus service with trolley-hybrid buses running independently on Li-Ion batteries. The concept of trolley-hybrid buses running in autonomous mode on battery traction is a key element of this use case. The feasibility study was (partly) already validated by CIVITAS-DYNAMO data evaluating the running demonstration for extending trolleybus operation on line 21 to service the new central area in Gdynia (extension by 2 km) without catenary connection. Such an operation run since May 2015 within CIVITAS DYNAMO project but was to be extended within ELIPTIC project.

Based on the extended test for trolleybus line 21 an initial set of requirements (technical and economical) was prepared, as a background for the ELIPTIC application. Such set was focused on highlighting the potential for charging trolley hybrid trolleybuses from trolleybus catenary allowing for replacing diesel buses with battery trolley hybrids. The analysis was carried out on the basis of registrations from vehicles of the *PKT Gdynia* operator.

There are numerous situations in Gdynia public transport system where battery trolleybuses function on bus routes, using for charging purposes the overhead contact line which covers the common sections of the routes of both vehicles. Such situation happened on the largest scale from 29th June to the 1st July 2016 when, in connection with the organization of the great event, namely Open'er Music Festival, there was a considerable shortage of vehicles in diesel bus transport, and in order to remedy the challenge trolleybuses equipped with high-capacity lithium-ion batteries were servicing some bus routes in Gdynia and Sopot, for example routes S, 159 and 172.

Using their auxiliary drive, the vehicles were able to cover long sections of the routes, sometimes as much as 29 km. This allowed for creating a measurement database concerning the operation of battery trolleybuses with considerable use of auxiliary drive and applying this data as guidelines when dimensioning the public transport routes.

The registered data from three of the newest trolleybuses type Solaris Trollino 12 MEDCOM, belonging to the fleet of PKT Gdynia, have been successfully used for a thorough analysis. The values for the catenary and battery operational modes, as well as the values of energy consumption for traction purposes and the total energy consumption value have been set on the basis of the acquired data. What has also been established was the energy consumption for the catenary supply with fast battery charging switched on. The measurements were collected by GPS logger devices installed in trolleybus vehicles.

The measure focused on pre-selected bus lines operated by diesel vehicles. The selection of criteria was conducted by different stakeholders asked by the University of Gdansk. Representatives of academia, operators, public transport authorities and consultancy companies were asked to weight 6 components covering spatial, economic, technical and exploitation issues of operations. Using Multicriteria Analysis, only few bus lines for potential replacement were thus selected. Of them, a special focus was on line 181 which covers the area of two cities, Sopot and Gdynia, whereas the bus lines operate across Gdynia area, only. Line 181 is an all-week line (this bus line works every day, as well as weekends and holidays). The bus route is 13,09 km long (26,18 km in both directions). The section without the catenary is 5,30 km long (from Sopot Reja to Kacze Buki) and 4,86 km long (from Kacze Buki to Sopot Reja. Total coverage of trolleybus catenary for the bus line 181 is ca. 61%.

A number of operational features and requirements were surveyed and measured (e.g. battery levels and energy consumption according to mileage) during different test sessions.

The trolleybuses covered, on battery supply, legs ranging between 0.5 km and 29 km. Battery charging from the traction network took place during the operation. This enabled the collection of data which made possible to establish boundary parameters of both battery and catenary drives for the vehicles charged:

Based on that, it was possible to assess

- The dependence between the length of autonomous drive and the degree of battery discharging resulting from it, based on the analysis of the sections covered by the vehicle with battery supply.
- The dependence between the degree of battery discharging and the required time for charging batteries from the catenary, based on the route section covered by the vehicle with catenary supply.
- Consequently, the dependence between the degree of traction battery recharging and the distance required for battery recharging based.

Measurement results led to technical conclusions, e.g. such as those in the field of the estimation of the charging times and the minimum relative length of a route under the catenary for other operational conditions. In the case of charging vehicles in the system used in the test, with the use of trolleybus collectors, current capacity of these collectors constitutes a limitation. As obsrved, the maximum charging currents in motion and during stopping time are 200 A and 150 A respectively, which corresponds to respective charging power of 120 kW and 90 kW. These values should therefore be regarded as boundary values for the tested system. In the case of charging with the power of 120 kW, it is sufficient to cover only 22% of the route length with catenary. The above measurements refer to springtime, when energy consumption is 1.3 kWh/km. During the winter season the total energy consumption may increase even to 2.3 kWh, which results in a greater degree of traction battery discharging and longer charging time. In such a case, using a 120 kW charger, it is necessary to cover 33% of a route with catenary, while in the case of currently used charging systems, this value rises to 46%.

### a.2.2.2 Outputs

Direct results of the measure can be summarized as follows:

- Acquisition of new trolleybus rolling stock (expected Autumn 2018-Winter 2019) would enable for regular operations of trolleybus replacing diesel bus on the line 181. Becouse of the fact that majority of diesel buses operating on line 181 are articulated, the full replacement is not possible;
- The city of Sopot expresses an interest in increasing volume of no-emission vehicle kilometres of public transport organized by the ZKM Gdynia (public transport authority). However, the challenge to be solved is still higher cost of full vehicle-km of trolleybus than diesel bus of comparable passenger capacity;
- Good coverage of existing catenary for the route of line 181 in Sopot and Gdynia makes regular trolleybus operations feasible, safe and undisturbed, even in winter period as well during hot summertime and topography of the route is complex. No additional infrastructure investments are needed;
- The question to be solved in the future is management and daily maintenance of bigger number of trolleybuses in the loop of Kacze Buki;
- ELIPTIC project influenced strategic documents recently passed by Gdynia City Council, providing political support for further electrification of its supply;

Next steps would include detailed investigation of:

- Replacement of other diesel bus lines located in neighbouring communes;
- Extension of trolleybuses to new areas and districts without catenary. Service should be based on hybrid trolleybuses with at least Li-Ion batteries;
- Re-routing of existing trolleybus lines to cover areas without catenary.

### a.2.2.3 Interaction with other measures

This measure is strictly interrelated with the other similar measures tested in Eberswalde and Szeged within the ELIPTIC Pillar A (Table 1); at local level it complements the other measure tested in Gdynia, concerning the opportunity (re)charging of electric buses connecting the Tricity agglomeration based on trolleybus infrastructure. The shared outlook is to assess the viability of introducing more electrification to save energy.

## a.2.3 Gdynia evaluation approach

The overall selection of Gdynia KPIs covered more evaluation categories, with *Operations* (namely *Staff, Supply* and *Maintenance*) and *Economy* (*Costs*) as core fields. It was also not negligible the importance attached to the impacts on energy consumption. However, the amount of KPIs selected for the No Eliptic scenario was slightly different from that of the ELIPTIC one.

### a.2.3.1 Impacts and indicators

The selection for the No ELIPTIC scenario is reported in Table 2.

Within the No-ELIPTIC scenario, for what concerned *Operations*, most of the data were collected on a weekly basis, over a four-month period (from March to June 2016). However, the No – ELIPTIC scenario relied on a sound consistency of the service as KPI *Osu2 - Service Coverage* was assumed to be associated to a fleet of 75 operational trolleybuses per day, over a 300 working-day annual period. As regards to Economy, general operating costs (Eco1) were calculated for the whole fleet, including non-operational vehicles. Similarly, *Eco6 – Vehicle Capital Costs* reported an average value including the depreciation per total number of vehicles (although Eco6 unit of measurement was to be defined on vehicle basis, the value provided for the whole fleet was still interesting, as it reports the range of expenditure requested for a metropolitan area). To be noted that depreciation, as also for *Eco7 – Vehicle Capital*

*Costs without Battery*, was calculated on the basis of the ratio between the initial value of vehicles and their period of depreciation, which up to now was equal to 12.5 years, whereas in the future is expected to be 15 years. *Eco 20 – Residual value of battery* was reported as almost 0, as in case of Ni-CD items, they are very unattractive for further use after 5-7 years of operations. Same value was reported *for Eco22 - Recharging infrastructure* as recharging was via catenary during daily operations, therefore no additional costs were involved. *Eco 27 - Fuel cost* was 0 as traction was totally based on electric energy (no data were provided for the diesel vehicles), which also explained the value of *Ecn3 – Usage of clean vehicles*, which was referred to the trolleybus fleet powered by electric energy. *Ecn 9 - Electricity consumption* was referred to the same period of Osu2 - Service Coverage above reported, but to a slightly larger fleet (89 units instead of 75). For what concerned *Ecn 10 - Electricity from renewable sources consumption*, the provided value in percentage was referred to the company supplying electricity, whose sources were 17% from hydropower, 15% from biomass and 10% from wind.

Gdynia also considered the possibility to assess environmental impacts in terms of noise (by Eno1 – Noise exposure) and emissions (by Eem1 - CO2 emissions); however, for the NO-ELIPTIC scenario for the former no data were available, whereas for the latter a lack of emissions was reported.

Along with that a selection of local Context Parameters was strictly focused on describing operations, including:

- Fleet composition (Unit)
- Operational vehicles (Unit)
- Battery-only range (km/veh)
- Vehicles operational time (h/day)
- Distance driven (route) (km/day)
- Distance driven (total) (km/year)
- State of charge of the battery at the end of operations (% per vehicle)

If the ELIPTIC Scenario is considered (with measurements progressing from January 2017 on), from the comparison with the No ELIPTIC one, *Operations* performance did not vary, with exceptions *Oma10 - Ratio of non working vehicle,* decreasing from 15 to 12.4 %; the service coverage (*Osu 2*) was unaffected (assuming for the ELIPTIC scenario 78 operational trolleybuses daily over a 300 working-day annual period, whereas for the No ELIPTIC one 75 units were calculated) and so were the other KPIs.

As regards to *Economy*, general operating costs (*Eco1*) slightly increased, in line with the introduction of new operations/performance, but it is expected a reverse trend once the novelty shifts into regular operations. *Eco6 – Vehicle Capital Costs,* as the average value including the depreciation per total number of vehicles and not including the depreciation for the infrastructure, also increased along with *Eco7 - Vehicle capital costs without battery,* even if the latter in a more modest way. As for the No ELIPTIC scenario, *Eco 7* was calculated on the basis of the ratio between the initial value of vehicles and their period of depreciation. Therefore, to have comparable values, the same timeframe for depreciation was established (12,5 years). Trends for residual value of vehicles in 10 and 15 years (*Eco 18* and *19*) increased, whereas that for batteries (*Eco 20 – Residual value of battery)* did not and still remained close to zero; reasons for this relies on the assumption made already for the No ELIPTIC scenario: in case of Ni-CD items, these are very unattractive for further use after 5-7 years of operations. Same trend was described for *Eco22 - Recharging infrastructure* as recharging is via catenary during daily operations, therefore still no additional costs were involved.

| Evaluation Category | Impact area | KPI # | KPI Name | Unit of measurement | Reference for measurement | period of collection (No ELIPTIC) | frequency of collection (D=daily, W=weekly, M=monthly; O=one-off; Ot=Other, specify) | Data Collection Procedure |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | available stats/database |
| Operations | Staff | Ost1 | Driving staff | man/vehicle | day | Mar' 16- Jun' 16 | W | X |
| | | Ost2 | Drivers workload | man-month/vehicle | month | | | |
| | | Ost3 | Maintenance staff | man/vehicle | day | | | |
| | Supply | Osu2 | Service coverage | km/veh | day | | | |
| | Maintenance | Oma1 | Vehicles failures | events/traveled km | month (possibly year to improve accuracy) | | | |
| | | Oma9 | Durability of vehicles | % | Eliptic demo timeframe | | O | |
| | | Oma10 | Ratio of non working vehicles | % | month (possibly year to improve accuracy) | Mar' 16- Jun' 16 | M | |
| Economy | Costs | Eco1 | Operating cost (general) | kEURO/vehicle | month | | | |
| | | Eco6 | Vehicle capital costs | kEURO/vehicle | | | | |
| | | Eco7 | Vehicle capital costs without battery | kEURO/vehicle | | | O | |
| | | Eco8 | Battery capital cost | kEURO/kWh | | | | |
| | | Eco8 | Battery capital cost | kEURO/kWh | | | | |
| | | Eco18 | Residual value of vehicles (10-years) | kEURO/vehicle | 10 years | | | |
| | | Eco19 | Residual value of vehicles (15-years) | kEURO/vehicle | 15 years | | | |

*Table 2 – Gdynia KPIs*

*Cont. Table 2*

| Evaluation Category | Impact area | KPI # | KPI Name | Unit of measurement | Reference for measurement | period of collection | frequency of collection (D=daily, W=weekly, M=monthly; O=one-off; Ot=Other, specify) | Data Collection Procedure |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | available stats/database |
| Economy | Costs | Eco20 | Residual value of battery | kEURO/kWh | battery lifetime | | O | X |
| | | Eco22 | Recharging infrastructure | kEURO/per charging operation | Eliptic demo timeframe | | | |
| Economy | Costs | Eco24 | Electricity costs for traction | kEURO/vehicle | month | Mar' 16- Jun' 16 | M | |
| | | Eco25 | Electricity costs for non traction | kEURO/vehicle | month | | | |
| | | Eco27 | Fuel costs | kEURO/MJ | month | | | |
| Energy | Consumption | Ecn 3 | Usage of clean vehicles | % | month | | yearly | |
| | | Ecn 5 | Fossil fuel (liquid) consumption | MJ/vehicle | day | Mar' 16- Jun' 16 | M | |
| | | Ecn 6 | Fossil fuel (gas) consumption | MJ/vehicle | day | | | |
| | | Ecn 9 | Electricity consumption | MJ/vehicle | day | | | |
| | | Ecn 10 | Electricity from renewable sources consumption | MJ/vehicle | day | | yearly base | |

### a.2.3.2 Process evaluation activities

The process evaluation of ELIPTIC assessed project activities in order to identify barriers and drivers during the implementation phase of all use cases. Data was collected through surveys, individual semi-structured interviews (face-to-face and via telephone) as well as pillar-specific focus groups, with use case managers and local evaluation managers. The interviews and focus groups were held at different stages throughout the project; the starting phase of the project, the interim stage and the final stage. The questions were adapted to the specific project phases, and focused on status, impacts, successes and problems in the implementation of use cases. All interviews and focus groups requested critical reflection on project processes as well as recommendations from use case and evaluation managers. Before analysing, the data were encrypted to protect the informers' identities. Using the Qualitative Data Analysis software NVivo, all interviews and focus group notes were thoroughly assessed and coded. Patterns in the data were identified and similar statements were sorted into drivers and barriers within the following categories:

- *Cooperation and Communication;*
- *Operation;*
- *User Perceptions;*
- *Spatial planning;*
- *Financial Framework;*
- *Political Framework;*
- *Regulatory Framework;*
- *Environmental Conditions*

As part of the data analysis, the frequency of occurrence of key themes in the data was counted in order to indicate the relevance of the respective themes. The findings of the process evaluation portrayed drivers and barriers on a use case cluster level that were agreed upon with the other supporting partners within the evaluation group. The findings will serve as the basis for information and recommendations for other European cities in the implementation of electric public transport measures

## a.2.4 Appraisal of evaluation approach

Based on the evaluation work in this measure, some issues can be highlighted:

- Given the technical quality of the measure, a mix of KPIs and other technical indicators was required; the former to ensure comparability with the other similar use cases within Pillar A, the latter to assess performance in the field of battery functions and charging operations, which during the evaluation stressed the need to have more comprehensive set of local indicators (not necessarily usable elsewhere) .
- As in other use cases, data to feed both series of parameters were (unexpectedly) not easy to collect, thus affecting the quality of the evaluation; however, the local demonstrator partners brilliantly overcome difficulties.
- Although initially planned, in the end the possibility to include environmental indicators is thwarted by the lack of specific data and surveys, especially when it comes to the assessment of noise.

## a.2.5 Reference documents

Corazza, M.V., Musso, A. (2017). *ELIPTIC* – Del. *3.3 Full Conventional Evaluation, the reference results*

Corazza, M.V., Musso, A. (2018). *ELIPTIC – Del. 3.6 Evaluation of findings and transferability potential at European level*

Wyszomirski, O., Bartlomiejczyk, M., Jagiello, A., Wolek, M., Woronowicz, M. (2018). *ELIPTIC – Del. 2.16 Gdynia Final Use Case Report*

# b) Brussels Use Case - Optimized braking energy recovery in light rail network (Pillar B)

## b2.1 Objectives of the studied measure

| Ranking | Objectives | Target group |
|---|---|---|
| 1 | estimate the amount of energy dissipated in the tram braking resistors | PT Operator |
| 2 | study solutions to capture and reuse this energy | PT Operator |

## b.2.2 Description of the measure: what is *to be* implemented ?

This use case is actually a feasibility study, with no actual implementation within ELIPTIC.

### b.2.2.1 General

The Use Case consisted of a feasibility study aiming at evaluating the opportunity to install braking energy recovery systems for the Brussels Tram Network, operated by STIB. Based on a previous positive experience of studying and installing braking energy systems for its metro lines, STIB was interested in calculating the potential for its tram network.

The specific objectives of this Use Case were aimed at: i) grasping the operational implications of braking energy recovery solutions, and ii) evaluating the financial costs and benefits of such technologies.
The study brought direct results related to:

- Impacts on tram traction substations
- Impacts on STIB electrical grid
- Impacts on tram vehicles and potential on-board storage solutions
- Evaluation of the energy recovery potential for the global tram network based on the simulations done on the representative lines
- Evaluate the financial costs and benefits of such technologies.

According to the technical outcomes achieved, STIB was able to evaluate the financial benefits, based on a cost-benefits analysis of braking energy recovery technologies, as well as the environmental benefits of the technologies.
The operational implications have been analysed for both the vehicles themselves and the traction infrastructure (traction infrastructure, electrical network …).
Three tram lines were studied to provide insights on the potential of braking energy recovery technologies for the local tram network, and three technology families were considered:

1. Reversible sub-stations can send back the energy collected from the overhead wires to the grid.
2. Mobile energy storage systems with batteries or super capacitors can collect the braking energy and sent it back to the vehicle during the next acceleration.
3. Stationary energy storage systems with batteries or super capacitors located as close as possible to the main breaking / accelerating area (stops, traffic lights,…) or in the sub-stations buildings.

Such three lines were representative of the diversity of STIB's tram network were selected. These lines differ in terms of topology, urban density, vehicle speed and load:

- **Ligne 7**: Line with a good recovery potential due to its separate lane, a high speed and rather high load.
- **Ligne 19:** Urban line with a high load – it also goes through several very urban zones.
- **Ligne 94**: Line with a variable profile, with an important load from Louis to ULB, followed by a lower load section.

### b.2.2.2 Outputs

Although the results of the study have unfortunately shown that the tram network in Brussels is very dense and interconnected, this Use Case brought very interesting inputs to STIB. Local tram network's high density and interconnection mean that a lot of braking energy is already exchanged between vehicles, and that the portion of wasted energy is very low. The business case for recovering braking energy from tram is hence not positive.
The corollary to this is that the Brussels tram network has been well designed and is already very efficient.
The ELIPTIC use case has however enabled to study deeper the potential of improving the energy efficiency of the tram network, in other areas than braking energy recovery.
The lessons learned for this project lead towards direct actions that will improve the efficiency of tram vehicles and network, and reduce CO2 emissions.

### b.2.2.3 Interaction with other measures

This measure is interrelated with the other ELIPTIC feasibility study involving Brussel case study concerning the local progressive electrification of hybrid bus network, using existing tram and underground electric infrastructure, both coherent with the ELIPTIC goal to assess electrification potential for local transit systems.

## b.2.3 Brussels evaluation approach

As a feasibility study, the evaluation of this use case relied on the creation of a No-ELIPTIC scenario as baseline, and the ensuing SWOT analysis to assess the overall energy saving potential of the measure. All of the above was in synergy with the measurements and simulations run by the local demonstration team to assess technical parameters such as the consumption of vehicles and substations and the voltage fluctuations on the line where the vehicle is running, or model operational patterns, such as predicting the substations load with heavier traffic conditions, or assessing the effect of introducing braking energy recovery technologies such as energy storage systems or reversible substations.

### b.2.3.1 Impacts and indicators

For what concerns the selection for the No ELIPTIC scenario, this is reported in Table 3. As expected, such selection focuses on KPIs to report possible operational and energetic variations due to the introduction of the local energy recovery system. Moreover, 16 additional context parameters were added to characterize substation operations, the energy consumption features specifically related to braking operations, and the related energy savings.
The three key areas of interest are *Operations, Energy* and *Economy* and impacts expected in the field of: *Staff, Supply, Maintenance Service, Demand; Costs*; and *Consumption*, respectively. Coherently, they are also reflected in the SWOT analysis, which highlighted the following elements of:
*Strength*

- Technology concept is ready for full commercial application, key components are market available, global standards of hardware, software and interfaces are established
- The application of the technology concept does not influence the reliability and availability of the tram network, whereas the energy efficiency can be increased (avg.: amount of used recuperated braking energy by 3%)

| Evaluation Category | Impact area | KPI # | KPI Name | Units of measurement | Reference for measurement | Availability of KPI/data from control line/vehicle/fleet before the demonstration | No ELIPTIC scenario | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Start | End | Frequency D=daily, W=weekly, M=monthly O=one-off; Ot=Other |
| Operations | Staff | Ost1 | Driving staff | man/vehicle | day | X | | | O |
| | | Ost2 | Drivers workload | Workload required to drive a vehicle | FTE | X | | | O |
| | Supply | Osu1 | Passenger capacity (line) | pass/h | peak time | X | | | O |
| | | Osu2 | Service coverage | km/veh | day | X | | | O |
| | | Osu3 | Daily supply | places/veh | day | X | | | O |
| | | Osu5 | Peak vehicles requirement | veh/route km | peak time | X | | | O |
| | Maintenance | Oma9 | Durability of vehicles | years | Eliptic demo timeframe | x | | | O |
| | Service | Ose2 | Bus frequency | events/h | peak time in working day | X | Nov'15 | Dec'15 | D |
| | | Ose3 | Dwell time | seconds | peak time in working day | X | Nov'15 | Dec'15 | D |
| | | Ose6 | Journey time | min | peak time in working day | X | Nov'15 | Dec'15 | D |
| | | Ose7 | Round trip time | min | peak time in working day | X | Nov'15 | Dec'15 | D |
| | | Ose8 | Operation time | h/vehicle | month | X | Nov'15 | Dec'15 | D |
| | Demand | Ode1 | Passenger demand | passkm | monthly | X | | | |

*Table 3 – Brussels KPIs for the No ELIPTC scenario*

*Cont. Table 3*

| Evaluation Category | Impact area | KPI # | KPI Name | Units of measurement | Reference for measurement | Availability of KPI/data from control line/vehicle/fleet before the demonstration | No ELIPTIC scenario | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Start | End | Frequency D=daily, W=weekly, M=monthly O=one-off; Ot=Other |
| Economy | Costs | Eco6 | Vehicle capital costs (for all different vehicles: E-bus / diesel bus, 12m / 18m version etc.) | kEURO/vehicle | | | | | |
| | | Eco24 | Electricity costs for traction | kEURO/vehicle | month | X | | | O |
| | | Eco25 | Electricity costs for non traction | kEURO/vehicle | | | | | |
| | | Eco26 | Electricity costs for facilities | kEURO/vehicle | | | | | |
| | | Eco27 | Fuel costs | kEURO/MJ | | | | | |
| Energy | Consumption | Ecn 1 | Vehicle fuel efficiency | MJ/vkm | | | Nov'15 | Dec'15 | D |
| | | Ecn 4 | Fuel consumption | MJ/vehicle | Day | | Nov'15 | Dec'15 | |
| | | Ecn 9 | Electricity consumption | MJ/vehicle | day | | Nov'15 | Dec'15 | O |

*Weakness*

- No tram substation in Brussels currently provides a positive business case in order to be upgraded to a reversible substation

*Opportunities*

- Reversible substations in the tram grid offer several synergy potentials, among them load balancing in the tram energy supply grid as well as public distribution grid
- Legal framework in terms of energy and grid, environment as well as safety does not constitute a barrier for the implementation and operation, given the public transport operator owns a high voltage grid
- (Local) politics and authorities as a main stakeholder are active supporters, having a moderate influence on the implementation and operation of the technology concept, however there is currently no direct support

*Threat*

- Reversible substations can become partly obsolete due to improved energy storage solutions (e.g. batteries, supercapacitors, flywheels) installed on-board or along the track
- Available space for the installation of reversible substations is a potential barrier
- Reasonable application of technology concept is not feasible in all environments, favorable characteristics for braking energy recuperation in general are: separated lane, high passenger load, many stops, high driving speed and a complex topography, for the application of reversible substations: low frequency in track section and isolated track parts

Funding for the implementation of reversible substations in the tram grid is not available or insecure (currently no positive business case), main funding sources are regional public funding, EU funds and own funds.

The SWOT analysis enabled thus to enlarge the set of evaluation categories and impacts to assess, as issues such political commitment, legal framework, funding policies, standardization, the technology *per se*, etc. were raised.

### b.2.3.2 Process evaluation activities

The process evaluation, run in the same way as in Gdynia and Oberhausen (further described), did not highlighted specific problems; the only main constraint for this use cases was represented by the technical failures or difficulties with the realization of optimized energy recuperation systems. This was mostly due to missing technological standards and a lack of specialized technical providers. The use case team rated the tested technologies as immature for service and recommended a different technological set-up, or further research and testing of the energy recovery systems.

## b2.4 Appraisal of evaluation approach

The evaluation approach including the quantitative (the KPIs) was able to highlight the technical background needed to make the Brussel measure feasible; however, the added value was represented by the qualitative analysis (the SWOT items) which stressed the utmost importance of other issues, usually neglected such in the assessment of “pure technical” measures such as the Brussels one, as the maturity of the technology, the political support, the quality and level of standardization, the shortcomings in the legal framework.

## b.2.5 Reference documents

Corazza, M.V., Musso, A. (2017). *ELIPTIC* – Del. *3.3 Full Conventional Evaluation, the reference results*

Corazza, M.V., Musso, A. (2018). *ELIPTIC – Del. 3.6 Evaluation of findings and transferability potential at European level*

Hegazy O., Coosemans T., Devaux F.O., Barrero R., Roelands B. (2018). *ELIPTIC – Del. 2.6 Brussels Final Use Case Report*

# c) Oberhausen Use Case - Fast-charging stations for e-cars powered from the tram network (Pillar C)

## c.2.1 Objectives of the measure

| Ranking | Objectives | Target group |
|---|---|---|
| 1 | demonstrate how the existing DC tram infrastructure can be used for fast-charging stations for private e-cars | PT Operator |
| 2 | demonstrate the LEVs (Light Electric Vehicles) cost efficiency | Whole community |

## c.2.2 Description of the measure: what is implemented?

### c.2.2.1 General

As known from studies one of the most important barriers for the purchase electric vehicles is the slow charging of the batteries. The existing DC tram infrastructure is also suitable for fast-charging of other vehicles. Hence the energy supplier Energieversorgung Oberhausen AG (EVO) decided to demonstrate how fast charging stations for cars and LEVs can be implemented relatively cost effectively in cities with existing DC tram infrastructure and thus enhance the rapid introduction of electric vehicles.

At the Oberhausen-Sterkrade train station from November 2017 such fast-charging stations (in total three) were put into operation. The electricity is taken from the 750 V DC tram catenary and transformed for the fast-charging stations powered with 50kW usable by cars and LEVs. The special feature of this technical solution is that the batteries can be loaded significantly faster than by a conventional technology.

### c.2.2.2 Outputs

The three charging stations were commissioned in the summer of 2017, and although the operations relied on a short duration thus far, it can be noted that the use of the charging infrastructure is increasing. The occupancy rate of the three charging stations is about 36min per day – with a rising trend.

Experience about billing with the end customer has not yet been sufficiently gathered because the use of the charging stations is currently free of charge.

However, due to unclear legal framework and risks for a business case realisation, there are currently no concrete plans for future expansion.

### c.2.2.3 Interaction with other measures

This measure is strictly interrelated with the other similar measures tested in London, Bremen, Barcelona, Leipzig and Szeged within the ELIPTIC Pillar C (Table 1); at local level it complements the other measure tested in Oberhausen, concerning the opportunity (re)charging of electric buses. As for the Gdynia use case, the shared outlook is to assess the viability of introducing more electrification to save energy.

## c.2.3 Oberhausen evaluation approach

The concept underpinning this measure is the use of tram infrastructure to supply energy to e-vehicles. Under the operational point of view, for the Oberhausen use case this means, on the one hand to assess the building opportunities and barriers to supply the fast charging station, and on the other how to cope with the current unavailability of charging stations which can be operated with input voltages of 600 volts DC (+ 20% / - 30%), which would enable the prompt implementation of this technological solution/concept.

### c.2.3.1 Impacts and indicators

As this use case focuses on a charging infrastructure only, indicators relating to vehicle technology, operations and components were considered by the use case leaders no relevant and thus not collected. Consequently, the selected KPIs for which data could be collected relied on a mix of economic, operational and energy-based issues as shown in Table 4. However, the selection of KPIs for the No ELIPTIC scenario appears to be clearly mono-focused to assess the economic side of the measure. Data collection occurred on a quarterly basis, from October – November 2015 to May 2018. A few additional KPIs were included for the ELIPTIC scenario assessment.

| Evaluation Category | Impact area | KPI # | KPI Name | Unit of measurement | Reference period | No Eliptic Scenario period of collection | Frequency D=daily, W=weekly, M=monthly O=one-off; Ot=Other |
|---|---|---|---|---|---|---|---|
| Operations | Maintenance | Oma6 | Durability of components | years | Eliptic demo timeframe | October – November 2015 on | Ot (quarterly) |
| | | Oma7 | Durability of charging infrastructure | years | Eliptic demo timeframe | | |
| Economy | Costs | Eco22 | Recharging infrastructure | EURO/per charging operation | Eliptic demo timeframe | | |
| | | Eco28 | Grid connection | KEURO/per charging equipment | Eliptic demo timeframe | | |
| | Revenues | Ere3 | Revenues per passenger | kEURO/ passkm | month | | |
| Energy | Consumption | Ecn 10 | Electricity from renewable sources consumption | % | day | | |
| | Supply | Esu5 | Recharging capacity | vehicles/ day | recharging facility | | |
| Other | | OBar5 | General demand | vehicles/ day | | | |
| | | OBar11 | Effective occupation charging of the spots deployed | min/day | | | |

*Table 4 – Oberhausen KPIs for the No ELIPTC scenario*

This use case serves also as a case in point to highlight a recurring problem in the evaluation of very innovative measures, such as in Oberhausen: the NO-ELIPTIC scenario was virtually “blank”, being not possible to provide tentative values for those KPIs associated to operations or performance still to come. Therefore, the comparison with the ELIPTIC Scenario was affected by the lack of “before” values for many KPIs. In other cases, KPIs on costs and

the modest general demand showed how the demonstrator is still at a very initial phase and more operations are needed to consolidate results.

### c.2.3.2 Process evaluation activities

The process evaluation was similar to that occurring in the other Pillars, as reported in the case of Gdynia as an example; however, in Oberhausen and the other use cases focused on multi-purpose use of electric public transport infrastructure (Pillar C) this process highlighted specific regulatory challenges. The legal uncertainty of the sale of electricity was the most prominent issue for all use cases. In several countries, the legality of energy and fiscal issues concerning the use of electric transport infrastructure are not clearly defined. In some use cases, the sale of electricity was tolerated temporarily, despite being only partially legal. In other cases, new laws on this issue were in the process of being formulated, however this is a lengthy and ongoing procedure, which led to further uncertainties and delays in the implementation of use cases.

Other legal uncertainties for use cases were caused by the lack of billing regulations for pricing of energy and service, as well as for the measurement of energy input into electric vehicles. Further difficulties were the determination of charging sites due to restricting infrastructure regulations, and the lack of available devices that allowed the use of existing PT networks for charging purposes. Some drivers for Pillar C use cases, and for Oberhausen too, were infrastructural advantages in the installation of charging points. For instance, where public parking spaces are managed by the city, site determination for charging points is facilitated and building permissions are unnecessary, which reduces the regulatory burdens for use cases to a large extent.

## c2.4 Appraisal of evaluation approach

Oberhausen is an example of when the evaluation had to comply with a recurring situation whenever very innovative measures are introduced, i.e. that of having “blank” scenarios, or few information to create a baseline. This complicates the usual before-vs-during performance comparison and the possibility to claim the measure’s success. However, since this use case is to be considered a showcase for fast-charging infrastructure for electric cars and light commercial vehicles by using electric power from the tram catenary, the extent of its KPIs set was merely to stress operational and economic viability at a very early stage of the measure. Needless to say, when switching from the “niche” to the full scale, regular status the list of KPIs should include more items. Moreover, additional qualitative analyses should be run to grasp the extent of problems like, for example, having to cope with the legal barriers for using subsidized electric power from the tram catenary to charge electric vehicles.

## c.2.5 Reference documents

Corazza, M.V., Musso, A. (2017). *ELIPTIC* – Del. *3.3 Full Conventional Evaluation, the reference results*

Corazza, M.V., Musso, A. (2018). *ELIPTIC – Del. 3.6 Evaluation of findings and transferability potential at European level*

Thurm, S., Gesing, J., Berends, H. (2018). *ELIPTIC – Del. 2.14 Oberhausen Final Use Case Report*

# 3 General EVALUATION FINDINGS

## 3.1 Impact of the measures

As said, results achieved during the ELIPTIC use cases activities are both quantitative and qualitative. Both sets of results are associated to the same evaluation categories, i.e.: *Operations, Economy, Energy, Environment, People*, to which an additional one was associated, *Technology*, to comply with the scope of the SWOT analysis. This enables to highlight univocal (as associated to common evaluation categories), general or specific (if common or not to more use cases) impacts.

These will be described in the next sections, according to the findings coming from both the ELIPTIC demonstrators and feasibility studies.

### 3.1.1 Results in the CIVITAS impact categories: findings from the ELIPTIC demonstrators

If performance variations of the demonstrators are analyzed, a first finding is that the KPIs to describe the ELIPTIC scenario measured either small improvements or no variations in the performance they were associated to, if compared to the situation prior to the ELIPTIC tests (No ELIPTIC scenario). This is an extremely positive factor to consider, as no performance variation implies that the ELIPTIC innovations worked well and did not generate problems or delays during the demonstration activities, thus stressing their prospective, smooth, full introduction in the regular service. Needless to say, this is also corroborated by the observed virtually general lack of negative results.

This might raise the typical research question: “would the results have been different if tested on a larger scale or over a longer period of time?” According to past experience, this may be particularly relevant if the emphasis is placed on economic and operational issues, especially for operators in medium-to-small size urban area: demanding innovations like those linked to electrification, in the end, can become unaffordable. At the same time, it should be considered that, the ELIPTIC testing activities, although might constitute small cases, are considered appropriate and the results achieved scientifically sound. The finding that no specific problems occurred during the tests and, in general, very infrequent negative performance variations were recorded is also important in terms of transferability as this means that all the ELIPTIC experiences can be transferable.

Still analyzing results from the EUCs, a second issue to consider is the performance variations registered by common KPIs. As observed when elaborating the No ELIPTIC Scenario, the selection of common KPIs by different use cases represented the local interest in assessing impacts in the areas such KPIs were associated to. It was also outlined how local preference favored mostly the *Operations* Evaluation Category and within this, the *Service* and *Supply* Impact Areas. The ELIPTIC Scenario enabled a restricted KPIs comparison (here is to be reminded that feasibility studies were not included, having no ELIPTIC quantitative scenario), but the interest for such areas was confirmed and concerns for poor performance markedly mitigated, as shown in Table 5.

Within the elaboration of results a sensitivity analysis was performed and the Variation Coefficient - VC[1] (last column in Table 5) was useful to further highlight the relevance of some impact areas.

[1] *VC* corresponds to the ratio between St Dev and AV:

$$VC = \frac{ST\ Dev}{|AV|}$$

| Evaluation Category | Impact area | KPI | KPI name | EUC | | | | | | | Variations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | A1 Bremen | A4 Barcelona | A5 Warsaw | A6 Leipzig | A8 Gdynia | A11 Szeged | C5 Oberhausen | Score | AV | St Dev. | VC |
| Operations | Staff | Ost1 | Driving staff | + | + | | + | + | ++ | | 6 | 1,20 | 0,45 | 0,37 |
| | | Ost2 | Drivers workload | | | ++ | | + | ++ | | 5 | 1,67 | 0,58 | 0,35 |
| | | Ost3 | Maintenance staff | | + | | + | + | x | | 3 | 1,00 | 0,00 | 0,00 |
| | Supply | Osu1 | Passenger capacity | + | + | | | | ++ | | 4 | 1,00 | 0,58 | 0,58 |
| | | Osu2 | Service coverage | | 0 | + | | ++ | 0 | | 2 | 0,50 | 1,29 | 2,58 |
| | | Osu3 | Daily supply | ++ | ++ | | | | | | 4 | 1,33 | 0,00 | 0,00 |
| | | Osu5 | Peak vehicles requirement | + | + | | | | 0 | | 1 | 0,33 | 1,15 | 3,46 |
| | | Oma1 | Vehicles failures | | x | | | x | | | 0 | | | |
| | Maintenance | Oma7 | Durability of charging infrastructure | | ++ | | | | | 0 | 2 | 1,00 | 1,41 | 1,41 |
| | | Oma9 | Durability of vehicles | | x | | | ++ | | | 2 | | | |
| | Service | Ose1 | Commercial speed | + | ++ | | + | | | | 4 | 1,33 | 0,58 | 0,43 |
| | | Ose3 | Dwell time | + | | | + | | | | 2 | 1,00 | 0,00 | 0,00 |
| | | Ose6 | Journey time | ++ | ++ | | | | | | 4 | 2,00 | 0,00 | 0,00 |
| | | Ose7 | Round trip time | + | ++ | | | | | | 3 | 1,50 | 0,71 | 0,47 |
| | | Ose8 | Operation time | x | ++ | ++ | + | | | | 5 | 1,67 | 0,58 | 0,35 |
| | | Ose10 | Charging time | | + | 0 | + | | | | 1 | 0,33 | 1,15 | 3,46 |
| Economy | Costs | Eco1 | Operating cost (general | | x | x | | 0 | x | | -1 | 0,00 | | |
| | | Eco6 | Vehicle capital costs | | x | | | 0 | x | | -1 | 0,00 | | |
| | | Eco19 | Residual value of vehicles (15-years) | | + | | x | ++ | | | 3 | 1,50 | 0,71 | 0,47 |
| | | Eco22 | Recharging infrastructure | | | | | 0 | ++ | x | 2 | 1,00 | 1,41 | 1,41 |
| | | Eco23 | Electricity costs for vehicles | | x | 2 | | x | | | 2 | | | |
| Energy | Consumption | Ecn1 | Vehicle fuel efficiency | | x | | | | ++ | | 2 | | | |
| | | Ecn4 | Fuel consumption | | ++ | | x | | | | 2 | | | |
| | | Ecn 9 | Electricity consumption | | | | | ++ | ++ | | 4 | 2,00 | 0,00 | 0,00 |
| | | Ecn 10 | Electricity from renewable sources consumption | | | | | x | | 0 | -1 | | | |
| | Supply | Esu5 | Recharging capacity | | x | | + | | | | 1 | | | |
| Environment | Emissions | Eem1 | $CO_2$ emissions | | | | + | | 0 | | 0 | 0,00 | 1,41 | 0,00 |
| People | Passengers | Ppa1 | Awareness | | ++ | | | | x | | 2 | | | |
| | | Ppa2 | Acceptance | | ++ | | | | x | | 2 | | | |
| | Drivers | Pdr1 | Driving comfort | | ++ | | | | x | | 2 | | | |
| | | Pdr2 | Acceptance | | ++ | | | | x | | 2 | | | |

| Key | | |
|---|---|---|
| | *0* | *No improvement* |
| | *+* | *no variations* |
| | *++* | *Improvement* |
| | *x* | *Blank scenario* |

*Table 5 Performance variations according to recurring KPIs*

VC is a very important parameter, as the smaller the value, the more similar the performance seems to be among the ELIPTIC use cases; hence the more likely it will be to have a conform situation in other contexts (for example in case of transfer) or over longer period. As the VC average value was 0.85, performance levels which are likely to be conform outside the ELIPTIC experience correspond to KPIs below this value, and are concentrated in the *Operations* Evaluation Category: *Ost1 - Driving staff* and *Ost 2 -Drivers workload*, associated to the *Staff* Impact Area*, Osu1 – Passenger capacity, Ose 1 - Commercial speed, Ose 7 - Round trip time*, and *Ose 8 - Operation time*, the latter three within the *Service* Impact Area. Also, it is to add *Eco19 - Residual value of vehicles*, in the Economy Evaluation Category.

Not the same can be said for other evaluation categories, where the high occurrence of "blank" terms of comparison is an element to consider, especially in terms of transferability. For example, this might raise the usual question about the operators' traditional concern on costs. In the case of the EUCs demonstrators, data provided to "feed" the KPIs associated to the *Economy* Evaluation Category were not homogeneous, with often "blank" terms of comparison. This can be interpreted in many ways: for example, the operators' actual impossibility to estimate costs when innovations are introduced (such as the ELIPTIC ones); confidentiality requirements on sensitive data; difficulties in processing, or no direct access to, the required data, price variations, etc.

More findings can be highlighted if the results of the Cost Benefit Analysis are considered. Under the technical point of view, along with costs, also mileage and the availability of infrastructure seems to be leading criteria to introduce more electrification. For example, electric vehicles and opportunity options should be used if there is no access to overhead wires and the mileage of a service is medium or high (as opportunity chargers are cheaper than the extension of the network), but at the same time, within this class of mileage, it is also stated that electric or trolley vehicles should be used if there is a possibility to charge from the existing trolley network. On the contrary, for short mileage services, diesel buses could still be an efficient option and they should still be used for peak services. Nevertheless, battery hybrid trolleybuses seem to be the most promising solution for cities that already operate trolleybus network, as long as no marginal overhead network costs have to be covered. Eventually, the Cost Benefit Analysis results stresses that positive results are strengthened whenever the share of renewable energy is high.

### 3.1.2 Results in the CIVITAS impact categories: findings from the ELIPTIC feasibility studies

The SWOT analyses performed for all the ELIPTIC use cases based on feasibility studies enabled to highlight a number of issues (i.e., SWOT items) and similarities recurring throughout the three Pillars.

Under the technological point of view, many of the public transport operators consider their own electric grid as a robust and complementary alternative to that of the public distribution. In terms of transferability, the message is clear: target cities, to theoretically transfer the ELIPTIC lesson, should have robust public transport grids available. Needless to say, the size of the city is a not negligible factor: smaller systems (for example Gdynia, Szeged, Eberswalde) could be very likely required to upgrade the power distribution system as the introduction of more electrification would inevitably result into a need for more capacity.

In terms of *Operations*, the operators' major focus on impact areas in this field (*Maintenance, Service, Supply, Staff* etc.) since the selection of KPIs for the No ELIPTIC scenario was an evidence of their own self confidence on their expertise in dealing with the introduction of more electrification; results from the SWOT analysis led to the same perception, albeit the awareness that increasing electrification is not an easy process (due to the complexity of the system) was likewise highlighted. Also in this case, in terms of transferability the message is clear: recipient cities should be highly skilled to introduce new technologies such those of ELIPTICs. "Technical" self-confidence is also coherent with one statement from the CBA, according to which hybrid trolleybuses, certainly innovative in many

ELIPTIC use cases , seem to be a technologically “safe” solution in case of mass electrification of public transport supply. A prerequisite to all of the above is flexibility, to meet the requirements of robust charging strategies underpinning the ELIPTIC solutions assessed in the feasibility studies; this means that charging strategies have to include different alternatives for optimal coverage.

The *Environment* and *Society* Evaluation Categories were not core issues in the selection of KPIs, thus stressing that performance relevance in both fields, although generally acknowledged, is still not perceived as central by the operators. This is contrasting with the observation that the ELIPTIC use cases, as such, are already on a path towards a more sustainable mobility system, and that electrification of public transport is a powerful mean to complete it. The continuous support from authorities, academicians and politicians is, therefore, still most needed if the goal is to comply with the stricter and stricter regulations on air quality, both at national and supranational levels.

Within the *Energy* Evaluation Category, the need to update regulations or to create new regulatory frameworks is generally recognized, especially to enable the use of the public transport grid to third parties ((bus and taxis operators, utility vehicles, etc., like in the case of Oberhausen), being this currently not allowed for many ELIPTIC use cases. It has been also observed that, actually, there are not even standardized meters to enable this. To be noted that such unsuitability is perceived more and more inconvenient by the transit companies which are both users and operators of their grid and *de facto* manage their own energy supply.

Difficulties in dealing with costs by the ELIPTIC demonstrators can be found also in results from the SWOT analyses. Here, a mix of positive and negative statements are reported due to a number of reasons: investment criteria that changes from site to site, long-lamented lack of constant subsidies, poor knowledge of lifecycle costs or not clear perception of the overall cost structures. Here, the message for the transferability study is that cost structures in general, although paramount factors in the decision process, might not be easy to assess and therefore left to the expertise of the target cities. All of the above clearly stresses that more electrification in public transport is a multifaceted issue, which puts inevitably many irons in the fire. If the above reported findings are synthesized in short statements (Table 6) and associated to the different evaluation categories, once again is clear that major attention is attached to operational issues, which will become the cornerstones for the development of this type of measures based on electrification.

| ***Synthesis of findings*** | ***Evaluation Categories/impact areas*** | | | | |
|---|---|---|---|---|---|
| | **Operations** | **Economy** | **Energy** | **Environment** | **People** |
| Small performance variations | | | | | |
| Service and Supply Impact Areas are major issues | | | | | |
| Costs are not clearly reported | | | | | |
| Service performance levels achieved by the ELIPTIC demonstrators are very likely to be replicable elsewhere | | | | | |
| Mileage and availability of infrastructure seem to be additional leading criteria to introduce more electrification | | | | | |
| PT operators consider their own electric grid as a robust and complementary alternative to that of the public distribution. | | | | | |
| Environmental issue is still not central. | | | | | |
| Support from the community and stakeholders is much needed to comply with the stricter and stricter regulation on air quality, both at national and supranational levels. | | | | | |
| Operators’ are self confident on their expertise in dealing with the introduction of more electrification | | | | | |
| Hybrid trolleybuses seem to be technologically „safe” solution in case of mass electrification of public transport | | | | | |
| Unsuitability of energy regulations | | | | | |
| Contrasting assessment about costs due to differences in investment criteria, lack of subsidies, etc. | | | | | |
| Flexibility is needed to meet the requirements of robust charging strategies, deployed by the provision of different charging alternatives | | | | | |

*Table 6 Synthesis of general findings*

### 3.1.3 Key impact results

According to all of the above a synthesis of the most recurring key impact results, from both the ELIPTIC demonstrators and feasibility studies, is reported as follows:

- **Key result 1 – Operation-ready - T**he theoretical full introduction of measures like those of Pillar A (for example the Gdynia use case) are very unlikely to affect in a negative way the local public transport regular service (or more in general the overall operations) and so would probably be in the case of the transfer of these measures elsewhere.
- **Key result 2 – Renewable energy matters!** – According to the Cost Benefit Analysis the possibility to rely on renewable energy sources to supply the operations tested within ELIPTIC evidenced savings, thus impacting positively on the local environmental and economic patterns
- **Key result 3 – More knowledge in the cost assessment leads to accuracy and certainty -** The lesson learnt is that costs are often incorrectly or unjustly reported by those in charge to "feed" the KPIs, which in the end, prevents stakeholders (operators, researchers, decision-makers in general) from properly assessing the extent of the economic side of electrification; as a consequence, the lack of univocal or clear references or data when dealing with costs creates a mix of positive and negative positions which create uncertainties in the overall assessment of electrification and, in the end, poor knowledge.
- **Key result 4 – Environment and Society –** For the operators involved in the use cases at the feasibility study stage operational reliability and affordability cast a shadow on the relevance of assessing impacts in the field of people perception, awareness and acceptance, as well as in the of the environmental implications.
- **Key result 5 – Specific regulations are needed to boost electrification –** Current energy regulation is perceived as an obstacle to be overcome in the smooth transition towards the electrification of mobility.

## 3.2 Process Evaluation Findings

Within Eliptic data and information on the process development were collected via the methods reported in Table 7[2] and complemented by information coming from the following SWOT and Transferability studies, all highlighting recurring barriers and drivers in the process activities for implementing the ELIPTIC measures. However, no specific contrasts arose and all the evaluation activities were successfully accomplished.

| Data category | Method | Source | Timing |
|---|---|---|---|
| **Written** | Review of existing material | Monthly TelCo notes | Continuous |
| | | Notes of WP4 workshops | |
| | | Review surveys | |
| | | Planning / Execution Checklist | |
| | | Risk Identification Form | |
| | | UC set-up report | |
| | Online questionnaire | Primary | One per UC, one per phase |
| **Verbal** | (Telephone) interviews | | One per UC, one per phase |
| | Focus groups | | Attached to consortium meetings |
| **Visual** | Drawing exercise | | Optional with interview |
| | Retrospective Gantt Chart | | Optional with interview |

*Table 7– ELIPTIC process evaluation methods to collect data*

[2] Refer to: Brand, R. (2017) *ELIPTIC Del. 3.2 - Process Evaluation Plan*

### 3.2.1 Barriers

The following barriers were observed:

- **Barrier 1** – **Use cases' initial reluctance to contribute to the evaluation activities.** At the early stage of the data collection, some use case leaders had difficulties in understanding the role of the evaluation activities in the project, perceived mostly as a way of "sniffing around". To cope with that, the evaluation team provided continuous support, preparing explanatory notes whenever needed and conf-calls to clarify specific issues concerning the local data collection.
- **Barrier 2** – **Exogenous factors.** While developing the evaluation activities and during the measures implementation, the evaluation team realized the relevance of issues not strictly related to the measures themselves, but to the contexts of application, typically the lack of specific regulations or standards. But what seemed to be an initial barrier turned out to be a resource especially in the development of the SWOT analysis, as it helped to improve the comprehensiveness of the study and, in the end, outline aspects which could have been underestimated or not studied.
- **Barrier 3** – **Environmental impacts difficult to calculate.** In the end, KPIs involving the assessment of air and noise pollutions where calculated in a very restricted amount of use cases and totally neglected in the others. This is due to the difficulties in processing these types of data, for which the operators had to rely on other local bodies not involved in the process.

### 3.2.2 Drivers

The following drivers were observed:

- **Driver 1** – **Full interaction.** The cooperation between the Evaluation team and the Project Coordination was continuous and fruitful; this helped the Evaluation team in progressing with the activities, avoiding delays and risks and fully complying with the evaluation plans.
- **Driver 2** – **Full commitment**. After the initial reluctance in providing data, the use case leaders showed, while ELIPTIC was progressing, a general interest in the evaluation process which facilitated the data exchange for the remaining part of the project…
- **Driver 3** – **Know-how**. The evaluation team was composed by members highly experienced in the field of evaluation, having some of them also been already evaluators in past CIVITAS projects. This made some tasks "lighter", although still demanding. Such expertise was especially fruitful in the preparation of the transferability methodology and the Cost Benefit Analysis, and in the development of the SWOT analysis, being this rarely applied in the field of the assessment of electrification of public transport.

### 3.2.3 Recommendations on the implementation process

According to the ELIPTIC experience, to successfully complete the implementation process it is recommended:

- **Recommendation 1 – Full cooperation and dialogue.** Following the Driver 1 above-mentioned, the mutual and continuous interchange of information, explanations and data among the consortium partners is essential to ensure the regular activity progress, avoid conflicts, and get sound results.
- **Recommendation 2 – Flexibility.** During ELIPTIC, due to technical reasons, some changes occurred (measures aborted, KPIs changed, activities lengthened/shortned, etc.). This requires strong flexibility in the methodologies to apply and to have evaluators ready to revise/reconsider plans.

## 3.3 Evaluation Conclusions

### 3.3.1 Main lessons learned

Implementing the ELIPTIC measures was an extremely demanding but "monofocused" process, as the goal was to boost electrification. The main lessons learnt, therefore, are affected by such specificity, but nevertheless extremely important for future sustainable mobility strategies:

- **Key lesson 1 – Funding.** The ELIPTIC measures require higher efforts to be implemented than usual sustainable mobility measures for rubber-tired transit. This means that appropriate funding is essential not only to carry out demonstration activities, but to have them regularly shifted into regular operations, once the project is over.
- **Key lesson 2** – **Appropriate regulations and standards**. The lack of specific regulations and standardization program was a constant-lamented issue during the project. Although this might only mildly affect the technical assessment, it becomes crucial if the goal is to upscale the ELIPTIC measures at local level or export them elsewhere.
- **Key lesson 3 – Duration and scale.** As said the ELIPTIC measures require higher efforts to be implemented, which also means sound test duration, to avoid the question "Would results be the same if the measure was implemented across a longer period'". Likewise, the possibility to observe demonstrations involving more vehicles or larger operations would improve the quality of the evaluation results.

### 3.3.2 Long term impacts

Based on the conclusions of the evaluation of the measures in the lifetime of the CIVITAS ELOPTIC project, it is difficult to evaluate long term impacts of these measures if they do not shift into regular operations, at city level. Should this happen, expectations would be associated to improved environmental conditions.

## 3.4 Potentials for transferability in other cities

Based on the ELIPTIC Transferability Exercise – TE of the measure (in which more than 70 respondents worldwide took part), the following is to be noted.

Among the priorities to trigger the transfer, the relevance of the *Environment* and *Energy* categories is surprising for two reasons: the first is because during the building of the No ELIPTIC scenario, a moderate interest was shown for both, thus suggesting that at use case level not much was expected in terms of performance variations. This was not a lack of confidence in the environmental or energetic potential of the three Pillars concepts, but the awareness that their contribution in both fields can be appreciated only after longer period than that of ELIPTIC's. The second reason is that in other TEs or similar studies neither *Environment* nor *Energy* issues play the role of drivers, but costs[3]. This was also initially corroborated by the attention paid, while building the No ELIPTIC Scenario, on the KPIs associated to the *Economy* Evaluation Category and specifically on costs for fuel and the use of the recharging infrastructure. Such concerns on expenditure was then interpreted in terms of expectations that introducing a change in the propulsion or in the energy provision might result into reduced costs. Needless to say, the cost concern is a long observed issue already highlighted whenever an innovation is introduced in the transit system[4]. Still, for what concerns the *Environment* Evaluation Category, it is also to be observed that in the case of Pillar A, no environmental

[3] Hanlin, J. et al., *Battery Electric Buses— State of the Practice*, Transit Cooperative Research Program, Transportation Research Board of the National Academies, Washington, D.C., 2018; Pihlatie, M., Kukkonen, S., Halmeaho, T., Karvonen, V., Nylund, N.O., 2014. Fully electric city buses - The viable option. In: IEEE International Electric Vehicle Conference (IEVC), Florence, Italy.

[4] Musso, A., Corazza, M. V., V*isioning the bus system of the future: stakeholders' perspective*, in: Transportation Research Record: Journal of the Transportation Research Board, n. 2533, Transportation Research Board of the National Academies, Washington, D.C., 2015, pp. 109–117

barriers were detected for the transfer. This is possibly the inception of a major trend for a European vision for more environmentally friendly buses.

The TE also highlighted that, in the end, the sentiment or more in general the perception is that categories such *Energy*, *Environment* and *People* are becoming not only as important as the conventional *Economy* and *Operations* ones, but also much important than the technology itself in the decision to transfer a given ELIPTIC concept. This is corroborated, the one hand, by the reiterated statements about the role of electric technology for transit: although assessed with low potential in terms of cost mitigation and operational improvements, it is acknowledged as viable, sustainable and community-friendly. On the other hand, the high scores given to the statements according to which technology is associated to people needs, perception or acceptance is one more evidence of that. A few examples among the many key drivers: "*This technology concept provides a backbone for the further efficient electrification of* the public transport in the city and has therefore a positive impact" referred to Pillar B; "*Hybrid Trolleybuses - HT are generally perceived as environmentally-friendly and innovative by the citizens*", for Pillar A; *"This technology concept increases social cost-benefit and urban resilience, and have high economic and social return since it synergizes two already existing systems" for Pillar C,* and eventually for Pillar A, cluster 1 *"Drastic growth in passenger numbers (past and in future) fosters demand for electric buses and consequently the demand for electric bus charging points in the city".*

The TE also stressed, one more time, problems long-lamented in the scientific and grey literature, as typically the lack of: political support; appropriate and constant funding; consolidated standardization. Moreover, at the same time, some constraints in the operations are assessed as still too difficult to overcome: the so-called "technology anxiety" (lack of comprehensive knowledge on functions obsolescence of the components); grid performance to manage when introducing the innovative concepts (unsuitability of the energy supply in light of the new operational requirements); poor flexibility (especially when wiring or the limited driving range by batteries are considered). Then, the TE underlined also some, apparently minor, practical issues whenever third parties are involved and for which solutions have to be sought: for example, the operators' impossibility to sell energy to supply vehicles owned by third party customers (and when this possible, even the lack of standardized metering systems to sell it); or location problems for the opportunity charging (due to urban constraints).

Among the constraints, wiring for HT is maybe the most debated one, due to the contrasting feelings behind. As noted, HTs are generally perceived as environmentally-friendly and reliable, and appreciated as such by citizens and operators respectively. At the same time "*people do not like wiring*", operators feel it as an element of limitation in the service flexibility ("*wiring/dewiring is not possible everywhere*"), and prejudices are in place ("*need to cut trees to accommodate catenaries*"). All of the above lead to positions, outside ELIPTIC, like those of the respondent cities of Copenhagen ("*not an interest from local authorities to invest in a catenary based bus transport system as the local authorities do not like catenaries in the cities)* or Reykjavik *("We will never have trolley buses with energy from overhead lines. …. will never at least for next 50 years bear such an investment as light rails or trolleybus.");* similarly, within ELIPTIC, one of the findings of the CBA stresses that most favorable conditions to operate trolleybuses is to have already available an existing trolley network.

Wiring is just a basic example on how the general perception of electrification seems, therefore, to be based on a mix of pros and cons, which are natural when engaging in innovation, but of no real help in a decision-making process on the possibility to include (more) electric modes in a local transit supply. This stresses the need to provide more and more advanced scientific knowledge to steer policy decisions towards the most suitable solutions. Needless to say,

demonstration activities such as the ELIPTIC's are much wanted if the goal is to assess "from real" the electrification potential.

## 3.5 Annexes and reference documents

Brand, R. (2017), *ELIPTIC – Del. 3.2 Process Evalaution*
Corazza, M.V., Musso, A. (2018). *ELIPTIC – Del. 3.6 Evaluation of findings and transferability potential at European level*