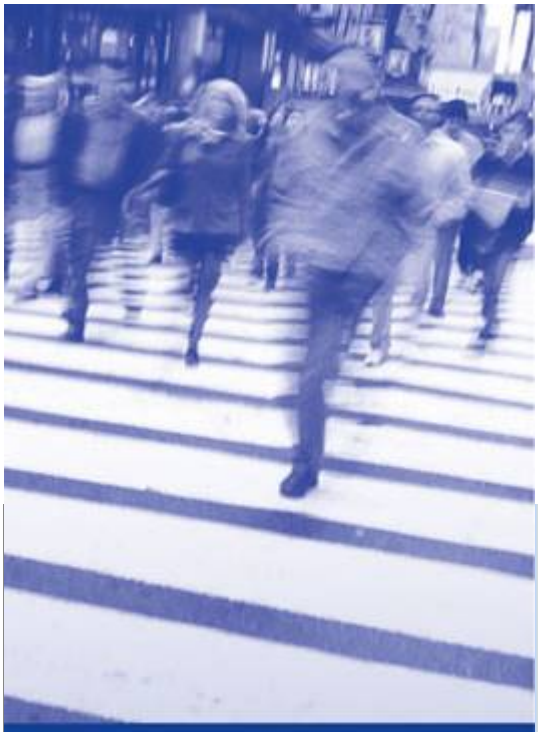

ECCENTRIC

D.2.7 Replication Package
New parking policies

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Cleaner and better transport in cities
ECCENTRIC
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Abstract

CIVITAS ECCENTRIC Work Package 2 “Inclusive urban planning, new parking policies and mobility management” is divided in three clusters. Cluster 2 “New parking policies” contains four measures. The Replication Report covers the final status of the implemented measures and discusses the potential and requirements for their replicability in other cities or districts. After a successful involvement of citizens in the planning process with the help of innovative processes as well as the general improvement of planning processes of mobility services regarding sustainable mobility in society, the implemented measures are examined regarding their replicability and continuation.

The report describes the final status of four measures in three European cities. This includes an “Adaptive parking management based on energy efficiency and occupancy” (MAD 2.3) in Madrid; measure “Smart and flexible parking by emerging technology” (STO 2.4) and “Transforming parking areas into new green uses” (STO 2.5), both implemented in Stockholm and a “Park & Ride system in a peripheral district” (RUS 2.6).

Project Partners

Organisation	Country	Abbreviation
Ayuntamiento de Madrid	Spain	AYTOMADRID
Grupo de Estudios y Alternativas 21 SL	Spain	GEA21
Consorcio Regional de Transportes de Madrid	Spain	CRTM
Empresa Municipal de Transportes de Madrid SA	Spain	EMT
Universidad Politécnica de Madrid	Spain	UPM
Avia Ingenieria y Disegno SL	Spain	AVIA
FM Logistic Corporate	Spain	FM LOGISTIC
Stockholms Stad	Sweden	STO
Kungliga Tekniska Hoegskolan	Sweden	KTH
Flexidrive Sverige AB	Sweden	FLEXI
Carshare Ventures BV	Sweden	CARSHARE
Ubigo Innovation AB	Sweden	UBIGO
Mobility Motors Sweden AB	Sweden	MM
Cykelconsulterna Sverige AB	Sweden	CYKEL
Gomore APS	Sweden	GOMORE
Landeshauptstadt Muenchen	Germany	LHM
Münchner Verkehrsgellschaft mbH	Germany	MVG
Domagkpark Genossenschaft EF	Germany	DOMAGK
Green City EV	Germany	GC
Green City Projekt GMBH	Germany	GCP
Technische Universitaet Muenchen	Germany	TUM
City of Turku	Finland	TUR
Varsinais-Suomen Liito	Finland	VSL
Turun Kaupunkiliikenne OY	Finland	TUKL

Western Systems OY	Finland	WS
Turun Ammattikorekeakoulu OY	Finland	TUAS
Gasum Biovakka OY	Finland	GASUM
Obshtina Ruse	Bulgaria	RUSEMUN
Club Sustainable Development of Civil Society Association	Bulgaria	CSDCS
ICLEI European Secretariat GMBH	Germany	ICLEI
FM Logistic Iberica SL	Spain	FMLOG

Document History

Date	Person	Action	Status	Diss. Level
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Dissemination Level: PC = Project Coordinator, SM=Site Manager, TC=Technical Coordinator, EM=Evaluation Manager.

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List of Acronyms

ca	*circa* (around)
CO_2	Carbon Dioxide
D	Deliverable
EC	European Commission
EU	European Union
EV	Electric Vehicle
e.g.	*exempli gratia* (for example)
GDPR	General Data Protection Regulation
H2020	Horizon 2020
i.e.	*id est* (that is to say)
LEV	Light Electric Vehicle
MIT	Motorised Individual Transport
ML	Measure Leader
NOx	Nitrogen Oxides
SM	Site Manager
WP	Work Package
WPL	Work Package Leader

Executive Summary

CIVITAS ECCENTRIC work package 2 contains eleven measures within three clusters. The activities of WP2, Cluster 2 are focusing on technical and infrastructural based approaches, for a modern and sustainable parking management. These measures in this cluster are predominantly hard instruments, focusing on solutions for an efficiency enhancement in parking management and to reduce (stationary) traffic in the long-term.
By evaluating innovative technologies and integrating them into existing traffic systems, statements can be made about the extent to which these sustainable topics in mobility are integrable and accepted by the involved stakeholders and can be consolidated in the future.
The Replication Package summarizes the final status of measures MAD 2.3 “Adaptive parking management based on energy efficiency and occupancy”, STO 2.4 “Smart and flexible parking by emerging technology”, STO 2.5 “Transforming parking areas into new green uses” and RUS 2.6 “Park & Ride system in a peripheral district”. In addition, the necessary requirements and general potential of these measures are described in order to discuss their replicability in other cities or districts or even their potential for upscaling.

Regarding the replication and upscaling potential of cluster 2, the following becomes apparent:

- The focus is on smart technological devices or processes, to support existing mobility infrastructure.
- In addition to the actual technological infrastructure, special software is required that is compatible with high data volumes (e.g. real-time data).
- Furthermore, such measures must always consider data protection factors (control of the data obtained).
- The initial implementation of the new hard- and software requires many test runs: in the real environment there are often new technical challenges that must be solved (trial and error).
- A key success factor lies in the location of the measure: the search for a suitable site is extremely important.
- Infrastructure-based projects require not only the technical equipment, but especially its maintenance and operation.
- Positive discrimination as a new approach to reduce negative external effects.
- The involvement of the population is necessary to explain the functionality of the new infrastructure: “How do I use it?” and to explain the background and purpose of the measure: “Why should I use it and what are the objectives?”

- Like the technical test runs, operational test runs are also required in practice. The long-term use is based on a process of habituation of the residents, which is slowly becoming permanent.

In summary, the measures as a whole have a high degree of replicability, precisely because they partly still have room for improvement and adaptation due to new possibilities based on smart and connected technologies in each city.

1. Introduction

1.1. Purpose of this document

In CIVITAS ECCENTRIC, five cities (Turku, Stockholm, Ruse, Madrid, Munich) have implemented in total 51 innovative sustainable urban mobility measures. The measures were addressing a variety on urban mobility challenges, organized in different thematic clusters. This document is intended to equip practitioners and decision makers with the information needed if they want to replicate measures of the thematic cluster "Inclusive Urban Planning" or aspects of these measures.

Replicability refers to the possibility of transferring results from a pilot case to other geographical areas. These areas have, of course different local contexts and conditions. When a specific measure proved to be successful in one area of a European city, it should be possible to transfer it to another city (or another area of the initial city), considering, the local conditions and conditionalities.

1.2. Target group

This document is tailored following the practical needs of project developers and planners / technical staff form cities to develop innovative measures, to consider potential barriers and to be able to select the appropriate solutions to match their contexts. This document provides evidence that particular measures have been successfully implemented in a city and have a good replicability potential.

2. Summary of the Cluster: New Parking Policies

2.1. European Context of CIVITAS ECCENTRIC

In the last decade, European cities have made significant steps forward in the delivery of sustainable urban mobility policies, proving that major impacts in terms of congestion and reduced emissions can be achieved through ambitious measures.

At the same time, peripheral districts remain largely unaddressed, with the effects of flagship projects being rarely transferred to these areas. Recent or future urban growth processes are posing additional pressure to peri-central areas. The main common challenges are to relieve central areas through clean and efficient urban logistics, as well as to increase the attractiveness and sustainable mobility of suburban districts.
To tackle these common challenges, the cities of Madrid, Stockholm, Munich, Turku and Ruse have formed the CIVITAS ECCENTRIC consortium. The overall objective of the CIVITAS ECCENTRIC project was:

To demonstrate and test the potential and replicability of integrated and inclusive urban planning and sustainable mobility measures that increase the quality of life of all citizens in urban areas, with a focus on suburban districts and new developments and the clean organisation of urban freight logistics.

New technologies and the changing user behaviour in mobility are changing the understanding of spatial development in a holistic way. New concepts and progressive approaches in mobility can now be implemented and evaluated within the cluster 2.2 New Parking Policies.

2.2. New parking policies as a progressive concept for liveable cities

The cluster New parking policies is particularly important at present, since the mobility system is overloaded in many cities worldwide and is showing various negative external effects. Not only the flowing traffic, through its emissions and congestion, causes negative effects, but also the so-called stationary traffic: high pressure on space in urban areas requires new concepts and a new division of space used – for example, by parked cars.
New technological possibilities can try to counteract these negative effects and work on solutions that make urban space more attractive: new areas for leisure and green spaces without restricting the accessibility of the inhabitants. The approach of positive discrimination of motorised individual transport, especially regarding parking, is to be discussed here and checked for its transferability. But also, a more efficient use of existing land, and thus a fairer distribution for all types of use will be a subject of discussion.
In cluster 2.2, measures are presented that are designed to overcome the above-mentioned challenges by using smart solutions: the measures presented are partly based on the support of technological innovations to make existing infrastructures and processes more efficient and smarter. The prerequisite for the replicability of the

measure is primarily the necessary technical equipment to supplement existing processes and infrastructures as well as the knowledge on how to set up the entire system. However, it is also apparent that maintenance and participation procedures are an essential factor that must be considered in order to implement the measure successfully. The replication potential is generally high once the technical devices themselves are available. For this, detailed preparations and planning processes are necessary to achieve that technical status quo. However, as motioned above, the maintenance and actual use of the infrastructure is dependent on good project management. The replication potential will be discussed in the next chapters in detail. The methods presented in cluster 2 include four measures, which took part in Madrid, Ruse and Stockholm (see table 1).

Table 1 Measures of WP2-Cluster 2.2 – New Parking Policies

Cluster	Measure	City	Partner(s)
Adaptive parking management based on energy efficiency and occupancy	MAD 2.3	Madrid	AYTO MADRID
Smart and flexible parking by ermerging technology	STO 2.4	Stockholm	City of Stockholm
Transforming parking areas into new green uses	STO 2.5	Stockholm	City of Stockholm
Park & Ride sytem in a peripheral district	RUS 2.6	Ruse	RUSE, CSDCS

3. From ECCENTRIC cities to replication in other places

When talking about replication, demand must match supply: The measures implemented by the CIVITAS ECCENTRIC cities should provide effective processes, methodologies and technological packages to cities interested in replication.

3.1. Brief summary of the respective measures

New parking policies are evident in the measure described in cluster 2, as a mix of soft and hard measure instruments that focus on implementing new technical devices and infrastructure to support establishing a sustainable mobility system as well as to reduce its negative external effects.

- **Measure MAD 2.3** "Adaptive parking management based on energy efficiency and occupancy", has changed since the beginning of the CIVITAS ECCENTRIC to a development and test of a technological tool to promote the prioritisation of high occupied vehicles HOV within parking management. In most cities there is a high parking pressure, which results in a large amount of space being taken up. However, the occupancy rate is usually only 1-2 persons, which means that the available parking space is not used efficiently. In order to increase the occupancy rate of the vehicles by creating incentives, the parking garages of the municipal operator EMT were equipped with an automatic door control, which measures the occupancy rate of the entering cars. The automatic control thus will make it possible to favour positive discrimination against vehicles with more than one passenger. It can be completed with other restrictions, such as the prioritisation of clean vehicles or compliance with other regulatory conditions in the future. Thus, car-pooling, public transport and zero emissions shall be increased and will be especially interesting for places with a high concentration of vehicles.
- **Measure STO 2.4** "Smart and flexible parking by emerging technology" focus on two aspects: smart parking occupancy and support implementation of the parking rules enforcement by using new technologies. Therefore, on the one hand an application, based on real time information about the current parking situation is used, in order to show where available parking places are and thus to reduce the duration of the search for a parking space. On the other hand, due to the competition for parking space with other types of use, the city's parking regulations are to be intensified and controlled in general. To this end, Stockholm provides a new fully digital parking system for parking surveillance and better-quality information about available parking for drivers. The overall aim is to make the use of parking spaces more efficient, in an ecological, economic and social way, which will also increase user satisfaction and quality of life in urban areas.
- **Measure STO 2.5** "Transforming parking areas into new green uses" deals with portable reuse parks – so-called "pop-up recycling stations". The transportation

of items such as waste from your home is hard to do without a car. The measure helps to reduce the car-dependency which in turn can help to reduce the need of a car. In detail, the re-use stations visit different neighbourhoods in Stockholm at different weekends during a year. Larger and unwieldy items can thus be regularly collected by households on site and taken to the recycling landfill, by booking a sustainable vehicle. Usable items can also be exchanged as an option and thus waste will be reduced. The municipal service is intended to prevent residents from having to drive individually to the landfill, to ensure that old, but still functional objects can perhaps be reused instead of being disposed of, and ultimately to save on parking space. The measure, both re-use pop-up parks and the e-friendly transportation has a potential to inspire, be copied and implemented in other cities.

- **Measure RUS 2.6** "Park & Ride system in a peripheral district" refers to the general problem that high commuter numbers regularly cause traffic in many cities worldwide to come to a standstill. In addition to congestion and increased emissions, this also leads to a high level of deterioration on (parking) spaces. In order to counter this problem, so-called 'Park & Ride' facilities have been implemented in the living lab in Ruse. The P+R facilities are intended to encourage driving commuters to change after the first few miles at the mobility hub and use public transport instead of driving all the way to the city centre. Through the smart networking of a P+R facilities at important transport hubs, the use of public transport should be increased, and motorised individual transport reduced. Thus, modal split shall be promoted in case of commuters and visitors, reaching the city centre.

3.2. Evaluation the replication potential of measures

In order to make replication possible, an in-depth analysis is required to understand the existing barriers that obstruct effective and successful implementation. Finance and governance aspects will accompany this analysis. In the following, it will be explained on which necessary structures and processes the measures are based in order to replicate them in the future. The respective experiences within the measures implemented in each living lab will be used for this purpose.

3.2.1 Drivers and barriers to be expected

In summary, various drivers and barriers can be identified for cluster 2.2. In contrast to the measures in cluster 1 and 3, the measures in cluster 2 have an infrastructure-based focus. Therefore, other drivers and barriers can be expected.

Main requirements

In addition to the technical availability of the infrastructure, important prerequisites for the implementation of these measures include cooperation and communication strategies with partners and residents.

The necessary infrastructure and requirements for the respective measures can be found in the factsheet developed within the project and will not be further elaborated here, as these are partly measure-specific criteria. The factsheets can be found here: MAD 2.3 here, STO 2.4 can be downloaded here, and RUS 2.6 here. In the following, an overview of general requirements for implementing technically based measures is given:

A distinction must be made between physical and digital **infrastructure**. Both are necessary to implement such measures in case of smart mobility solutions. In addition to the provision of the equipment, the safe and successful operation of the equipment must be guaranteed.

Figure 1: STO 2.4 Area of the pop-up recycling station in Årsta (left) (Source: City of Stockholm)

Figure 2: RUS 2.6 Park & Ride facility in Druzhba (right)

In the case of Madrid (MAD 2.3), Ruse (RUS 2.6) and Stockholm (STO 2.5), the availability of **physical infrastructure** was very important, to provide a suitable space and the needed equipment for the Park and Ride (P&R) areas as well as a location for the containers in terms of the pop-up recycling stations (see figure 1 and 2). In the case of physical infrastructures, the choice for location is a key success factor. In addition to spatial factors (e.g. size, density and accessibility), social factors (e.g. habits and acceptance by residents) also play a major role.

In all measures, however, **technical equipment and software engineering** was needed. A further distinction must be made as to whether the devices are

- **used directly for the use of the measure** (e.g. MAD 2.3 OCR camera and vehicle detection sensors/cameras; RUS 2.6 ticket machines at P&R station; STO 2.4 smart phone application to search for a parking space; STO 2.5 crane and other vehicles for placing the containers and transporting waste),
- **required for its installation** (STO 2.4 laser radar and cameras to digitize the road network), or are
- **indirectly necessary for its operation** (MAD 2.3 software licenses and LAN or WLAN connection, serial converter/Ethernet and uninterruptible power supply; STO 2.4 databases and legal permits)

.

Figure 3: STO 2.4 technical equipment parkling scan car (left) (Source: City of Stockholm)

For example, in Stockholm (STO 2.4), it was necessary to digitize the road and parking network, in order to enable digital surveillance and parking searches. In this case, technical solutions like APDR and LIDAR, have been used as applications (see figure 3).

In measure MAD 2.3 even more equipment was used, to implement the test pilot for a smart parking management system (see figure 4). Furthermore, for both measures, interfaces and databases were needed to operate within a protected firewall. By using these networked technologies and processing of partly sensitive data, legal security precautions must be taken. Thus, data protection rights and data capacities play an enormously important role in these measures. In order to use and operate certain devices, clear agreements and contracts with the cooperation partners are also required, as for example in Ruse, where a new ticket system was introduced and had to be integrated into the existing public transport system. This is where the manifold interfaces become apparent, both on the technical side (connected systems, IoT) and on the actor-based side (cooperation, negotiations and contracts).

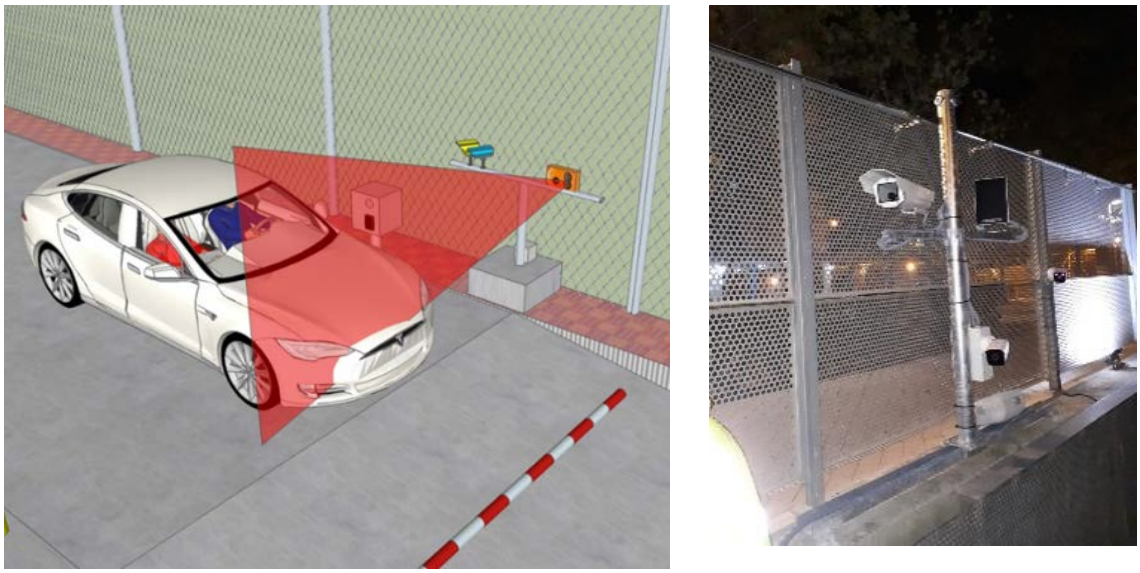

Figure 4: MAD 2.3 HOV parking system (middle, right) (Source: City of Madrid)

In terms of the use of the implemented projects, there are requirements for the **information and communication strategies**, which were similar in all cities. The early involvement of the inhabitants is fundamental for the project and thus create the conditions for the later acceptance and use of the measures. General requirements for communication lie in the timing, which must be started early. But also, in addressing the “right” actors: i.e. all those who are directly or indirectly affected by the measure. In addition to the users, these are also companies or political actors who are active locally. The example of Madrid (MAD 2.3) shows that the information campaign must not only inform about the concrete objectives of the project (e.g. reduction of emissions and traffic) but also about how the equipment and infrastructure are ultimately to be operated:

- “*Why should I use it?”*
- *“How do I use it?”*

As already mentioned, existing requirements lie in bringing on board the actors involved. Projects can only be implemented through new **cooperation and intensive collaboration**. In the case of Ruse (RUS 2.6, see figure 5), the public transport company was involved in the planning of measures to implement the P&R system in a target-oriented way. Finally, the **timing** should be highlighted. All infrastructure-based projects are very time-consuming in their planning and implementation, since several test runs are often necessary to successfully install new and innovative projects and equipment. In addition, further precautions often must be taken regarding data protection aspects, some of which must be re-examined (see STO 2.4 GDPR law).

Figure 5: RUS 2.6 participatory process (Source: City of Ruse)

Expected difficulties

As the measures mentioned here are partly novel and **innovative, new knowledge and technology** is often necessary to implement them (compare STO 2.4, necessary staff or databases with sufficient capacity). As a proposed solution, the Europe-wide competition procedure can be mentioned here, which Stockholm has used to find a suitable company for carrying out the measure. The **innovation contest** newly used here was only carried out for the second time in Stockholm and involves risks such as delays in the competitive process or even requirements for repetition due to mistakes made. In general, it is important to know which technologies are available on the market and can be used in practice. Only based on this knowledge, tenders can be made. Based on the Stockholm experience, it can be mentioned here that once the

tender has been published, there was a risk that there will be a shortage of applications from companies that are to provide the technical solutions. In addition, it is often not possible to guarantee one hundred percent that the selected technology is ultimately feasible. This can be mitigated by allowing some flexibility and adjustments while still following the overall ideas and criteria. However, it is apparent that not only the infrastructure mainly used must be purchased within a **tender procedure**, but in some cases the operation of the infrastructure must also be guaranteed. This can also be done by means of a tendering procedure if these activities do not yet exist. In this respect, it should be mentioned that novel items and processes are often based on novel procurement methods and cooperation.

Regarding digitally networked infrastructures, the difficulty of guaranteeing **data security and personal rights** become apparent (see the European GDPR law). For example, in the Stockholm project STO 2.4, the basic data protection regulations had to be considered in order to be able to operate the digital surveillance system legally. These legal permissions must be emphasized and must be questioned within special investigations. For this purpose, various studies were carried out in Stockholm to query the legal situation and market introduction.

Regarding the **suitable locations** to carry out the measures, the special requirement is already evident in Ruse and Stockholm. In both cases the location was successfully chosen. However, the search was time-consuming, as in many urban areas there is little free space that can be generally used. An intensive spatial analysis was therefore necessary in the case of Ruse in order to find available areas or to establish cooperation with landowners. This was part of the process in Ruse for the P&R facility (see figure 6).

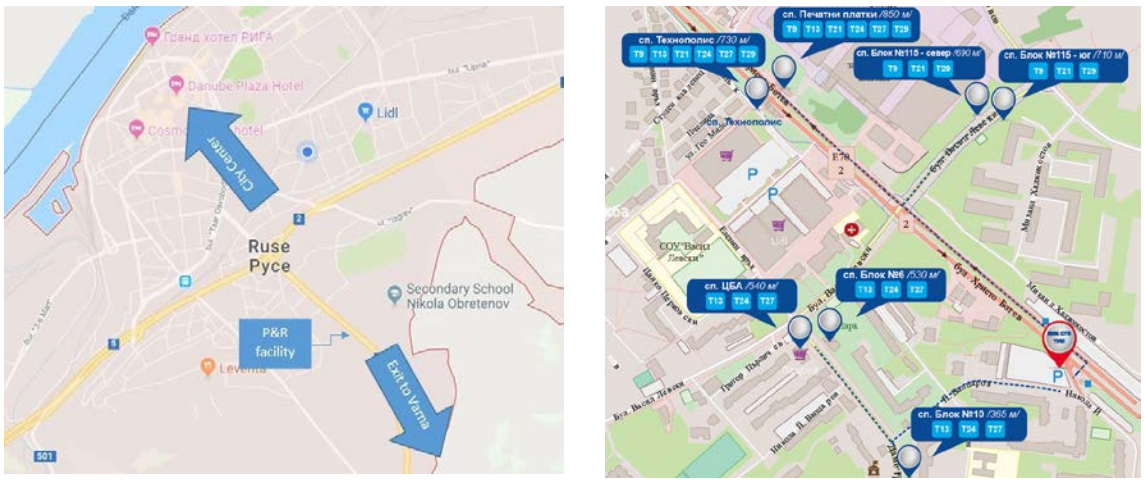

Figure 6: RUS 2.6 location of P&R facility in Ruse and connection to public transport (Source: City of Ruse)

Another aspect within the expected **technical difficulties** is that the initial installation and use is based on the concept of “trial and error” and must be considered in the timing. In Madrid (MAD 2.3), for example, the cameras and the vehicle windows had to

deal with light reflections. In general, the hardware and software used must function perfectly and must not be too error prone.
Further difficulties may arise in matters of **public communication** and political discourse. Good public relations work should counteract this. However, this is time-consuming and must therefore be considered! This also applies to the above-mentioned requirement for necessary information campaigns to bring the measures closer to the users and ultimately to explicitly explain their use ("*Why should I use it* and *how do I use it?*").

Success factors

As already mentioned in the requirements and possible difficulties, a good and well mapped target group to be involved in the **specific information and communication campaign** is an important success factor. The target group should therefore be informed about the project and its use at an early stage. The focus here is on communicating the actual **objectives**! Special services that facilitate use are also considered a success factor. For example, the booking service for bulky waste, which was introduced in STO 2.4, can be listed here. A similar user-oriented service was introduced by the simple payment method via a SMS of the P&R station in Ruse, thus reducing the usage barrier and opening it up to everyone, due to its self-explanatory system. Building on the introductory information campaign, the successful use of the new infrastructure is already encouraging many more residents to use it. Therefore, these innovative projects depend on collected **user experience**. This can even be extended by creating **incentives** for users. In the example of Ruse, commuters were encouraged to use the P&R car park by allowing free parking at the station when buying a ticket for the public transport.
From the providers' perspective, it is evident that innovative projects are based on a "**learning by doing**" process and often only lead to success based on the lessons learnt. In the case of digital networking and data use, **legal studies** should be carried out to determine the extent to which the infrastructure can be used, or which legal regulations are necessary. In the case of Stockholm, this task was outsourced and given to an **external legal advisor**. This can be recommended in order to obtain legal protection.

Business model

The measures presented here are mainly implemented using **EU funding**. However, in some cases the operation of the infrastructure (e.g. RUS 2.6 P&R station with ticket machine; MAD 2.3 car park with ticket machine; STO 2.4 parking tickets), which is partly subject to **charges**, can already cover the maintenance costs. In the case of Stockholm (STO 2.5), having a free of charge operation of waste transport services was considered by the municipality or to outsource it and finance it with fees. This can depend on the regulation of the country and available service-providers.

Human resources and skills

Due to the focus on innovative technologies used in the measures, there is an increased need for personnel skills. This concerns on the one hand the **knowledge** necessary to set up the innovative procurement processes (e.g. STO 2.4 innovation contest) and on the other hand the actual operation and maintenance of the infrastructure by personnel (see MAD 2.3 knowledge about functionality of hard- and software). This must be introduced into the system processes and know how to operate the technology. **Training and introduction to the technical equipment** must therefore be considered. For example, the parking guards in Stockholm (STO 2.4) have been introduced to their new way of working with parking surveillance, using digital equipment, by trainings and knowledge transfer.

Political, administrative and public support

In comparison to the measures in cluster 1 and 3, on average more stakeholders are involved, since the technological focus requires more technical equipment, knowledge and operation. For this purpose, contractors and subcontractors were often used in the measures presented. This multifaceted cooperation also requires **political approval** and orders form the local authority. In many cases, the measures concern tasks that are operated by the municipality (public transport system, parking system, waste system etc.) and are therefore based on its approval and **operational takeover**.
In general, the same applies here, it is important that social and political players are involved in the measure, that they are well informed and that the initiative is endorsed by that sectors with administrative competence and in these cases also with technological support.

Long-term effects and sustainability

Long-term effects can be expected from these measures on the one hand if the infrastructure functions smoothly and is accepted by the residents. If the system proves effective from the point of view of its operation, it is the best method for its long-term maintenance. At the same time, this long-term effects result from the fact that the new innovative systems can finance themselves to this extent. This means that running costs and commissioning can be covered, due to their self-sustaining. For example, through parking tickets or garbage fees.
In terms of the “learning by doing” approach, it is ultimately apparent that the measures require continuous review and further development and must always be aligned with the needs of the residents.

3.2.2 Foreseeable Impacts

Innovative parking policies tamper with the traditional approach to provide unrestricted flow to Motorized Individual Transport (MIT) by increasing the usage efficiency of space, conditioning its usage, or plainly reducing the available area for parking manoeuvres. The introduced constrains have a direct impact on the acceptance,

affecting differently users, citizens (users and non-users), and other people that come into contact with the measure in temporal visits or via media distributions.
Parking related measures pursue the goal of **reducing traffic and the emissions** caused by it. The external effects are to be reduced through approaches of positive discrimination but also through the **simpler design** of existing processes (e.g. waste collection, parking lot search, multimodal mobility etc.).
Based on such projects, the following objectives and effects can be achieved exemplified:

- Higher **occupancy rates** in passenger cars and reduction of traffic and emission values

  For this purpose: long-term monitoring and evaluation necessary!
- **Reducing time** spent for parking crusing and thus lower emission values
- Long-term **reduction of space** requirements through smart parking management

  For this purpose: long-term monitoring and evaluation necessary!
- Increase of the **modal split** and promotion of public transport
- In general, **reduction of daily traffic**
- **Clear regulations and easier control** for the municipality in the parking sector
- **Networking effects** between other transport sectors through digitised services,
- and thus, a **modern and innovative mobility and parking system**.

Especially in the case of measures, aiming for a long-term change in the mobility behaviour, direct effects can, for the most part, only become visible after a longer period.
In addition to the expected direct effects on the transport sector, further positive effects can be achieved. Based on the advancing digitalisation in transport, a large number of new **technical and cross-sectoral interfaces** are emerging. This results in new cooperations and increased exchange between individual sectors. New synergies can be built up and thus, further projects can be advanced. One example of this is the digitization of the road and parking system, which allows many processes to be implemented more quickly and in a more user-friendly manner.
Regarding the implementation of such projects, new, unexpected aspects or even problems can arise. Due to the new types of infrastructure, however, it can also lead to a **misunderstanding** when it comes to their use. New digital services require an intensive training period for employees but also a **transfer of knowledge** about the operation and use of the new services to the users. This shows once again how important information campaigns and early involvement of users is. This can be expected to have an impact on usage.

On the other hand, there can also appear positive unexpected effects: as a result of measures aiming to reduce the dependence of the own car, vulnerable target groups can be easier integrated, and benefit from the measures. This social inclusion is an important step towards increasing acceptance.

Various methods were used to measure the direct and indirect effects.
In terms of the presented measures, especially quantitative measurement methods could be used to analyse the user behaviour of the new technical devices and systems. The most commonly used ones are:

- **User figures**: e.g. numbers of scanned cars, issued tickets, parked cars, financial turnover, amount of reused or recycled material
- **Acceptance**: of visitors and users and personal feedback

Finally, the effect of the decreasing dependence on one's own car can only be measured in the long-term and cannot yet be proven at the current stage.
In summary, car parking-related measures can make a visible contribution to the sustainable redesign of cities. By redesigning or redistributing space, clear signals are set and **sustainable mobility** is promoted. A positive effect is already the **discourse** about the visible changes. In contrast, a transport-related change in **user behaviour**, as already mentioned, can usually only be observed in the long-term. However, existing processes and traffic situations can be simplified, improved and thus make a **social, environmental and economic contribution** for all.

3.2.3 Policy Recommendations

Such projects are based on multifaceted **cooperation** and contractors and thus involve various stakeholders. An early involvement of these stakeholders is important for the successful implementation of the project. Both the providers of the technical infrastructure and the city that uses the services pursue a goal-oriented of these. It is important to clarify in advance to what extent innovative measures can be implemented – maybe even within in a 'trial and error' process. This is because innovative or infrastrucuture-based projects in particular require intensive preparation and the resulting test phases in practice also take time, whithout the effects of the projects wil be fully visible from the outset and to the full extent.

As some of the technologies and infrastructures are quite innovative, **new tendering and procurement processes** must be considered. In order to ensure a scheduled implementation, the choice of providers and other stakeholder's dependencies is crucial. **Transparent negotiations and clearly regulated contracts** can guarantee increased security for these projects.

At the same time, such projects offer the opportunity for leading technology companies to become aware of these projects and to include these challenges in their own portfolio in the future. This can create a **win-win situation** for both parties through increased cooperation and integration of politics and business. For example, technologies can be tested together within the 'learning by doing' approach.

Regarding implementation, the following needs to be clarified:

- *What clear added **value** does the new technology promise?*

  → Transparent information and communication strategy!

- *How can it be **integrated into existing systems** (e.g. waste system, parking system, public transport system etc.) and cooperation?*

  → Early involvement and negotiations with stakeholders!

- *At which **location** does the measure make the most sense?*

  → Spatial analysis and studies on suitable locations and property rights!

- *How is the **operation and maintenance** guaranteed?*

  → Internal and external tenders; enable knowledge transfer and training!

- *Is **sensitive data** used and to whom do the data belong?*

  → Clarification of privacy issues, legal regulations and possibilities for legal permits

In terms of digital connected technologies, the measures presented show the great challenge of dealing with sensitive and high **data** volumes. Official data protection rights and regulations, such as the GDPR, must therefore be considered at an early stage and possible approvals must be obtained. A detailed external study of the legal situation in each case is recommended here, to clarify this issue. Because of these legal regulations, secure interfaces (e.g. protective firewall) and databases must be set up. At the same time, the demand for simple operation (for users) must be guaranteed, as well as its security. This aspect is particularly important for innovative and digital connected projects. On the one hand, this is very time-consuming, but on the other hand it is necessary in order not to endanger the course of the project and to achieve future user acceptance.

There is an impact in **acceptance and ownership**, on the account of the resistance and reallocation of space. As discussed before, there is a differentiated impact across the affected groups, users or not users of the parking facilities. Although opinion and acceptance are heavily influenced by other factors beyond the measure itself, this is no to be taken lightly. A strategic approach tailored to the local conditions have to address the perception and reaction of each group, in order to mitigate the risk of a decline in politic support, and eventually a reverse on the implemented policies and projects.

Finally, it should be mentioned that these kinds of measures aim to reduce traffic and emissions by discussing the use on one's own car. On the one hand, this means an intervention in the personal decision-making rights of the residents, but on the other hand it is also a long-term process aimed at changing mobility behaviour. In both cases it is important to have a **continuous information campaign** towards the citizens to **raise the awareness and visibility** of the project. Only through this transparent communication and the indication of the objectives, it can become possible for the new infrastructures and services to be positively accepted and finally used.

4. Example measures

4.1. Measure STO 2.4 Smart and flexible parking by emerging technology

The measure is based on smart technologies, to support enforcing parking rules in terms of accurate parking surveillance as well as testing systems that guide drivers to currently unoccupied parking spots on the streets via a special application. Through the clear legal regulations and their easier verification, enforcement will be supported and thus parking will be made more efficient and ecological. Due to lower occupancy rates, unnecessary parking will be prevented and thus parking space for other functions will be made available in long-term. At the same time, mobility and accessibility for residents should be maintained, which is why a smart parking guidance system was implemented, to simplify the process of cruising for parking spots for the citizens. This should reduce emissions and traffic jams. Two smart solutions serve to achieve these goals, in terms of

(1) **Parking occupancy**: using a Light Detection and Ranging (LIDAR) solution

and

(2) **Parking enforcement**: using an Automatic Number Plate Recognition (ANPR) method

By integrating these smart solutions, the measure aims specifically to:

- Provide drivers with better-quality information about available parking
- Provide a new fully digital parking system for parking surveillance
- Identify parking discrepancies through comparison between reality and the pre-registered parking information
- Digitize parking restrictions
- Test the digital system for surveillance/enforcement and occupancy
- Evaluate the system and compare it with the regular procedures

In general, the measure will contribute to a more liveable peripheral environment by reducing cruising time for parking and its caused emissions, improving traffic conditions and traffic safety and optimising the road space available in the long-term.

Implementation

*Note: To obtain a detailed version of the necessary implementation steps, reference is made here to the deliverable **D 2.3** "Implementation Report of work package 2, cluster 2: New parking policies". Due to the replication potential, the following list contains the most important steps and comments for other cities to replicate the measure.*

The measure is based primarily on the use of new technologies, such as scan cars, to digitally capture road infrastructure, and parking infrastructure (see figure 8). This real-

time data is then communicated not only to the city authorities in terms of parking enforcement and surveillance, but also to drivers, so that they can find a parking space more easily via an app. Since this is a data-intensive measure, some steps must be taken in advance to implement it and, at the same time, further measures must be taken regarding data protection precautions. In the case of Stockholm, this involved two main steps:

- **Digitization of the whole parking management system** (e.g. digital maps of the city and its parking spaces, information of parking fees and permits, digital parking machines and paying methods etc.)
- **Warranty of data protection guidelines** (e.g. European General Data Protecting Regulation (GDPR))

Figure 7: STO 2.4 Scan cars companies Brickyard (left) and Parkling (right) (Source: City of Stockholm)

In terms of **digitization**, the car park infrastructure (parking occupancy) was surveyed and mapped using so-called scan cars. This shows an interesting factor within some innovative measures: In this case, the invitation to tender was organised on a European scale, after it was not clear whether suitable companies could be found in the domestic market. By extending the catchment area, the providers could be selected within an innovation contest. This involves a longer preparation period for the urban authorities, which must be considered in the planning process. Subsequently, the so-called scan cars were able to map the parking infrastructure and transmit the data to the newly designed system (see below).

In terms of **data security**, it also shows that intensive preparation and the creation of a basis was necessary. In this context, several law studies have been carried out, due to the required legal permit for the demonstration with technical solutions regarding the European GDPR act, especially in case of using camera surveillance while mapping (e.g. ANPR and LIDAR method). Regarding data transmission, suitable interfaces and databases had to be created. This smart database had to be designed for large data volumes (real-time data) and meet the high requirements of data security (protective

firewall). In case of the necessary legal examination in Stockholm, a local legal consultant firm was commissioned to examine these issues. All this took four months already.

The actual **data collection and first tests** took another 15 months. Therefore, in case of Stockholm, two technical systems were used to map the parking infrastructure. One with scan cars and integration to parking machines and another one with Automatic Number Plate Recognition (ANPR) and Light Detection Ranging (LIDAR) solution. An important quality feature in the case of Stockholm was the recurring survey of the parking infrastructure by two companies: This allowed critical factors such as weather conditions and other changing factors to be considered. At the same time, the independent mapping by the two companies meant that the data could be verified and provided better results. This in turns means more effort and financial resources. The scan car drivers operated during two weeks per quarter according to a predefined route and time interval. Thus, the raw data could be generated and integrated into the system. Another important step to be mentioned here was the **stress test**, to check the parking management system for its viability. Test drivers were used to simulate the parking situation and to test the heat map application. Regarding the user side, the app for the search of parking spaces was developed and evaluated together with the car park operators (see figure 9). The app is continuously revised based on the feedback coming from its users. All in all, it is evident that the technical systems require **regular review** and need to be constantly developed further. Furthermore, the range of new technological devices and their evaluation shows that the necessary **know-how** for the implementation and operation of the measure is in the foreground. In particular, the maintenance of the system must be ensured by qualified employees, who must be trained in the new systems and introduced in advance. Special skills and knowledge were also required, for example, in the EU-wide procurement process of the innovation contest, in the case of Stockholm.

Figure 8: STO 2.4 Test run mobile apps (left) in Årsta area (right) (Source: City of Stockholm)

Business model and contractual partnerships

The **owner** of the measure and the system is the City of Stockholm. The owner of the technical solutions, on the other hand, are the companies commissioned from the Europe-wide innovation contest.

The necessary **costs** for the measure depend on the individual factors of the implementation. For example, the scan cars can be rented or purchased. The more intensive and frequent the mapping of the road system, the more cost-intensive the project will be. Once the new digital parking management system is integrated, personnel costs for traffic surveillance can be saved. If the necessary hardware should only be borrowed, the following costs can be identified:

- Rental of scan car (around 3500 Euro per week)
- Software (around 20000 Euro per year)
- Driver (around 110 Euro per day)

Consequently, costs of a total of 250000 Euro per year can be expected.

Critical challenges and success factors

During the implementation the following critical factors and challenges as well as their respective solution strategy could be identified:

- **Data security and data law:** The collection and dissemination of this sensitive data requires reliable and secure systems and stakeholders, who have access to the data. Various external law studies have been carried out to address this problem (e.g. GDPR, video surveillance)
- **Data capacity and data compatibility of new IT system** (high load capacity): to eliminate this risk, a stress-test was launched to examine the IT system
- **New technology as a risk factor:** This barrier was dealt with through testing (intensive testing phase) and through partnership with other companies to supplement with the additional knowledge and skills needed (e.g. partnership with Flowbird in case of Stockholm)
- **Acceptance of citizens:** In the case of Stockholm, the population was very interested in the new technology and the general measure, so no project-specific communication campaign was launched. In other cities, however, this can be considered as an option, as some of the data involved is sensitive.
- **internal organizational resources:** As already mentioned, technical know-how is needed to implement and maintain the technical solution. It is therefore advisable to introduce and explain the technical equipment to city employees so that they can operate the system.

Lessons learned from implementation/replicability

In retrospect, it has become clear that especially in projects, based on new technical solutions and sensitive data, comprehensive preliminary planning is necessary to

consider aspects such as data law or technical test runs. Regarding the data-based application, it also becomes apparent that a continuous update and improvement of the software-driven system is necessary.
Especially the test runs of the participating companies with the scan cars show that a long test phase, considering different conditions, like weather, delivers better results in the long run. Projects with new technical solutions should therefore consider that their implementation is often associated with errors and setbacks. It is often a first test version. However, this is a constructive process in which all stakeholders, based on their experience, feedback and their requirements, can continuously improve the technical system. This joint learning effect is positive, if feedback is taken on board and the infrastructure will be continuously developed.

Recommendations

By and large, the digitalisation of the parking system, including examining occupancy, is the basic prerequisite for the implementation of this measure. But also, for other measure, which gain to implement new technologies like in measure STO 2.4, it is advisable for a City to:

(1) examine the **privacy issues** and expresses concern for its citizens,

(2) have the rules and regulations in a **digital form**, which can also be done by a supplier

(3) develop a **digital map** of the City with good accuracy at least in the area where it intends to use Scan Cars

Regarding the **procurement process**, if a city plans to implement both, to measure the occupancy rate and to enforcement using a Scan car, then a city might have to make two tenders: firstly, to procure services of a company, which is able to establish maps of the parking places and the rules attached to these places and secondly, to procure services of a company which is specialized in enforcement and is in need of the new map. According to the experiences of one of the technological suppliers who took part in the measure of Stockholm, this two-part tender procedure is been done often in European cities.

Regarding the implementation, a **stress test**, to examine how many enquiries the city system can handle, should be implemented before launching the measure. Thus, the manual guards, who rely on the system, have no problems during the demonstration. For this purpose, a test-driver should also be taken into consideration as well, in case of the “heat map” application. Regarding the time frame of testing the measure, around 15 months have been estimated, which has been done by two different firms, in order to verify the test results. Moreover, the occupancy and enforcement were examined two weeks over a year – every quarter, to test the technology in different environments and weather conditions.

Another recommendation is the **timing** of the measure. In particular, a large time buffer should be considered for the tendering as well as the basis for the measure. It is

significantly dependent on the EU-wide procurement process, existing technical know-how and the digital registration of the road system by the local authorities.

Regarding the **spatial conditions**, it has been shown that a larger part of the suburbs should be subject to paying parking feeds as well as subject to enforcement of compliance. It is assumed that the city should have more than 6000 parking spots to benefit from the measure.

In retrospect, Stockholm has a positive attitude towards the measure and explains: *"Implementation of a scan car technology which this measure tested, can not only reduce parking search time, but also reduce emissions, increase compliance of citizens with the rules and regulations integrated and thereby increase the liveability of the city. This measure, which deals with testing new technology, responds to the broader objectives of many cities!"*

5. Conclusions

Even though the projects presented here are innovative and technically complex, the replication potential can be considered high. The development of smart solutions, which on the one hand aim at simpler use and on the other hand at reducing external effects in the transport sector (congestion, emissions etc.), can be regarded as a generally valid objective of all stakeholders involved and should therefore find easier acceptance.

It should be noted, however, that these projects are infrastructure-intensive and require intensive preparatory work in view of their intensive data use and digital connection and thus their resulting complexity. Not only the planning of these projects is time-consuming, but also the actual operation a maintenance of the infrastructures, since innovative projects often follow the “learning by doing” approach and therefore require continuous development. One of the most important aspects is public relations work, in order to inform about the objectives and thus promote and enable their future use. The added value must be clearly argued to the population, thus awareness and acceptance for the project has to be shaped. Innovative projects can create this awareness on their own, but also subject to intensive support.

6. Sources

- D2.3 Implementation Guide “New Parking Policies”
- D8.5 Measure Evaluation Report WP 2 / MAD 2.3
- D8.5 Measure Evaluation Report WP 2 / STO 2.4
- D8.5 Measure Evaluation Report WP 2 / STO 2.5
- D8.5 Measure Evaluation Report WP 2 / RUS 2.6
- CIVITAS ECCENTRIC Factsheets
- Discussions with Measure Leaders (interviews, workshops, etc)