Project no. 691735

REPLICATE PROJECT

Renaissance of Places with Innovative Citizenship And Technology

This Project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N° 691735

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REnaissance of PLaces with Innovative Citizenship And Technology

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H2020-SCC-2015 Smart Cities and Communities

Innovation Action (IA)

D10.13 Guidelines for ex-ante impact evaluation of replication scenarios

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1. EXECUTIVE SUMMARY

The objective of this document is to identify the guidelines (lessons learnt, barriers or difficulties overcame, etc.) that help cities to build the replication scenarios of the interventions implemented based on the monitoring process.

In Replicate, the monitoring is structured into 4 sections:

- City level monitoring: The monitoring programme for city level has 7 dimensions defined for classifying KPIs, covering all the city performance (city description, energy & environment, mobility, infrastructures for innovation, governance, social, economy & finance).
- Intervention level monitoring: The monitoring programme for interventions implemented in cities defines specific indicators to measure the impacts of interventions that are already in operation in each city.
- City Business Canvas monitoring: The monitoring programme for business models defines specific procedure for monitoring the viability of business models with the project.
- Replicability and success factors evaluation: The monitoring programme for replicability and success factors provides a qualitative way to evaluate the factors that make an intervention replicable and successful for a city.

To understand and to analyse the monitoring in Replicate, the steps or the working process followed in the WP10 to define and to apply the monitoring programmes of the three Lighthouse cities are summarized in these three points:

1. **Definition of the monitoring programme of each city**

   Firstly, the monitoring framework of the REPLICATE project was defined, in one hand, the city level monitoring framework was defined and, in the other hand, the main steps of the structure for monitoring of interventions were established. Based on this general framework, a KPI selection process was carried out and, the city level KPIs and the intervention level KPIs were selected by each Lighthouse City accordingly to their particular characteristics and specific interventions.

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Then, the monitoring procedure were defined for the city business models and the guidelines or methodology for the monitoring of the business models of interventions have been defined.

In addition, the monitoring platform in REPLICATE projects was defined and developed, with the objective of making visible the results of the monitoring programmes.

2. Monitoring process

The monitoring process has these steps:

- Request and compilation of required data / information in the city monitoring programme and final data of the baseline
- Data checking process
- Processing of the monitored KPIs and redaction of the "D10.10/11/12 Yearly reports monitoring city level indicators for the three lighthouse cities"

The process is aimed at monitoring the baseline situations and the indicators defined for each of the cities i.e. the city level KPIs and also for each intervention implemented in cities compiling the data for the intervention level KPIs, in order to evaluate the actual impacts or effects that the specific implemented projects have at city level.

3.Identification of guidelines [Related tasks: T10.6 | related deliverables: D10.13]

Finally, the guidelines (lessons learnt, barriers or difficulties overcame, etc.) are identified that help cities to build the replication scenarios of the interventions implemented based on the monitoring process.

With the aim at identifying the lessons learnt in the whole working process followed in the WP10, a survey is proposed and answered by the cities and their technical partners. The survey proposes questions to:

- Identify how appropriate / adequate the definition process of the monitoring programmes of each city had been
- How the results of the monitoring may facilitate the replication and scaling up of the interventions overcoming the difficulties / barriers

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- General recommendations cities would like share with other to explain their experiences

This document compiles the guidelines about the monitoring process of the three Lighthouse Cities, thanks to the answers provided in the abovementioned survey based on their own experiences, expectative and results obtained.

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2. REPLICATE

The main objective of REPLICATE project is the development and validation in three lighthouse cities (San Sebastián – Spain, Florence – Italy and Bristol – UK) of a comprehensive and sustainable City Business Model to enhance the transition process to a smart city in the areas of the energy efficiency, sustainable mobility and ICT/Infrastructure. This will accelerate the deployment of innovative technologies, organizational and economic solutions to significantly increase resource and energy efficiency improve the sustainability of urban transport and drastically reduce greenhouse gas emissions in urban areas.

REPLICATE project aims to increase the quality of life for citizens across Europe by demonstrating the impact of innovative technologies used to co-create smart city services with citizens and prove the optimal process for replicating successes within cities and across cities.

The Business Models that are being tested through large scale demonstrators at the three cities are approached with an integrated planning through a co-productive vision, involving citizens and cities' stakeholders, providing integrated viable solutions to existing challenges in urban areas and to procure sustainable services. Sustainability of the solutions is fostered in three areas: economic and environmental and finally, fostering transparency in the public management.

In addition, the Model features the replicability of the solutions and their scale up in the entire city and in follower cities, particularly in three follower cities (Essen – Germany, Lausanne – Switzerland and Nilüfer-Turkey) that are involved in the project and therefore, have access to know-how and results achieved on the project so they can apply the developed model. At the moment, there are 2 observer cities, Guanzhou (China) and Bogota (Colombia).

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3. INTRODUCTION

The main objective of this work package 10 is to elaborate and implement a monitoring methodology to be integrated in the general evaluation framework of the project. Once the whole process is carried out, it is interesting to have a look behind and to learn about positive and negative experiences in the whole process.

The objective of this deliverable is to identify the guidelines (lessons learnt, barriers or difficulties overcame, etc.) that help cities to build the replication scenarios of the interventions implemented based on the monitoring process.

3.1 Relation to Other Project Documents

Reviewing the working process followed, we can understand the relation to other project documents.

Steps of the WP10	Related tasks	Related deliverables
1. Definition of the monitoring programme of each city *In task T10.1 the monitoring framework of the REPLICATE Project was defined, in one hand, the city level Monitoring framework was defined and, in the other hand, the main steps of the structure for monitoring of interventions were established. Based on this general framework, a KPI selection process was carried out and, the city level KPIs and the intervention level KPIs were selected by each Lighthouse City accordingly to their particular characteristics and specific interventions.* *In task T10.3, the monitoring procedure were defined for the city business models and the guidelines or methodology for the monitoring of the business models of interventions have been defined.*	T10.1, T10.2, T10.3, T10.4	D10.1-9

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In task T10.4, the monitoring platform in REPLICATE projects was defined and developed, with the objective of making visible the results of the monitoring programmes.		
2. Monitoring process *The monitoring process has these steps:* • *Request and compilation of required data / information in the city monitoring programme and final data of the baseline* • *Data checking process* • *Processing of the monitored KPIs and redaction of the "D10.10/11/12 Yearly reports monitoring city level indicators for the three lighthouse cities"* *The task T10.5 is aimed at monitoring the baseline situations and the indicators defined for each of the cities i.e. the city level KPIs and also for each intervention implemented in cities compiling the data for the intervention level KPIs, in order to evaluate the actual impacts or effects that the specific implemented projects have at city level.*	T10.5	D10.10, D10.11, D10.12
3.Identification of guidelines *The objective is to identify the guidelines (lessons learnt, barriers or difficulties overcame, etc.) that help cities to build the replication scenarios of the interventions implemented based on the monitoring process.*	T10.6	**D10.13 Guidelines for ex-ante impact evaluation of replication scenarios**

Table 3.1: Working process followed and relation to other project documents

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3.2 Reference documents

This document is based in the following projects level documents:

Ref.	Title	Description
REPLICATE Grant Agreement signed 240713.pdf	Grant Agreement	Grant Agreement no. 691735
REPLICATE Consortium agreement signed December 2015 (7th December version)	Consortium Agreement	REPLICATE project – Consortium Agreement
REPLICATE Project Management Plan	D1.1 Project Management Plan (v.1) (29/04/2016)	REPLICATE Project Management Plan
REPLICATE WP10 Monitoring	D10.1 Report on indicators for monitoring at project level D10.2 Report on indicators for monitoring at city level D10.3 Baseline analysis of city level indicators for follower cities and benchmarking with lighthouse cities D10.4 Monitoring programme for San Sebastián D10.5 Monitoring programme for Florence D10.6 Monitoring programme for Bristol D10.7 Report for monitoring business models – energy/mobility/ICT D10.8 Protocol for integrating monitoring data into the ICT platform D10.9 Operational Dashboard and online visualization tool for key performance indicators	See *Table 3.1* above.

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Ref.	Title	Description
	D10.10 Yearly reports monitoring city level indicators for the three lighthouse cities Y1 D10.11 Yearly reports monitoring city level indicators for the three lighthouse cities Y2 D10.12 Yearly reports monitoring city level indicators for the three lighthouse cities Y3	

Table 3.2: Relation of the report "D10.12 Yearly reports monitoring city level indicators for the three lighthouse cities Y3" with other project level documents

3.3 Abbreviations list

CoM	Covenant of Mayors
DH	District heating
EC	European Commission
EV	Electric vehicle
GA	General assembly
PV	Photovoltaic
RES	Renewable Energy Source
TES	Thermal energy storage
WP	Work Package

Table 3.3. Abbreviations list

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4. DELIVERABLE DESCRIPTION

This deliverable compiles de guidelines about the monitoring process of the three Lighthouse Cities, thanks to the answers provided in the abovementioned survey based on their own experiences, expectative and results obtained.

Each city answered the survey (check Annexes) and based on those answers an analysis has been carried out specifically for each lighthouse city:

1. Quality of the Monitoring Process in the city: The city provides the feedback or opinion related to:

    1.1 The ex-ante situation and general opinion of the monitoring process, including an overall opinion and expectations

    1.2 The definition process of their monitoring programme.

    - The monitoring framework of the REPLICATE Project was defined, in one hand, the city level Monitoring framework was defined and, in the other hand, the main steps of the structure for monitoring of interventions were established. Based on this general framework, a KPI selection process was carried out and, the city level KPIs and the intervention level KPIs were selected by each Lighthouse City accordingly to their particular characteristics and specific interventions. The monitoring programmes in REPLICATE are structured into 4 blocks:
        - City level monitoring
        - Intervention level monitoring
        - City Business Canvas monitoring
        - Replicability and success factors evaluation
    - So, cities provide their experiences during the whole definition process and they assess the resulting structure of the monitoring programmes.

    1.3 The monitoring process, which is an iterative process:

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- Request and compilation of required data / information in the city monitoring programme and final data of the baseline
- Data checking process
- Processing of the monitored KPIs and redaction of the deliverables "D10.10/11/12 Yearly reports monitoring city level indicators for the three lighthouse cities"

2. Monitoring results of the city

   2.1 Firstly, a general opinion of the results obtained thanks to the monitoring is explained by cities. Considering that the deliverables D10.10-12 are the format to show the results of the monitoring in the Replicate project, cities provide their point of view on regard to the usefulness and the quality of the results of the monitoring and also have the opportunity to suggest tips to improve these monitoring results.

   2.2 After that, an intervention by intervention analysis is carried out in each city, assessing those aspects or factor that may facilitate or make it more difficult or less interesting betting for a specific kind of intervention.

3. General Recommendations from the city

   3.1 To finish, the cities have the chance for story-telling about their own experience in the WP10 and in other projects or initiatives, so that their total monitoring experience can be reflected without questions to guide their words, resulting in a really enriching contribution.

After this city by city analysis, some general conclusions are obtained and agreed among all the partners, and mainly the Lighthouse cities, as guidelines for others (projects, cities, companies, etc.) facing a process of monitoring the evolution and the performance of their activities or projects.

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5. GUIDELINES for DONOSTIA – SAN SEBASTIAN

5.1 Quality of the Monitoring Process in Donostia – San Sebastián

The city of Donostia – San Sebastián has previous experience in monitoring processes and has extensive track record in European, national and regional projects having as a result the experience to afford monitoring processes. The expectations of Donostia – San Sebastián in the REPLICATE project regarding the monitoring were to collect, process, analyse and evaluate detailed data about the interventions carried out in the city for at least two years getting the Key Performance Indicators (KPIs) of the implementations. The monitoring process was expected to be a tool for measuring results that would help the decision-making processes, in order to improve the impacts obtained for each intervention regarding the city goals and would also be important for the scale-up and replication plans definitions. In addition, the monitoring would provide the city with objective data that would help to communicate and disseminate the project achievements.

All the Donostia – San Sebastián partners involved in REPLICATE have taken part in the monitoring program and it should be highlighted that these stakeholders' commitment has been an important aspect for the success. From the very beginning of the project, meetings were carried out with all the partners first and with individual interventions partners afterwards, in order to explain and to make them aware of the importance of the monitoring activities. Not all the partners had previous expertise in monitoring and Fomento de San Sebastián has undertaken the role of coordinating the city monitoring and supporting the pilot partners in the process.

The KPIs have been designed together being a positive aspect for the engagement and awareness of the partners. The methodology and the KPIs design are not simple processes and they require an analysis of what should be monitored, how, when and of course what for.

On regard to the data, the monitored data are used by project partners, by city coordinator Fomento San Sebastian, by the Municipality and some data are made public through the Municipal open portal, being part of it also Linked Open Data (LOD), contributing to the transparency and democratisation of the data, while linking the city to others.

In addition, the monitoring of the interventions has allowed the intervention leaders to take decisions in order to improve the results obtained in an iterative process. The impact in the city has been measured thanks to the monitoring and its evolution has been analysed, contributing to the process to scale-up of interventions in the city and also to their replication analysis and processes.

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An aspect that should be taken into account is the availability of some data and their periodicity. Several data sources are considered for city level monitoring and it has not been easy to get all the desired information in a similar way. In order to face this difficulty, the data collection process needs to be carefully designed to optimise the efficiency of the resources required for the data collection. Even if many data are automatically obtained, not all data can be integrated in that way. Evidently, the quality of the obtained data is also to be taken carefully in order to get accurate KPIs. An important aspect to consider is the type of data is being processed, taking exquisite care in relation to compliance with GDPR.

On the other hand, a great temptation with monitored data is to use it to compare interventions implemented in different cities. However, it should be considered that data usually are not measured exactly in the same conditions (baselines, climatological conditions, etc.) and the conclusions would not be of a value neither representatives therefore, monitored data should be analysed carefully.

Sharing monitoring methodologies and experiences is of a great value and should be reinforced since it allows cities to learn from each other, getting information that would facilitate the design of specific and adapted replication plans. The contribution of monitored data to European initiatives, such as SCIS (Smart Cities Information System) or Smart Cities Market Place, which allows the dissemination of city and project data, constitutes a very interesting platform to which REPLICATE has contributed since the beginning of the project.

The city of Donostia – San Sebastián and its stakeholders are aware of the benefits of monitorisation and other initiatives and projects are also undertaking monitoring processes.

Finally, Donostia – San Sebastián has taken advantage of the monitoring process also to analyse the effects of the exceptional COVID-19 impact in the city.

5.2 Monitoring results of Donostia – San Sebastián

For all Lighthouse Cities, a number of facilitators and difficulties or barriers (technical, economic, social, environmental, political and legal) have been identified before sending the surveys (thanks to the workshop held in October 2019 in the GA in Florence) for the following interventions:

(1) District Heating

(2) Building Retrofitting

(3) Smart Public Lighting

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(4) Electric buses and recharging infrastructure

(5) Four wheels electric vehicles

(6) Two wheels electric vehicles

These results obtained in cooperative work among all the cities and the results of the analysis of Donostia – San Sebastián, with a total of five interventions, are shown in Table 5.1:

Intervention	Facilitator aspects	Difficulties or barriers
District Heating	**Technical:** Benchmark of similar experiences in size and location. **Economic:** (1) Economic savings, (2) Procurements lessons, (3) Comparison between different costs of fuel. (4) Analysis of proximity forest resources (biomass) (5) Information on the trend of energy/fuel costs **Social:** (1) Avoid fluctuance costs, (2) Supply guarantee, (3) Impact in the bill of energy. (4) Avoid individual gas boilers. (5) Positive environmental impact. **Environmental:** (1) Use of renewable resources, (2) Decrease of non-renewable primary energy use, (3) Increasing of local resources use, (4) Improvement of the environment, (5) Save of energy in terms of demand and use. **Political and Legal:** (1) Develop of Municipal regulatory framework in order to promote this type of solutions, (2) National framework (and regional/local) and incentives.	**Technical:** (1) Procurement procedures. (2) Inexistence of other similar public initiatives in the region. (3) Coordination with parallel urbanisation works. **Economic:** High cost. **Social:** Not used to DH solutions. **Environmental:** Emissions' analysis needed. **Political and Legal:** (1) Availability of space in existing urban contexts, (2) Procurement procedures for public DH.
Building retrofitting	**Technical:** Assessment of the table work done. **Social:** (1) Community of "green people", (2) Building/home value increased, (3) Comfort, healthy. (4) Noise reduction (insulation, new windows and DH connection). **Economic / Environmental:** Less energy consumption – Efficient buildings. **Political and Legal:** (1) National framework and financial contribution, (2) Less taxes, (3) Compulsory improvements for building >50 years.	**Technical:** Good execution and coordination is required. Social: (1) Citizen engagement required. (2) Noise and dust, (3) Works time. **Economic:** (1) Funding needed. (2) Financing may be difficult without funding or the adequate financing model. (3) Owners' payment.
Smart Public Lighting	**Technical:** (1) Possibility to offer more services (IP services, WiFi, video surveillance, etc.). (2)	**Technical:** In some cases, decrease of lighting levels.

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Intervention	Facilitator aspects	Difficulties or barriers
	Optimization of lighting levels possible. (3) Optimization of lighting municipal management and maintenance. **Economic:** Economic savings. **Social:** (1) Potential of offering smart services. (2) Security provided. **Environmental:** Mitigation of climate change, less CO2, less emissions.	**Economic:** Funding required for city level scaling-up.
Electric buses and recharging infrastructure	**Technical:** Local manufacturers with required technology. **Social:** High social acceptance. **Environmental:** Mitigation of climate change, emissions and noise reduction	**Technical:** (1) Batteries performance, duration of the recharge. (2) Some bus operators prefer hybrid buses. **Economic:** Expensive.
Four- and two-wheels electric vehicles	**Technical:** Technology already available. **Social:** (1) Administration as a showcase to foster electromobility actions in the city. (2) High social acceptance. **Environmental:** Mitigation of climate change, emissions and noise reduction. **Economic:** Maintenance costs reduction.	**Technical:** (1) Batteries performance, duration of the recharge. (2) Few models available in the market. (3) Recharging infrastructure required. **Economic:** High initial investment.

Table 5.1 Facilitator aspects and difficulties or barriers for interventions realised in Donostia – San Sebastián

All interventions have clear environmental advantages. Economic savings is evident for Smart Public Lighting, but not so much for other interventions, especially EV, due to the investment required. The establishment of regulatory frameworks will promote district heating and building retrofitting, and counter e.g. the high investments. In general, social acceptance is high, either due to economic savings, the well-known environmental benefit or other advantages such as the increase of homes value, greater comfort and healthier homes in the case of retrofitting. Technically, some hurdles have to be overcome, but all interventions are feasible.

The **District Heating** System (DH), developed by Fomento San Sebastián, has been a complicated project due to several factors, as it has been the first DH project for the Municipality and the first publicly owned DH system in the region, and the difficulty of ensuring compliance with a sustainable business plan. In addition, the variables of demand and the required investment, as well as the quality of the service that is to be lent, have generated doubts about the suitability for the City Council. For its approval, finding financing channels has been key, as well as the public-private collaboration model defined, and the number of homes built in the Txomin-Enea neighbourhood to be connected to the DH. The reality is that it is not usual to build new neighbourhoods of this size in Donostia – San Sebastián. A feasible project has been designed with a business plan with sufficient

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guarantees to overcome the obstacles encountered along the way. Thanks to the extensive knowledge and experience obtained from the process of developing this DH installation, the Municipality could detect potential opportunities to replicate in other areas of the city.

The **Building Retrofitting** intervention has numerous benefits. On the one hand, the interior comfort of homes is improved while reducing energy consumption (and associated costs) and CO_2 emissions, improving the environmental quality of the old buildings and so of the neighbourhood. On the other hand, the renovation of the dwellings means they are revalued and are properly integrated within the neighbourhood. In this case retrofitted buildings have been connected to the new DH and as a result the energy consumption in the buildings is renewable energy. In addition, the noise is reduced due to the insulation, windows replacement and DH connection (individual boilers suppression). The citizen engagement is one of the key factors of the success of retrofitting interventions while maintaining fluid communication and confidence with neighbours is essential. The inconveniences caused by the works together with the high costs and the necessity of a financing model might be the most complicated aspects of the intervention.

Smart Public Lighting intervention has mainly advantages. There is a relevant reduction on energy consumption thus reducing the expenditure for the municipality while reducing the CO_2 emissions, which contributes to the environmental improvement. Maintenance and management costs are also reduced. The created LAN network can be used for additional IP devices and to support new services taking advantage of the existing infrastructure. The main barrier to the scale-up at city level is the cost of the intervention, so funding would be a facilitator to accelerate the replicability of this intervention.

In the case of **electric buses and recharging infrastructure** intervention, technological limitations should be taken into account by urban transport operators. The performance of the batteries and the time required for a full charge might be considered when scheduling bus assignments, which will allow to maximize e-buses performance and to make them suitable and attractive for more bus lines. Therefore, monitoring is necessary to obtain detailed information on the service performance and constitutes a tool to adjust and improve the service. Nevertheless, the technology is improving rapidly, and the limitations are being resolved with new models. Apart from technical aspects, the actual high cost of e-buses might be a significant barrier that could be overcome by specific financing models. Everything else is all benefits: reduction of emissions and noise that contribute to mitigating climate change in cities, high social acceptance, etc.

Four- and two-wheels electric vehicles actions undertaken by the Municipality serve as a showcase to foster the transformation towards electromobility among citizens and other public and private entities in cities. Electric vehicles are accepted as a real alternative having a high acceptance in the citizenship in spite of the still high prices and the technological limitations (few models available in

the market, autonomy improvements requested for higher acceptance, etc.). The need of a recharging infrastructure slows down this transformation and monitoring has been and is a key tool to publicize the positive impact of the solution and to influence the general opinion. Emissions and noise reductions clearly contribute to the environmental improvement. On the other hand, business and funding models are needed to accelerate and extend the number of electric vehicles in cities.

5.3 General Recommendations from the City of Donostia – San Sebastián

The monitoring process is an appropriate tool for measuring and sharing results of different interventions that contribute to the decision-making processes for the scale-up and replication plans not only in city of Donostia – San Sebastián and REPLICATE Lighthouse and Fellow cities, but also in other European cities. Some European initiatives, such us SCIS (Smart Cities Information System) or Smart Cities Market Place, also contribute to this end. That way, European cities without prior experience could take advantage of other cities with experience in monitoring processes.

Involving city stakeholders and municipal departments in the process is a key aspect from the design phase. It might be difficult to define the KPIs in the early stages of implementations, however this effort is invaluable and speeds-up the iterative monitoring process that is undoubtedlyimproved with stakeholder participation. The results obtained are useful for the entities involved in the implementations and would allow them applying measures to improve the performance and management of the interventions, thus contributing to the increase of the impact of the interventions in the city. Municipal portals, fed by the monitored data, contribute to the transparency and democratisation of data.

Coordination between the city stakeholders (companies, entities and municipal departments) involved in the monitoring program, together with the municipal leadership, are essential, and the flexibility and adaptability during the process are necessary to achieve a successful monitoring program of great value for all of them. Sharing experiences both internally at city level and also at project and European level is important to continue improving the process.

Thanks to the monitoring program already implemented, it has been possible to measure the impact of the COVID-19 in the interventions of the REPLICATE project and in the city's KPIs. The data from the period of the pandemic situation has been compared (and is still being compared) with the data from previous "normal" situation, measuring the impact through the project KPIs. This information constitutes an important value for local entities and for the Municipality. All the data related to COVID-19 is also being published on the municipal portal, thus taking advantage of the REPLICATE deployments already carried out in the city.

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6. GUIDELINES for FLORENCE

6.1 Quality of the Monitoring Process in Florence

The city of Florence already has experience in monitoring and had a clear idea about what to expect from the REPLICATE project. The expectation of Florence on regard to the WP10 is obtaining information on the impact of interventions in order to:

- Highlight achievements and weaknesses
- Support decision making and planning
- Determine the replication potential
- Communicate results

One way of maximizing impact has been by making data available to stakeholders in the Smart City Control Room and, thanks to the H2020 CoME EAsy project, by publishing them for benchmarking and for using them for the Covenant of Mayors (CoM) monitoring.

One of the problems that has been detected is that precisely the obtained data is useful for defining the boundary conditions of the interventions, making their initial definition difficult. Partly the iterative process has countered this, so that positive results have been obtained.

Another barrier is the fact that rough data is not easy to interpret and had to be processed, which has demonstrated to be time consuming.

For some data GDPR has to be considered and frequently, it is hard to obtain data yearly, so it is recommended, especially since the whole process is time consuming, to collect date every two years.

Concerning the methodology, it did not allow to detect other services that could be exploited or external threats such as the pandemic. Also, no information on the legal framework or the economic context (as no comparative data on energy costs or investments have been reported) was searched for.

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6.2 Monitoring results of Florence

For all Lighthouse Cities, a number of facilitators and difficulties or barriers (technical, economic, social, environmental, political and legal) have been identified before sending the surveys (thanks to the workshop held in October 2019 in the GA in Florence) for the following interventions:

(1) District Heating

(2) Building Retrofitting

(3) Smart Public Lighting

(4) Electric buses and recharging infrastructure

These results obtained in cooperative work among all the cities and the results of the analysis of Florence, with a total of five interventions, are shown in the Table 6.1:

Intervention	Facilitator aspects	Difficulties or barriers
District Heating and RES	**Technical:** Benchmark of similar experiences in size and location. **Economic:** (1) Economic savings, (2) Procurements lessons, (3) Comparison between different costs of fuel. (4) Analysis of existing energy demand for existing boilers in the city, (5) Information on the trend of energy/fuel costs. **Social:** (1) Avoid fluctuance costs, (2) Supply guarantee, (3) Impact in the bill of energy. (4) Avoid responsibilities about boiler management, (5) Positive perception of its environmental impact. **Environmental:** (1) Use of renewable resources, (2) Decrease of non-renewable primary energy use, (3) Increasing of local resources use, (4) Improvement of the environment, (5) Save of energy in terms of demand and use. **Political and Legal:** (1) Develop of Municipal regulatory framework in order to promote this type of solutions, (2) National framework (and regional/local) and incentives.	**Technical:** (1) Procurement procedures (only components on the market), (2) Poor quality of historical data for the baseline and of the data of border conditions, (3) Room space for RES. **Economic:** Procurement: difficulties comparing costs. **Social:** No control on fixed costs, days/hours of heating. **Environmental:** (1) In case of biomasses local emissions, (2) Emissions' analysis should include other pollutants than CO_2. **Political and Legal:** (1) Availability of space in existing urban contexts, (2) Procurement procedures (and timing) in case of public DH.
Building retrofitting	**Technical**: (1) Assessment of the table work done. (2) Adequate type of building.	**Technical:** (1) Good execution is required .(2) Not adequate type of building, (3) Shape of

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Intervention	Facilitator aspects	Difficulties or barriers
	Economic: (1) Action on shell and plant together, (2) National supporting framework (and regional/local) and incentives, (3) Detailed baseline conditions and data. **Environmental:** Extending monitoring to other pollutants than CO_2. **Economic / Environmental:** Less energy consumption – Efficient buildings **Social:** (1) Community of "green people", (2) Building/home value increased, (3) Comfort, healthy. (4) Noise reduction (insulation, new windows). **Political and Legal:** (1) National framework and financial contribution, (2) Less taxes, (3) Compulsory improvements for building >50 years.	buildings and year of construction, details on ex-ante situation required. **Economic:** (1) Funding needed. (2) Different costs in different nations, (3) Procurement procedures in case of public buildings, (4) National (and regional/local) framework and incentives for timing and requirements. **Social:** (1) Disruption of external spaces during works, spoiling of balconies and terraces, (2) Noise and dust, (3) Construction time. **Legal:** (1) Landscape/historical buildings boundaries, (2) Lack of detailed baseline conditions and data.
Smart Public Lighting	**Technical:** (1) Possibility to offer more services (Wi-Fi, video surveillance…). (2) Optimization of lighting levels possible. **Economic:** Economic savings. **Social:** (1) Potential of offering smart services. (2) Security provided. **Environmental:** Mitigation of climate change, less CO_2, less emissions. **Political and Legal:** Presence of lighting plan and national standard requirements.	**Technical:** In some cases, decrease of lighting levels. **Economic:** Extension of the service, number of km^2 or m^2 lightened.
Smart Grids	**Technical:** Adding the "users served" KPI will facilitate replication. **Economic:** Highlighting indirect impacts and services enabled that could be part of the business model **Social:** A more reliable grid could enable more services like vehicles charging stations, RES… **Environmental:** Highlight indirect impacts would facilitate replication.	**Social:** Faults can cause problems to home devices. **Legal:** Not or not well-regulated ownership and procedures for connected services.

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Intervention	Facilitator aspects	Difficulties or barriers
EV and Recharging Infrastructure	**Social:** (1) High social acceptance. (2) Standardization of the approach (sockets, payments, apps…). (3) Monitoring duration of batteries (real consumptions / km). **Environmental:** (1) The de-carbonisation of electricity mix could multiply the effects of e-mobility actions, (2) The local emissions could benefit from the absence of other pollutants (NOx, PM, noise, COx…). **Legal:** (1) Standardisation, (2) Easier authorization procedure for the deployment of charging stations.	**Technical:** (1) Compatibility with vehicle models, (2) Duration of the recharge, (3) requirements of the grid. (4) Some taxi operators prefer hybrid vehicles. **Economic:** (1) Expensive. (2) For market offers for mobility sector, electricity rates can affect the business models (for example in case of an e-taxi). **Social:** Users are sceptical because of the technical requirements and the different approaches.

Table 6.1 Facilitator aspects and difficulties or barriers for interventions realised in Florence

In general, all interventions have clear environmental advantages and social acceptance is high, either due to economic savings, the well-known environmental benefit or other advantages (such as the increase of homes value, greater comfort and healthier homes in the case of retrofitting). Technically, some hurdles have to be overcome, but all interventions are feasible.

In the case of the specific combined intervention **District Heating and RES** (Renewable Energy Sources) a few drivers and many barriers were found due to the location selected for the pilot. The environmental advantages, particularly less CO_2 emissions, and having more information on the energy demands and fuel costs will facilitate the implementation of District Heating. The establishment of regulatory frameworks will promote district heating and building retrofitting, and counter e.g. the high investments .Procurement has been found to be a major barrier, being complicated and time-consuming in the case of public procurement. Only component offers and difficult comparison of costs were an added difficulty. Also, it has been found hard to cope with poor baseline date and the fact that often not enough space is available for RES. Users were not so happy with not being able to control fixed costs compared to autonomous systems.

Building Retrofitting has numerous advantages. Positive effects can be increased when working on as well the shell as the plant. The type of building can either facilitate or make more difficult retrofitting. For example, in the case of historic buildings or protected landscapes, retrofitting may not be possible or be very difficult. Incentives by the administration are a true facilitator, as the investment is relatively high for habitants, even though some of the requirements might block true progress. For dwellers, savings, both economically and environmentally, are important and the noise reduction is an added motive for satisfaction. On the other hand, works are great disruption,

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especially outside, and a source of noise and dust. Frequently, works do not finish on time, creating more inconveniences in the neighbourhood.

In the case of **Smart Public Lighting**, except for the investment required to extend the service over many km^2 or m^2, only advantages and facilitators were found. It has been found very interesting the additional services can be offered, such as Wi-Fi or video surveillance, allowing smart services and more security. Since light levels can be adjusted to optimal levels, electricity consumption goes down meaning less CO_2 emissions and therefore contributing to mitigating climate change. Having a lighting plan and national standard requirements facilitate extending or replicating Smart Public Lighting.

Nowadays, for **Smart Grids** substantial barriers have been found. For instance, not or not well-regulated procedures for connected services may block implementing new services. If this would be solved and if the grid would be more reliable, new services such as RES or electrical vehicle charging stations could be implemented. Also, faults are a problem, since devices may be damaged. For facilitating replication, indirect impacts and services should be considered and highlighted. With indirect impacts, both economic as environmental, are meant. Finally, it would interesting for replication having an "users served" KPI, as this is a clear and significant impact.

For **EV and Recharging Infrastructure**, important setbacks have been found due to the lack of standardization, the long duration of recharges and the increasing requirements on the grid. Compatibility issues with vehicle models and different requirements and approaches demotivate potential users. Strong standardization (e.g. sockets, payments, apps…) and more agile procedures for authorizing charging stations would facilitate take-off of EV's and recharging infrastructures. Even though local pollutants (NOx, PM, noise, COx…) will be reduced by increased use of EV's, decarbonizing the electricity mix could multiply the effects of e-mobility actions. Finally, business models based on e-mobility have to be carefully analysed, such as the case of the e-taxis, whose profitability strongly depends on electricity rates.

6.3 General Recommendations from the City of Florence

The monitoring methodology developed and applied in the WP10 in the REPLICATE project has represented great learning for the city and is considered very useful for the future., Specifically, for the case of Florence, the methodology has been replicated in the framework of H2020 CoME EAsy project to develop open tools compliant with different initiatives (CoM, SCC, ISO, EEA,…). This project has been taken as reference by the European Energy Award network in the framework of CoME EAsy project, coordinated by SPES, and Florence has been one of the Ambassadors of pilots.

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The city level indicators set, inherited by STEEP and further developed for Smart cities in REPLICATE, has become a good reference to trace achievements and to benchmark with other cities: it has been further developed to create a KPIs dashboard for the EEA/CoM members. And the intervention level has been included in the description of the Best practices to be published in the new EEA library.

This is a clear sign of the value of the procedure followed, the methodology developed, and the results obtained in the WP10 of the REPLICATE project and the importance of standardizing methodologies and procedures flexible enough to adapt to the specific reality of each city.Summarizing, the alignment of the monitoring programme implemented in REPLICATE with the European standard and procedures, together with the adaptation to the reality of the city of Florence and the interventions deployed in, results in a good mark for the monitoring applied in the WP10 in REPLICATE, despite of the inherent difficulties of this kind of methods.

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7. GUIDELINES for BRISTOL

7.1 Quality of the Monitoring Process in Bristol

Bristol City Council has experience in monitoring processes and has been involved with many H2020 and UK funded projects and is aware of the requirements of monitoring needed. The expectations of the monitoring process were that partners would gather information for two years from the point of deploying their intervention and record centrally so the data could be collated and evaluated by the University of the West of England. However, these expectations were not fulfilled as many interventions went under some kind of amendment or deviation from the original plan which had impacts on monitoring. This challenged expectations due to unforeseen changes to deployment which affected some methods of data capture which were no longer viable and had to be rethought, dates to start monitoring moved and format of data required, i.e. energy/CO_2 consumption recorded but this doesn't seamlessly align to requirements to report as savings. Partners have struggled to capture data across all four sub sections for monitoring depending on the intervention and changes required in their deployment.

It has been found that the monitoring process offers added value for partners and other cities by evaluating whether an intervention is valuable or not. This added value also coincides with the goal of the City Council for the project. Concerning exploitation of the potentiality of a monitoring programme, stakeholders and the city are ready to do so through the One City Plan, in which outputs are already monitored and benchmarked. Thanks to this approach, many stakeholders across the city are undertaking monitoring programmes looking to exploit potential and are particularly addressing interdependent challenges such as: growing an inclusive, sustainable city that both resolves social fractures, inequalities and reaching carbon neutrality.

It must be said that working on the monitoring framework before implementing innovative interventions has caused confusion and difficulty. Depending on the position of the partner involved, it was difficult to foresee the whole picture. Bristol would suggest in the future that key aspects of the framework are explored and kept in mind, but closer to the time of deployment when all details are known (and changes taken into consideration) would be a better time to fully define details of the monitoring framework maintain a clear approach to the project outcome format requirements (i.e. CO2 emissions savings). Concerning the working process, not all partners of an intervention are technical or have full oversight of the companies' outputs and find it difficult to understand the need and relevance for monitoring at such a detailed level. Also, it may have been beneficial to have one technical partner who oversees monitoring and evaluates findings for consistency.

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City Level KPIs monitoring has proved in some cases difficult to collate. Different data sets are collected from various sources and not all available internally or consistently year on year. While the KPIs were agreed at an early stage of the project, changes in the council meant that some data was only provided for a snapshot in time and proved too difficult to maintain yearly. Additionally, when internal and UK policy changed, some data fields were no longer collected. Utilising data from an external website carried risk that it was no longer supported part way through the project. The time lag (such as, census data and UK regulated data) and units measured of some data has proven not to be useful also in providing a picture for the city. Datasets within the council are evaluated annually by specific departments on their validity and therefore some datasets are deemed unnecessary or have been collated as a snapshot in time which then just highlight holes in the system.

The overall picture of the city is to compare the benefits provided, and even more so, the annual updates of city level KPIs, in some areas, made no sense from the point of view of the beneficiaries (service areas in the municipality, companies, etc.) of the monitoring reports. Monitoring city and council level KPIs is carried out by the strategic insights team who report quarterly. While some of the KPIs were close to the data collected, it did not always directly correlate. For other data, this was only being recorded for the department and not centrally recorded for council purposes.

With regards to the intervention level monitoring, the process can be improved by having the foresight of the data that can be collected and that will provide valuable insight for the project. As interventions have deviated throughout their deployment, new datasets and KPI have been discovered as more valuable. Also working with third party contractors, it has not always been easy to access data or have the ability to collate in the ways needed due to delivery timescales not running according to plan even when planned for at an early stage. Bristol partners recognise that there is a need for top level mandatory KPIs, however as innovative solutions often change in nature during deployment, there is a need to allow for organic processes to develop key datasets as the deployment evolves. Unfortunately, this does not align with the need to report progress back to the European Commission yearly through deliverables . A clearer understanding from the city is needed of the measurement format requirements of data collected to ensure an easy process of achieving results from partners and reporting the data effectively.

In addition, not all partners have a monitoring background and some, particularly if not involved in a project of this size, don't understand the need for this level of data. Training for all partners could perhaps have ensured all cities are on the same understanding basis from the start of the project (although with staff turnover, this does raise issues).

For the city, it is not clear whether the iterative process is useful. However, it is easier to ascertain the progress of the technical partners as more is understood around the intervention and dependencies. The main challenges the technical partners have faced in this process were due to

some amendments throughout the project and ultimately changing the timescales of that intervention and potentially dependent interventions also. Planning the monitoring process for the whole theme has also been an issue as each city will have a different method and potentially collating data and often has had to join different types of data that come from several sources as well as different formats. This can result in the displayed data not being accurately comparable even though it is reporting the same action.

7.2 Monitoring results of Bristol

For all Lighthouse Cities, a number of facilitators and difficulties or barriers (technical, economic, social, environmental, political and legal) have been identified before sending the surveys (thanks to the workshop held in October 2019 in the GA in Florence) for the following interventions:

(1) District Heating

(2) Building Retrofitting

(3) Smart Public Lighting

(4) Electric vehicles and recharging infrastructure

These results obtained in cooperative work among all the cities and the results of the analysis of Bristol, with a total of five interventions, are shown in the Table 7.1:

Intervention	Facilitator aspects	Difficulties or barriers
District Heating	**Technical:** Benchmark of similar experiences in size and location. **Economic:** (1) Economic savings, (2) Procurements lessons, (3) Comparison between different costs of fuel. **Social:** (1) Avoid fluctuance costs, (2) Supply guarantee, (3) Impact in the bill of energy. **Environmental:** (1) Use of renewable resources, (2) Decrease of non-renewable primary energy use, (3) Increasing of local resources use, (4) Improvement of the environment, (5) Save of energy in terms of demand and use. **Political and Legal:** (1) Develop of Municipal regulatory framework in order to promote this type of solutions, (2) National framework (and regional/local) and incentives.	**Technical:** Product designed for the project. **Economic:** (1) Low gas price, (2) Cost of data transfer and software administration, (3) Pipeline costs higher than expected due to historic and dense underground environment. (4) Delays delivery due to unforeseen issues, such as water quality of pipe. . **Social:** Education required for getting used to the new heating system for optimal exploitation. **Environment:** Biomass generates local pollution. **Legal:** Changes to government policies / reduction in funding streams mid project development

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Intervention	Facilitator aspects	Difficulties or barriers
Building retrofitting	**Technical:** (1) Assessment of the table work done. (2) Assessment of existing property efficiency, (3) Estimated energy savings (CO_2 and kWh/m^2) **Economic:** (1) EU Funding. (2) Reduction in fuel cost. **Environmental:** Renewable system to homes who proceeded with Solar PV install. **Social:** (1) Community of "green people", (2) Building/home value increased, (3) Comfort, healthy. (4) Reduced risk to health of living in cold home, (5) Working with community energy groups, (6) Events within the community to engage, (7) Reduction in fuel poverty. **Economic / Environmental:** Less energy consumption – Efficient buildings. **Social and Environmental:** Reduction in CO_2 emissions. **Political and Legal:** (1) National framework and financial contribution, (2) Less taxes, (3) Compulsory improvements for building >50 years. (4) Helping towards Bristol's 2030 carbon neutrality target.	**Technical:** (1) Good execution is required. (2) Monitoring can be difficult as it may be hard to get bills from end users as unable to use SMETS meters for collating data **Economic:** (1) Funding needed. (2) Financing may be difficult without funding or the adequate financing model – depending on intervention households pay some costs **Social:** The view of the council within the community. **Environment:** KWh savings from bill data.
e-Bikes Sharing System	**Social:** Interest of some individuals in the data that was being generated. **Environmental:** E-bikes are increasingly being seen as an effective alternative to the car (and since COVID-19 to public transport as well).	**Technical*:** a robust system for tracking bookings and bike movements is essential. Users need easy access to facilitate use **Social:** incompatibility between privacy and monitoring. **Economic:** original e-bikes needed to be upgraded to a different model. **Legal:** need to be a consistent set of objectives across the municipality areas, for approval of initiatives. **Political*:** Buy-in of all areas of municipality is required.
EV cars (Co-Wheels Car Club)	**Technical:** (1) Using a relevant booking system, (2) Continue using off the shelf hardware and provided by TrakM8 for replication. **Social:** Inclusion of social-economic considerations including demographic make-up of location / travel to work methods, etc.	**Economic:** (1) Not yet competitive sales price, (2) Funds required to support TrakM8 subscription for monitoring. **Social:** (1) Monitoring activities may cause social pushback. (2) Use of electric vehicles range capacity still causes scepticism.

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Intervention	Facilitator aspects	Difficulties or barriers
	Environmental: Focus on sustainable /zero emissions policies. **Legal:** Enforcement of Car Club / Car Share dedicated charging points.	**Legal:** Need to study impact of GDPR.
Electric vehicle charging points	**Economic:** Previous deployment of 120 charging points in Bristol through the Go Ultra Low project from which 34 are funded by the REPLICATE project. **Social:** (1) High social acceptance. (2) Wide presence of EV charging bays and promotional campaigns encourage citizens to switch from traditional vehicles to electric ones. **Environmental:** (1) Emissions reduction. (2) Monitoring has enabled a better understanding of the air quality of the city.	**Technical:** (1) For monitoring, manual analysis of the charging points, (2) Poorer replication since technical work is carried out in a different way in each city. (3) Some bus operators prefer hybrid buses. **Economic:** Expensive.

Table 7.1 Facilitator aspects and difficulties or barriers for interventions realised in Bristol.
(*) Asterisk marked barriers are not real barriers, but potential difficulties or barriers.

In general, all interventions have clear environmental advantages and social acceptance is high, either due to economic savings, the well-known environmental benefit or other advantages (such as the increase of homes value, greater comfort and healthier homes in the case of retrofitting). Technically, some hurdles have to be overcome, but all interventions are feasible.

For **District Heating**, besides the great number of facilitators, many barriers have also been observed. Having to have the product specifically designed for the project and at the same time undergo changes in government policies and reductions in funding streams mid project development are very challenging. The actual low gas price, higher than expected pipeline costs (due to the historic and dense underground environment) and the cost of data transfer and software administration affect negatively the economic viability. For end-users, for optimal exploitation, education is required. Finally, even though District Heating reduces emissions and increasingly makes use of renewable energy sources instead of fossil ones, biomass combustion generates local emissions and pollutants. New commercial customers joining the network in the future should start to demonstrate an economic benefit.

When studying the case of **Building Retrofitting**, information on the estimated energy savings (CO_2 and kWh/m^2) and an assessment of existing property efficiency facilitate the intervention. EU funding and the reduction in fuel costs make the intervention economically interesting while for end users, the reduced health risks related to living in a cold home, working with community energy groups and the reduction of fuel poverty are essential. As in the case of all interventions, reduction

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in CO_2 emissions are both well considered and good for the environment. This can by enhanced adding solar PV systems to homes. The Bristol's 2030 carbon neutrality target definitely helps, despite a historic view of projects the council has delivered within the community in the past. On the other hand, building retrofitting is a major intervention for most families and financing may be difficult without funding or an adequate financing model. On monitoring, it has been observed that due to being unable to collate energy data electronically through meters, difficulties are encountered as many end users are reticent on sharing their energy bills long after the intervention has been installed.

Curiously enough, for the **e-Bikes Sharing System** obtention of data was both appreciated and considered negative. Appreciated because some individuals were interested in some of the generated data and negative due to privacy reasons. E-bikes are considered a wonderful alternative to both cars and, since COVID-19, public transport. Finally, for the whole system to work in the case of e-Bikes made available by the municipality, there needs to be a consistent set of objectives across the municipality areas, for approval of initiatives.

For **EV cars (Co-Wheels Car Club)**, in particular the enforcement of Car Club / Car Share dedicated charging points would facilitate extending it. Monitoring was done with off the shelf hardware and provided by TrakM8 – they already provide this service for a very large number of vehicles nationwide – so scaling up their REPLICATE related activities would be trivial. The booking system for members of the car club also helps, while the success of the scheme would need to include social-economic considerations including demographic make-up of location / travel to work methods, etc. Obviously, a focus on sustainability and/or zero emissions policies will promote this and other sustainable interventions. On the other hand, sales prices are not yet competitive, and funds are required to support TrakM8 subscription for monitoring and the cars are leased. Monitoring activities may cause social pushback, even though board vehicle monitoring is more and more widespread and therefore more accepted. In this sense the impact of GDPR should be studied. During Covid-19, shared car use has dropped due users being cautious.

Finally, for **Electric Vehicle Charging Points**, 120 charging points in Bristol had been deployed through the Go Ultra Low project from which delivery of 34 was supported by the REPLICATE project, adding to its viability. This wide presence of EV charging bays and promotional campaigns would encourage citizens to switch from traditional vehicles to electric ones. The monitoring that took place has enabled a better understanding of the air quality of the city, but unfortunately, has had to be manual. Also, replication will encounter some difficulties as the technical work is carried out in a different way in each city.

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7.3 General Recommendations from the City of Bristol

Monitoring of interventions provides a valuable tool to measure the results of interventions. This can inform decision making of how to progress certain activity either in part or whole and where further efforts may need to be concentrated on. It is vital to measure the management in Bristol in order to decide whether to scale or replicate in other parts of the city. This also allows the city to share learning with other cities.

It is important to get monitoring outcomes right from the start to align with the format outcomes of the project. This will ensure a faster process time and allow better and easier evaluation of interventions. Additionally, understanding what measures are appropriate to collate for Bristol and not collate data for data sake. This also ensures compliance with GDPR. Following a 6 / 12 months period, it is a valuable process to evaluate the data collected to ensure it is fit for purpose and modify if necessary, with supporting documentation of any changes.

Having a local technical partner on board to support monitoring is important. Not just for setting up monitoring measures and the collation of data, but to be proficient in interpreting information as collected and to be able to understand it and catch errors early. This could also be supported by training for all non-technical partners to highlight the importance and increase understanding of datasets and their value.

Covid-19 restrictions has affected services and interventions across Bristol, but it has been useful to benchmark their effects on data collected. Transport services have reduced as expected as people were not moving around the city as much, but it has been difficult to ascertain reductions of energy use in people's homes as we are home more, and our behaviours are changing during these unprecedented times.

It is often difficult to predict when creating a new innovative solution what will be required from a monitoring perspective. Assessing other projects and collaborating with stakeholders to understand their needs and outcomes can provide a useful mechanism to focus what to collate. Additionally, utilising initiatives such as the Smart Cities Information System (SCIS) for comparable findings can be beneficial.

One possibly controversial thing to note that we have learned through the monitoring process in Bristol is that in some cases, we may not have been able to provide monitoring data as had been anticipated during the project, but overall, this has provided valuable lessons learned about the process of implementing and deploying these interventions. This insight has proven just as valuable to the City Council and to the City of Bristol as the monitoring data and used alongside this data has ensured that we are able to continually evolve interventions and learn how they can work in Bristol.

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8. CONCLUSIONS

The monitoring (WP10) in the REPLICATE project can be divided into two main phases / steps or the working process:

Monitoring phase	*Description*	*Related tasks*	*Outputs*
1. Definition of the monitoring programme of each city	The monitoring framework of the REPLICATE Project was defined, in one hand, the city level monitoring framework was defined and, in the other hand, the main steps of the structure for monitoring of interventions were established. Based on this general framework, a KPI selection process was carried out and, the city level KPIs and the intervention level KPIs were selected by each Lighthouse City accordingly to their particular characteristics and specific interventions. Then, the monitoring procedures were defined for the city business models and the guidelines or methodology for the monitoring of the business models of interventions have been defined. In addition, the monitoring platform in REPLICATE projects was defined and developed, with the objective of making visible the results of the monitoring programmes.	T10.1 T10.2 T10.3 T10.4	D10.1 D10.2 D10.3 D10.4 D10.5 D10.6 D10.7 D10.8 D10.9
2. Monitoring process	The monitoring process has these steps: • Request and compilation of required data / information in the city monitoring programme and final data of the baseline • Data checking process • Processing of the monitored KPIs and redaction of the "D10.10/11/12 Yearly reports monitoring city level indicators for the three lighthouse cities" The process is aimed at monitoring the baseline situations and the indicators defined for each of the cities i.e. the city level KPIs and also for each intervention implemented in cities compiling the data for the intervention level KPIs, in order to evaluate the actual impacts or effects that the specific implemented projects have at city level.	T10.5	D10.10 D10.11 D10.12

As a result of these two phases, in REPLICATE, the monitoring programmes of the Lighthouse Cities is structured into 4 sections:

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- City level monitoring: the performance of the city as a whole is evaluated in different dimensions that cover the sectors of energy & environment and mobility and also the infrastructures for innovation, the governance in the city and socio-economic aspects. The indicators finally covered in different cities show that although a common monitoring framework was the starting point, each lighthouse city has established its specific and individualized monitoring programme taking into account its own particularities. The starting point of each city has been different and the mechanisms for collecting and processing data were also different, due to service specifications, specific management of municipal departments, or city strategies, among other reason. Huge effort has been made by cities and the partners involved in the monitorization to establish a valid common framework to collect the info from the three cities and analyse it with a common but particularized methodology. These monitoring reports generated yearly in REPLICATE project may contribute to the harmonization of the evaluation of different cities across Europe.

- Intervention level monitoring: The monitoring programme for interventions implemented in cities defines specific indicators to measure the impacts of interventions that are already in operation in each city, i.e. the impacts of the specific interventions that are implemented and in operation in the Lighthouse cities within the REPLICATE projects are assessed. These interventions can be understood as small-scale-tests of technologies or measures aimed at assessing the potential impacts that the massive deployment of that technology or measure may have throughout the city, so that their valuation in several levels is needed. It is important that the assessment of the intervention itself during the project, considers technical, environmental and socio-economic criteria or indicators.

- City Business Canvas monitoring: The monitoring programme for business models defines specific procedure for monitoring the viability of business models with the project. Given that the conditions of implementation of the interventions correspond to the special or advantageous conditions of a financed European project, it is critical to evaluate the viability and performance of the business model associated to the intervention in real market conditions. The monitoring programme for business models is based on a survey-methodology developed within the project, and the objective is to evaluate the feasibility / viability of business models of each of the interventions of each city.

- Replicability and success factors evaluation: The monitoring programme for replicability and success factors provides a qualitative way to evaluate the factors that make an intervention replicable and successful for a city. In other words, the cities assess qualitatively the success and the potential replicability of the interventions within their city-characteristics and context.

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The final objective of the monitoring programmes of the three Lighthouse Cities is to compile and reflect the evolution of the main indicators of the cities and the total impact of REPLICATE project in the whole city and also the bounded impacts of the energy-, mobility- and ICT- interventions deployed in each of the cities. In other words, the results and conclusions obtained thanks to these 360° monitoring programmes in REPLICATE allow Lighthouse cities to have useful and real information from different smart-solutions in order to prepare future plans aimed at achieving the most ambitious energy-, environmental- and socioeconomic-objectives of the city.

In this deliverable D10.13 (related task: T10.6), the guidelines (lessons learnt, experiences, facilitator aspects and barriers or difficulties to overcome, etc.) on regard to the whole monitoring process and the application and results obtained on the monitoring programmes are identified. The goal is to help cities to build the replication scenarios of the interventions implemented based on the monitoring process and the monitoring data obtained.

Each of the Lighthouse cities, working together with their technical partners, identified (answering a survey) the lessons learnt in the whole working process followed in the WP10 and also assessed the usefulness and the quality of the results obtained thanks to the application of the monitoring programmes.

Firstly, each city provides the feedback or opinion related to the quality of the monitoring process. For that, each city explained the ex-ante situation and general opinion of the monitoring process, including an overall opinion and expectations, and analysed and evaluated their experiences during the whole definition process and the resulting structure in 4 blocks of the monitoring programmes.

After that, each city analysed the application of the monitoring programme itself, i.e. the data gathering, data analysing and data reporting (redaction of the deliverables "D10.10/11/12 Yearly reports monitoring city level indicators for the three lighthouse cities") process. Additionally, the results obtained thanks to the monitoring are assessed by each city. Considering that the deliverables D10.10-12 are the format to show the results of the monitoring in the REPLICATE project, cities provide their point of view on regard to the usefulness and the quality of the results of the monitoring compiled in these deliverables.

Logically, an intervention by intervention analysis has also been carried out in each city, assessing those aspects or factor that may facilitate or make it more difficult or less interesting betting for a specific kind of intervention.

And to finish with the exercise, each city provided some general recommendations about the monitoring and told about their own experience in the WP10 and in other projects or initiatives, so

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that their total monitoring experience can be reflected to guide their words, resulting in a really enriching contribution.

As **general recommendations**, the contributing partners in WP10, and especially the three Lighthouse cities, propose the following points as lessons learned on monitoring:

- The results and conclusions obtained in the monitoring provide really interesting and powerful information to cities, allowing them to base on all these useful and real information from different smart-solutions the preparation of future plans aimed at achieving the most ambitious energy-, environmental- and socioeconomic-objectives of the city.
- The monitoring programme structured into 4 blocks is an innovative approach to a holistic monitoring of interventions covering not only the technical and economic indicators but providing a much richer vision of the implications associated to the implementation of these interventions. This is very useful not only for Lighthouse cities but also for follower cities of the project and for other European cities to understand the benefits and the difficulties linked to each type of intervention.
- It is also remarkable that the availability of data and KPIs in each city for the different years has been different. Many people from each city have been involved in the monitoring process, which is a laborious job of sharing information from different sources and departments. In some cases, as it was described in the deliverables D10.10-12, some of the KPIs could have not been evaluated due to several changes (such as modifications data collection processes within any department in the city or differences between the data planned to be collected and what finally was gathered).
- Flexibility and practicality are key to succeed in monitoring.
    - Flexibility – On the one hand, it is important and interesting to know how to measure the performance of an intervention before implementing it, since it facilitates the selection and implementation of measurement devices and procedures. On the other hand, this "taking the lead" requires important amount of efforts and the preselection of indicators to be gathered is not always correct for the intervention finally implemented, due to various events that alter the final intervention. In this sense, true coordination between the monitoring process and the intervention deployment is recommended, combined with a bottom-up and matchmaking approach for final KPI definition.

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- Practicality – In order to streamline the monitoring work and obtain more powerful and useful results for the beneficiaries, it is very important that the data collection and processing formats as well as the formats and periodicities for the provision of monitored data to the commission are adequate. The formats have to be practical, agile, simple, and friendly, such as and spreadsheet, and the complex "report format" could be reserved at the end of the monitoring process.

- Comparability and sharing of results could make a big difference.
  - Comparability should also be pursued: normalizing some KPIs with size or other measures has allowed benchmarking between cities and not only evaluation of trends in the same urban environment through the years. Benchmarking, as shown also in WP7 and WP8, is the starting point for the bench-learning process which takes into account both quantified aspects from monitoring and other "ingredients" (like human skills, procedures, stakeholders etc.) highlighted in the replication and City2City learning process.
  - Results need to be shared as much as possible internally, to collect feedbacks and inform the structure, as well as among stakeholders. It is fundamental they're clear and understandable by a wide public.

- "*Long story together…*" The three cities in REPLICATE started working together in the STEEP project. Actually, the REPLICATE project is the continuation in many aspects of the work started on the STEEP project. The REPLICATE project, and also the STEEP project has worked with the same holistic methodologies in the three cities, and each city has applied and adapted these methodologies to its own particularities, thus accelerating and deepening the learning. The specific work carried out in the "WP10 Monitoring" has been really important also for other WPs in the project. For example, the WP7 about the cross-cutting activities has taken advantage and worked with the results of the "Replicability and success factors evaluation". This is just a sample of the cooperation among the WPs and the different partners in the project and this is one of the aspects that what makes the project so valuable.

To finish, the COVID crisis has to be mentioned, as this unexpected situation has disturbed and unfortunately is still disturbing so much our lives. Despite this terrible reality that we are facing, which has also affected the progress of the project, the partners of REPLICATE have functioned as a great team and we have made a significant effort to complete the monitoring phase of the project with quality and within the estimated deadlines.

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ANNEX: Survey sent to the three lighthouse cities

SURVEY [T10.6]

People answering the survey	City representants (names, emails)
	Energy interventions representants (names, emails)
	Mobility interventions representants (names, emails)
	ICT interventions representants (names, emails)
	Others (names, emails)
Ex-ante situation and general opinion	Had your city had previous experience in monitoring?
	Which were the expectations of your city regarding the monitoring at the beginning of the project? Did these expectations change during the project? How?
	Which is the added value that the monitoring gives to your city and to the technical partners?
	Are the stakeholders and the city ready to exploit the potentiality of a monitoring programme? How?

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	Nowadays, how are the technical partners and the city using the results of the monitoring?
	[*explain any additional idea / opinion regarding the ex-ante situation and the general opinion about monitoring of the city and the technical partners*]
Definition process of the monitoring programmes	*Explanation: the monitoring framework of the REPLICATE Project was defined, in one hand, the city level Monitoring framework was defined and, in the other hand, the main steps of the structure for monitoring of interventions were established. Based on this general framework, a KPI selection process was carried out and, the city level KPIs and the intervention level KPIs were selected by each Lighthouse City accordingly to their particular characteristics and specific interventions.*
	In general term, what is the goal of your city regarding the monitoring?
	What do the city and the technical partners think about working on the monitoring framework before implementing the interventions? Is it useful? Is it a procedure to be recommended? Please, give an explained opinion.
	From the point of view of the city, which are the best and the worst characteristics of this working process?
	From the point of view of the technical partners, which are the best and the worst characteristics of this working process?

	Explanation: The monitoring programmes in Replicate are structured into 4 blocks: • *City level monitoring* • *Intervention level monitoring* • *City Business Canvas monitoring* • *Replicability and success factors evaluation*
	Is this structure complete enough? Is any key aspect uncovered? How would you improve / complete it?
	Does this structure provide to the city and the technical partners all the required information to make a decision regarding the replication of the interventions?
	[*explain any additional idea / opinion regarding the definition process of the monitoring programmes of the city*]
Monitoring process	*Explanation: The monitoring process has these iterative steps:* 1. *Request and compilation of required data / information in the city monitoring programme and final data of the baseline* 2. *Data checking process* 3. *Processing of the monitored KPIs and redaction of the deliverables "D10.10/11/12 Yearly reports monitoring city level indicators for the three lighthouse cities"*
	From the point of view of the city, which are the main difficulties of the process? How would you improve this process?

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	From the point of view of the technical partners, which are the main difficulties of the process? How would you improve this process?
	Does this iterative process fulfil the expectations of the city?
	Does this iterative process fulfil the expectations of the technical partners?
	Which are the main challenges the city has faced in this process?
	Which are the main challenges the technical partners have faced in this process?
	To guarantee the good quality of the monitoring process, a clear definition of the responsible people and structure is required. How would you evaluate the responsibility and the working-flow in your city regarding the monitoring? How do you think this working- and responsibility-flow could be improved?
	[*explain any additional idea / opinion regarding the monitoring process applied*]
Results of the monitoring	The deliverables D10.10-12 are the format to show the results of the monitoring in the Replicate project. In general, is this format useful for you? What is your general opinion on the results already obtained in the

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	monitoring of the city and the interventions? If so, how can the quality of the results be improved? Please, explain your answer.
	[*explain any additional idea / opinion regarding the results of the monitoring programmes of the city of the deliverables D10.10&d10.11*]
	Explanation: In the last General Assembly (October 2019, Firenze), a workshop was held to discuss about the contribution of the monitoring programme (technical, economic, social and environmental factors) on the replication of the interventions, trying to identify the recommendations about the planning and the implementation of each specific actions implemented in the LH cities. *Based on the results of this workshop and with the aim at completing the results, next questions are intervention-specific, analyzing the faciliatory aspects and difficulties in each case.*
	Energy intervention
	Technical aspects: *Already identified Facilitator aspects:* • *Already identified Barriers / Difficulties:* • Are there any other technical aspect of the monitoring that may facilitate / hinder the replication of this action? Which ones? Please, explain your answer.
	Economic aspects (business models, investment plans, etc.):

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	Already identified Facilitator aspects: • *Already identified Barriers / Difficulties:* • Are there any other economic aspect of the monitoring that may facilitate / hinder the replication of this action? Which ones? Please, explain your answer.
	Social acceptance: *Already identified Facilitator aspects:* • *Already identified Barriers / Difficulties:* • Are there any other social aspect of the monitoring that may facilitate / hinder the replication of this action? Which ones? Please, explain your answer.
	Environmental aspects: *Already identified Facilitator aspects:* • *Already identified Barriers / Difficulties:* •

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	Are there any other environmental aspect of the monitoring that may facilitate / hinder the replication of this action? Which ones? Please, explain your answer.
	Politics and legal aspects: *Already identified Facilitator aspects:* • *Already identified Barriers / Difficulties:* • Are there any other legal aspect of the monitoring that may facilitate / hinder the replication of this action? Which ones? Please, explain your answer.
	Is there any **other aspect** of the monitoring that may facilitate or hinder the replication of this action? Which ones? Please, explain your answer.
	ICT intervention
	Technical aspects: *Already identified Facilitator aspects:* • *Already identified Barriers / Difficulties:* •

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	Are there any other technical aspect of the monitoring that may facilitate / hinder the replication of this action? Which ones? Please, explain your answer.
	Economic aspects (business models, investment plans, etc.): *Already identified Facilitator aspects:* • *Already identified Barriers / Difficulties:* • Are there any other economic aspect of the monitoring that may facilitate / hinder the replication of this action? Which ones? Please, explain your answer.
	Social acceptance: *Already identified Facilitator aspects:* • *Already identified Barriers / Difficulties:* • Are there any other social aspect of the monitoring that may facilitate / hinder the replication of this action? Which ones? Please, explain your answer.
	Environmental aspects: *Already identified Facilitator aspects:*

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	• *Already identified Barriers / Difficulties:* • Are there any other environmental aspect of the monitoring that may facilitate / hinder the replication of this action? Which ones? Please, explain your answer.
	Politics and legal aspects: Is there any other legal aspect of the monitoring that may facilitate / hinder the replication of this action? Which ones? Please, explain your answer.
	Other aspects: *Already identified Facilitator aspects:* • *Already identified Barriers / Difficulties:* • Are there any **other aspects** of the monitoring that may facilitate or hinder the replication of this action? Which ones? Please, explain your answer.
	Mobility intervention
	Is there any **technical aspect** of the monitoring that may facilitate / hinder the replication of this action? Which ones? Please, explain your answer.

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	Economic aspects (business models, investment plans, etc.): *Already identified Facilitator aspects:* • *Already identified Barriers / Difficulties:* • Are there any other economic aspect of the monitoring that may facilitate / hinder the replication of this action? Which ones? Please, explain your answer.
	Social acceptance: *Already identified Facilitator aspects:* • *Already identified Barriers / Difficulties:* • Are there any other social aspect of the monitoring that may facilitate / hinder the replication of this action? Which ones? Please, explain your answer.
	Environmental aspects: *Already identified Facilitator aspects:* • *Already identified Barriers / Difficulties:* •

	Are there any other environmental aspect of the monitoring that may facilitate / hinder the replication of this action? Which ones? Please, explain your answer.
	Is there any **legal aspect** of the monitoring that may facilitate / hinder the replication of this action? Which ones? Please, explain your answer.
	Is there any **other aspect** of the monitoring that may facilitate or hinder the replication of this action? Which ones? Please, explain your answer.
Tell your story	*[The city may provide a qualitative opinion about the monitoring process in the city in the "story-telling" format]*