

PlastiCircle

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Abstract

The PlastiCircle approach is a holistic way of improving circular economy for plastics working mainly on plastic packaging waste to change the relation quantity vs. quality of the material collected, by focusing on four axes of the plastic value chain: collection, transport, sorting and recycling.

This Final replication guide builds up on the initial replication guide published six months prior to this one and presents final results of the pilot implemented in three European cities (Valencia, in Spain; Utrecht, in the Netherlands; and Alba Iulia, in Romania), introduces lessons learnt, and gives recommendations to industries and cities who wish to develop and implement the PlastiCircle approach.

Abbreviations

PA: PlastiCircle Approach

Partners short names

1. ITENE: INSTITUTO TECNOLÓGICO DEL EMBALAJE, TRANSPORTE Y LOGÍSTICA
2. SINTEF: STIFTELSEN SINTEF
- 3.
4. AXION : AXION RECYCLING
5. CRF : CENTRO RICERCHE FIAT
6. UTRECHT : GEMEENTE UTRECHT
7. Las Naves: FUNDACION DE LA COMUNITAT VALENCIANA PARA LA PROMOCION ESTRATEGICA EL DESARROLLO Y LA INNOVACION URBANA
8. ALBA: PRIMARIA MUNICIPIULUI ALBA IULIA
9. MOV: MESTNA OBCINA VELENJE
10. SAV: SOCIEDAD ANONIMA AGRICULTORES DE LAVEGA DE VALENCIA Spain
11. POLARIS: POLARIS M HOLDING
12. INTERVAL: INDUSTRIAS TERMOPLÁSTICAS VALENCIANAS
13. ARMACELL: ARMACELL Benelux S.C.S.
14. DERBIGUM : DERBIGUM N.V.
15. PROPLAST : CONSORZIO PER LA PROMOZIONE DELLA CULTURA PLASTICA PROPLAST
16. HAHN : HAHN PLASTICS Ltd.
17. ECOEMBES : ECOEMBALAJES ESPAÑA S.A.
18. KIMbcn : FUNDACIÓ KNOWLEDGE INNOVATION MARKET BARCELONA
19. PLAST-EU: PLASTICS EUROPE
20. ICLEI: ICLEI EUROPASEKRETARIAT GMBH
21. PICVISA
- 21.1. CALAF
22. SINTEF AS

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Publishable summary

This document presents how the PlastiCircle approach was implemented by the three pilot cities (Valencia in Spain, Utrecht in the Netherlands, and Alba Iulia in Romania) and what steps should be taken by other cities interested in acquiring the technologies and implementing the concept.

This final replication guide aims at:

- providing a knowledge base to map risks, identify vulnerabilities and other factors that make planning less effective;
- presenting and explain good practices that can be implemented to guarantee better results;
- separating the best recommendations for cities interested in replicating the approach, and
- showing the variances and similarities of the PA in different backgrounds.

The three pilot cities also share their lessons-learnt, as well as their recommendations so that other municipalities and cities can run a smoother path when adapting the PA.

The guide at a glance

1	Introduction	Setting the scene
2	Replication Guide Goals	What are the aims of this document?
3	Policy implications of plastics	The regulatory and strategic framework
4	The PA implementation	
	Cities overview	The three pilot cities: Valencia, Utrecht & Alba Iulia
	The 4 phases	Collection, transport, sorting and reprocessing
	Application in the pilot cities	Insights about the deployment in the three pilot cities - Challenges, success factors & outcomes
	Lessons learnt	Learning gained from the process of performing the project
5	A guide for replication	
	Before	Setting the basis
	Inception, planning & finance	Structures to facilitate its understanding development
	Political approval and engagement	Effective planning and process to achieve these
	Implementation	Key steps to be taken
	Monitoring and progress evaluation	Tracking and assessing results and interventions
6	Conclusions	Final recommendations

1. Introduction

PlastiCircle is a Horizon 2020 project aimed at improving the efficiency of the plastic waste management process and promoting circular economy principles in the core of local governments strategies. From 2017 to 2021, twenty European organisations have joined forces to reinvent the treatment of plastic packaging. At present, more than 25.8 million tonnes of plastic waste are produced per year in the European Union (EU) Member States, with only 29.7% being recycled.

In a further step to enhance waste management, in 2018 the main EU waste laws were revised with an increased ambition to prevent household waste and to boost recycling. Recycling targets in particular for municipal waste will gradually move up from 50% in 2020 to 65% in 2030 - 75% by the same year for plastic packing. At the same time, Member States will have to reduce the landfilling of municipal waste to a maximum of 10% in 2035.

The PlastiCircle project pilots' innovative solutions along the waste management value chain for plastic packaging in support of the European Union's 2030 waste management and recycling targets. Rethinking various phases of waste management for plastic packaging – including collection, transport, sorting and recycling – PlastiCircle ultimately aims to transform waste into valuable products including new end of life applications.

The consortium sets out to rethink the plastic packaging treatment process to obtain higher recycling rates, better quality and cheaper secondary raw materials, as well as better recovery and valorisation within the same value chain. In particular, the consortium focused on the development of smart containers for separate waste collection, on the improvement of transport routes and of sorting and reprocessing technologies, eventually converting packaging waste into value-added products such as foam boards, automotive parts, roofing membranes, garbage bags, asphalt and urban furniture.

Among PlastiCircle direct benefits to the plastic packaging management system, are:

BENEFITS



Figure 1: The benefits of the PlastiCircle approach

2. Replication Guide Goals

The Final Replication Guide aims at guiding local and regional governments in Europe to implement the PlastiCircle approach for the circular economy of plastics, based on the tests piloted in three cities between 2018 and 2020: Valencia (Spain), Utrecht (the Netherlands), and Alba Iulia (Romania).

The project builds on four different steps of the plastic waste management chain, namely, collection, transport, sorting and reprocessing, making it possible to adapt to local realities and implement it partially (introduce some of the technologies to the city's plastic waste management system or introduce the first two or three steps) or in a whole (all four steps). Among the perceived benefits in the pilot cities are:

- increase in packaging collection
- reduction in the costs of transport
- increase in the quality of recovered plastic
- added value to new products from recycled plastic

This document aims to provide guidance for local politicians and decision-makers, as well as plastic industry representatives that seek to improve plastic packaging waste management in their cities. The main objectives of this guide are to share lessons learnt and inspire other cities and regions to implement the PA and enable interested stakeholders to participate in this process.

In addition, the guide aims to:

- provide a knowledge base to map risks, identify vulnerabilities and other factors that make planning less effective;
- present and explain good practices that can be implemented to guarantee better results;
- separate the best recommendations for cities interested in replicating the approach, and
- show the variances and similarities of the PA in different backgrounds.

3. Policy implications of plastics

Generally, any circular economy measures implemented should also make progress towards compliance with international sustainable development frameworks, such as the United Nation's Sustainable Development Goals (SDGs) and the Paris Agreement. The [European Green Deal](#) and new [EU Circular Economy Action Plan](#) (CEAP) outline comprehensive strategies to make Europe carbon neutral by 2050, involving a transformed industrial strategy, an expanded Ecodesign Directive and empowered consumers.

The CEAP also includes a Circular Cities and Regions Initiative, which focuses more specifically on support of local and regional stakeholders in the implementation of circular solutions. Furthermore, the updated [EU Bioeconomy Strategy](#) provides a strategic framework for shifting the economic resource base in Europe to a circular model that is grounded on renewable and bio-based materials. Moreover, the [Green City Accord](#) recognises the pivotal role of the circular economy in order to step up implementation of EU environmental policy among European cities.

The [European Strategy for Plastics](#) outlines a vision for Europe's plastics economy in which the production and use of plastics fully meets the requirements needed for repair, reuse and recycling, thereby contributing to creating a more circular economy that in turn should create jobs, better protect the environment and decrease the dependency on fossil fuel imports into the EU. This goal towards a smart, innovative and sustainable production industry, however, can only be met when accompanied by an innovative entrepreneurial environment as well as a society that understands the urgent need to reduce wastes and, where not possible, enable reuse and recycling as much as possible.

Current EU Directives on waste, are set to promote these objectives, while there is also the need for more efforts to increase depth and speed up the pace of this pathway. According to a study put forth by the European Parliament (2017), some of the most influential Directives include: [Directive 2008/98/EC on waste](#), [Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste](#), [Directive \(EU\) 2018/852 amending Directive 94/62/EC on packaging and packaging waste](#), [Directive 2012/19/EU on waste electrical and electronic equipment \(WEEE\)](#) and [Directive 2006/66/EC on batteries and accumulators and waste batteries and accumulators](#). Furthermore, the CEAP promises updates and amendments in waste and circular economy legislation by 2021/22 in the areas including e.g. waste reduction/prevention, separate collection labelling, tracking of- and harmonising information on 'substances of concern', waste shipment and circular economy monitoring.

Within this regulatory and strategic framework at European level, the PlastiCircle project, as an H2020 innovation action, is designed to demonstrate some of the innovations needed to move quicker and more effectively towards a circular plastics economy in Europe.

4. The PlastiCircle Approach (PA) Implementation

4.1. Cities Overview

Valencia, Utrecht and Alba Iulia are cities with different characteristics in terms of urban infrastructure, governance and social diversity that have been working to comply with European Directives and national regulations on environmental quality and have aligned their urban sustainability goals to the EU decarbonisation goals by 2020 and 2030. The three cities are signatories of the EU Covenant of Mayors and are active in the development of European research and innovation projects for urban sustainability, such as PlastiCircle.

These cities have been working to drive local innovation in their territories, especially with the support of digitalisation of their local services provision, including solid waste management services. Utrecht, Valencia and Alba Iulia are also part of the EU Smart Cities and Communities Lighthouse projects that puts them in the front line to develop innovative ICT-based projects, including circular plastic waste management initiatives, which are the core of the PA.

QUANTITATIVE INFORMATION

	VALENCIA	UTRECHT	ALBA IULIA
POPULATION/ CITY	801,545 (2020)	357,719 (2020)	74,212 (2018)
POPULATION/ PILOT AREA	10,125 (2020)	8,608 (2018)	8,300 (estimated by administrators)
SIZE/ CITY (KM2)	138.35	99.21	103.65
SIZE/ PILOT AREA (KM2)	0.33	1.79	1.13
POPULATION DENSITY	8,114	3,811	566
CITY GDP	22,153 € (2014)	28,000 €	11,995 €
OVERALL -ALL STREAM - RECYCLING RATE	14% - Plastic (Ecoembes)	-	14% (national)
WASTE MANAGEMENT STATISTICS (FOR PLASTICS)	Plastic waste generation (tons/year): 9,593.59 (2018) Plastic waste generation per capita (kg/inh/year): 448kg	-	-

Figure 2: Quantitative information of pilot cities

QUALITATIVE INFORMATION

	VALENCIA	UTRECHT	ALBA IULIA
PLASTIC WASTE COLLECTION SYSTEM IN THE PILOT AREA	25 Yellow containers dedicated to light packaging are distributed in the area. They are emptied twice a week.	Door to door collection with mini-containers (once every 3 weeks)	Eurocontainers, 1.1 m3, in dedicated locations; rear truck load; transport to transfer ramp.
PLASTIC WASTE MANAGEMENT VALUE CHAIN AT THE CITY LEVEL	Collection, transport	Collection	Collection, transport and gross sorting
PLASTIC WASTE MANAGEMENT BILLING PROCESS	Collected in two different ways: 1. Collection and transport: the tax is included in the real state tax (IBI). 2. Treatment: This fee is collected through bi-monthly receipts for the water supply.	Through taxes at municipality level (yearly fixed fee)	Paid as waste; people pay per number of persons, to the administration, who receives and pays bills to the operator according to waste volume collected.
REGULATORY FRAMEWORK CONDITIONS FOR WASTE AND PLASTIC WASTE MANAGEMENT	<u>PLAN INTEGRAL DE RESIDUOS DE LA C.V. (PIRCV) 2019</u>	Law at national level, not defined source separation, post collection separation also possible.	Main EU > Local legislation DE 2008/98 > L.211/2011 DE 2005/20 > L.249/2015 DE 2002/96 > OUG 5/2015 DE 2006/66 > HG 1132/2008 DE 1975/439 > HG 235/2007 DE 1999/31 > HG 349/2005
SPECIFIC POLICIES SUPPORTING WASTE RECYCLING	Awareness campaigns focused on reducing the amount of improprieties that are collected in the fractions. This objective is prioritized over increasing the amount of collected material. In this sense, Valencia City Council has signed an agreement for the specific treatment of coffee capsules, which can be deposited from May in the yellow container to ensure proper treatment and reuse.	Policy framework "Afval is grondstof"	Under implementation: 1. Underground, different fractions containers and collection. Initial target: 50% of waste collected separately 2. Various systems for encouraging recycling (ex. tariff discount vs. specific/personal recycling reward, dedicated/supermarket recycling locations, etc.)

Figure 3: Qualitative information of pilot cities

4.2. The 4 phases

The PA has the main goal of improving Circular Economy of Plastics (Closure of the European Plastic Loop) by providing more sustainable options to treat plastic packaging waste. To do so, a holistic treatment process was developed to reintroduce in the value chain the plastic packaging of products after their discard, focusing on four stages of the plastic waste management: collection, transport, sorting and recycling.

THE PLASTIC CIRCULAR ECONOMY STEPS



Figure 4: The four phases of the PlastiCircle Approach

In addition to a strong consortium counting with 20 partners from different branches of the plastic industry, local governments, non-profits and other stakeholders, the technological component was key to the success factors of the PlastiCircle approach.

In Figure 1, the four axes of the PA can be visualised: 1) development of smart containers to separate waste collection, 2) improvement of transport routes, 3) sorting and 4) reprocessing technologies, eventually converting packaging waste into value-added products, such as foam boards, automotive parts, roofing membranes, garbage bags, asphalt and urban furniture.

Below you will find a brief explanation of each stage:

a) Collection

PlastiCircle developed an innovative smart collection system able to identify not only the quantity, but also the quality of plastic waste dumped in public trash cans and to automatically inform waste transport companies. Referred to as “smart containers”, each one includes a set of technologies, such as user identification capabilities, label expanding functionalities, anti-fraud measures, garbage level detection, and state-of-the-art communications devices.

A simple and small device placed inside the container sends the signal to antennas installed nearby through an IoT cloud platform informing them when the container is full and ready to be collected. This signal is, then, retransmitted to the transportation company. The solution consists of a simple portable prototype that can be integrated in already existing non-smart containers. That said, it can be commercialised and adapted according to different countries' collection policies and regulations.

In addition, there is a personalised structure for the disposal of waste. A labelling system placed inside each container identifies and tracks the citizen/family who disposed of the waste through a personal magnet card that each one needs to use to open the container and/or identifiable bags.

In some pilot cities (Valencia and Alba Iulia), PlastiCircle implemented an individual compensation procedure to encourage citizens to collect and sort packaging waste through positive reinforcement, such as prizes and awards. Utrecht did not implement an individual system but, instead, defined a community reward system.

b) Transport

PlastiCircle proposes to optimise the costs to transport plastic waste from the containers to the sorting plants. First, measuring the filling level of containers allows containers to only be collected when full. Second, the system is based on the compaction of plastic both in the container (citizens pay less for lower packaging volumes, thus they will compact plastic waste at home) and in the trucks (pressing systems). Last, but not least, a smart efficient eco-driving system was also integrated with optimised routes, saving fuel and transport costs.

As explained in [PlastiCircle's Deliverable 3.3 Truck Traceability System](#), waste collection with trucks can experience tangible benefits with vehicle tracking. Fleet tracking allows complete control over the fleet in order to improve the productivity and to reduce the economic and environmental costs, in terms of fuel consumption and greenhouse gas (GHG) emissions.

The goal with the three pilot cities was to develop its own truck traceability system that requires low investment for the municipalities. The system has been developed *ad-hoc* considering the urban waste collection necessities, especially for the cities of Valencia and Alba Iulia. In Utrecht, the local company in charge of waste transport had already a similar fleet management system in place. In addition, the PlastiCircle truck tracking solution is designed and developed to be integrated as a part of the IoT cloud platform, allowing data collection of transport routes for further optimisation processes.

c) Sorting

The PA enhances sorting technologies to achieve a better separation of different types of plastic in treatment plants, including multilayer and multi-material packaging, since plastics can be only recycled if separated correctly. This innovative technology is based on a conveyor-belt free equipment able to achieve an excellent performance not only on rigid plastics, but also on films. A special focus is offered to the stages of material feeding, identification and ejection.

PlastiCircle developed a study on plastic separation applicable technologies to learn the best way to separate plastic waste. According to [Deliverable 4.2 Sorting System Definition](#), some of the methods that have been used so far for the separation and classification of plastics include: separation by magnetic density, flotation, triboelectric effect, artificial vision. The study showed that infrared spectroscopy was the best alternative.

In the first half of the project, PlastiCircle achieved its main objective of increasing efficiency and recovery in the sorting stage of the process. Picvisa, the partner

responsible for the sorting process, worked on improving the segmentation algorithms to be able to better detect objects on the conveyor belts. As a result, improvements were made to the analysis of the NIR (near infrared) hyperspectral information to improve the classification of material, especially regarding the identification of multilayer materials. Besides, the sorting process in Valencia resulted in more recycled plastic and less material thrown to landfills. The project also demonstrated the recovery of the polythene (PE) film and the importance of also treating PET Trays as an important material to be detected and separated.

[Deliverable 4.1 Sorting Requirements](#) explains that, even though the waste from all three pilot cities varied in type and quantity, the sorting requirements remained broadly the same. The criteria in terms of recovery and purity have been set by the project as 80% and 95% respectively. In order to achieve the required purity and recovery set out in the project, material will first need to be pre-sorted to remove metals, glass and fines. Once sorted the material must be screened at 300 mm, as is common for this material. A special focus is offered to the stages of material feeding, identification and ejection.

All the details about the sorting technical process can be found [here](#).

d) Reprocessing

PlastiCircle is developing additional end markets for recycled polymers derived from post-consumer household packaging waste. The plan was to reprocess the recovered materials into added-value products like automotive parts, foam boards for wind turbines and roofing structures, garbage bags, asphalt, fences and benches - based on extrusion, injection and compression moulding. The manufacturing of these products is to be based on extrusion, injection and compression moulding.

4.3. Application in the pilot cities

The complete PA involves all four stages, as described above, and can be replicated partially or in its entirety. The city of Valencia implemented the four steps of the waste management chain, while Utrecht and Alba Iulia implemented it partially.

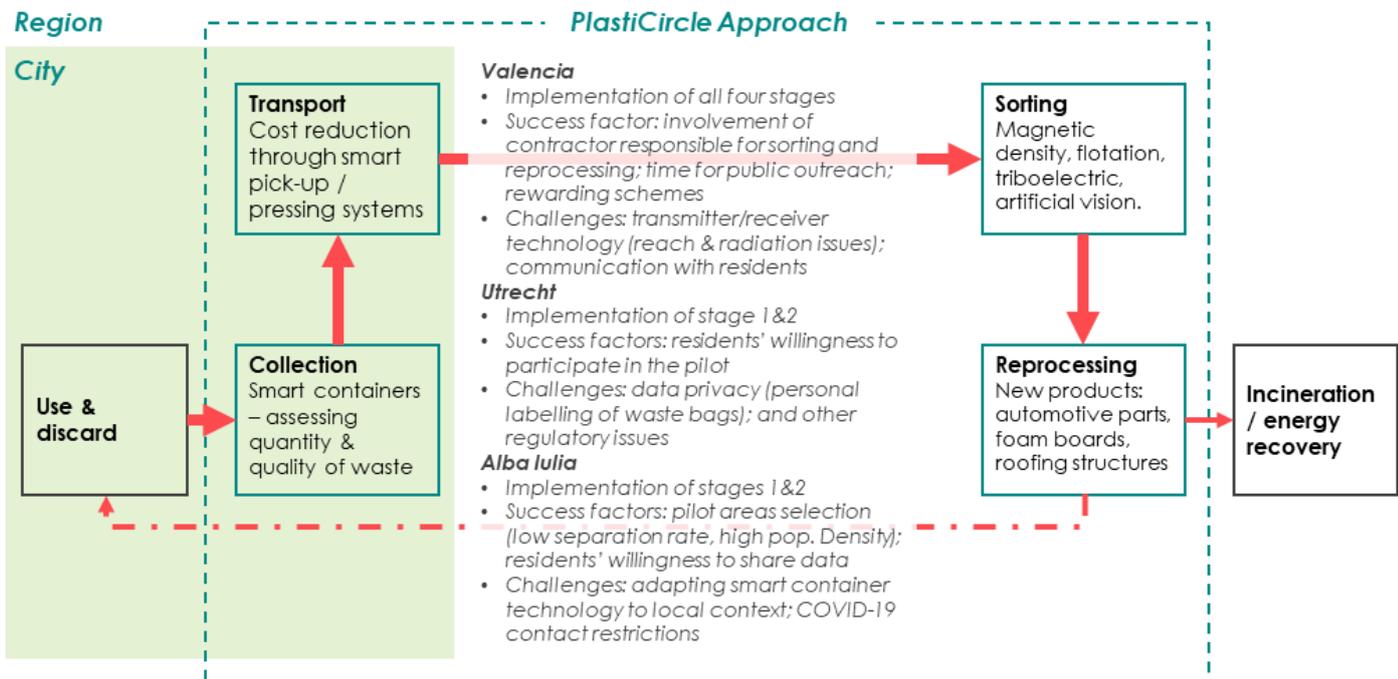


Figure 5: Application of the PA in the pilot cities

Valencia

Valencia applied the complete PA, executing the collection, transport, sorting and reprocessing according to the project's conditions. Valencia City Council is responsible for the collection and transport, while the sorting and reprocessing are responsibility of the region.

The City of Valencia subcontracts the collection and transport of waste to different private companies. In the pilot area, the company responsible for those stages (SAV - *Agricultores de la Vega de Valencia*) was involved in the pilot from the beginning, which proved to be a positive factor for the project implementation. According to the subcontract, the companies have a responsibility to develop pilots or experiments to improve the collection and transport in the waste management system, with budget separated for that end. Thus, Valencia did not face regulatory or framework barriers for the implementation of the first two steps.

After transported, the waste goes to recycling plants that are managed by Public Private Partnerships at the regional level.

Utrecht

The City of Utrecht implemented the first two phases of the PA (collection and transport) but, differently from Valencia and Alba Iulia, combined other types of technologies that they already had in place, with the PlastiCircle technologies. Utrecht City Council is the sole responsible for collection and transport, while sorting and reprocessing are subcontracted to private companies.

During the pilot, the City executed collection using smart containers already existing in the pilot area and did not make use of the labelling system to identify the citizens due to local data protection regulations. The City collects the waste and transports it to a station run by a private company, which is responsible to handle sorting and separation. At this stage (processing/ separation), Utrecht subcontracts a private company with the obligation to recycle as much as possible. After that phase, the separated material is sent to a manufacturer (also a private company) to produce new products (reprocessing) with that recyclable material.

Without the identification of participants, it was not possible to use the compensation system, so they used part of the collected plastic to manufacture products that could benefit the whole community, such as a bench placed in the neighbourhood where the pilot took place.

Alba Iulia

Alba Iulia executed the collection and transport phases of the PA. The City used to do the collection of plastic waste in two fractions (wet and dry) but, due to the new legislation, it is in a process to move to a four-fraction collection. Unlike the other two pilot cities, Alba Iulia did not have dedicated containers for plastics before the pilot, hence the PlastiCircle smart containers were placed in the same locations of the containers already in use.

*“PlastiCircle was a first step to migrate to four fractions,”
Valentin Voinica, PlastiCircle pilot coordinator in Alba Iulia*

In Alba Iulia, the collection of plastic waste is outsourced, mainly subcontracted to private companies. The City has association contracts for waste management, coordinating the implementation of an integrated waste management system for the entire district. There are several projects in place to improve the waste management in the area.

The reprocessing stage of the plastic waste management chain is a work in progress, as the City still faces issues with the integrated sorting and the collection of materials. Currently, Alba Iulia transports its waste to another district, where there is an authorised ramp for sorting and collecting waste.

For these reasons, Alba Iulia did not implement the four phases of the PA, focusing mainly on collection and transport. The City also planned to use Picvisa's facilities in a city close to Barcelona to proceed with the sorting process but, as it happened with Utrecht, Alba Iulia could not send the waste to Spain due to regulatory issues in Europe, which proved even more difficult during the COVID-19 pandemic.

4.3.1 Implementation Challenges and Success Factors

As described in Tables 1 and 2, Alba Iulia, Valencia and Utrecht have different regulatory frameworks and waste management backgrounds, thus each city faced distinct issues when preparing for the pilot implementation. On the other hand, positive factors that enabled the success of the PA were also peculiar in each city.

4.3.1.1 Valencia



The City of Valencia has been sorting plastics for 20 years before implementing the PA, hence there were plastic containers spread over the city. On the other hand, the quality of the material deposited in the dedicated containers was not satisfactory, so the City decided to focus its work on that front in the last years. The goal with PlastiCircle was to improve the quality of the waste in the containers by educating people to throw the right waste in the right container.

The containers are spread over the streets according to density population and conditions, not connected to any specific building. In normal conditions, the collection is made twice a week but for restaurants and places with a lot of commercial activities, the frequency is higher.



Figure 6: Containers of Valencia

Valencia had a favourable set up in place before implementing the pilot, such as the regulatory conditions with the subcontractors responsible for waste management. The early involvement of the stakeholders, such as the private company responsible for the pilot district (SAV), was a positive factor for the pilot implementation.

On the other hand, the City still needed to do little adaptations to implement the pilot, like modifying the location of some containers based on the transport KPIs or changing the routes and frequency of the collection. Everything was based on the obligation of SAV as a provider of the service.

a. Technology

During the preparation and implementation of the pilot, the City of Valencia encountered some barriers with the installation of the transceivers, such as safety concerns related to the signal waves transmitted in the areas nearby. Initially, the City decided to prioritise public buildings as spots where to install the transceivers, but as there were not enough in the pilot area, the private sector and citizens were sought to volunteer their residences for the installation.

Another issue was that the real conditions in the district of San Marcelino (pilot area) were different from the ones initially encountered during the tests at ITENE facilities, such as the reach of the transceivers, which showed not to have a signal strong enough to reach all containers in the area.

As a final solution, the City installed the new transceivers in the district church and in specific shops, which were not very high, but could cover at least some containers nearby. As the issues were only fixed after the pilot started, the City missed some data from some citizens who were already participating in the pilot. Aiming at being fair with all participants, extra points were granted to the citizens of those locations where problems were proved.

b. Communication

With the aim to reach as many citizens as possible and increase engagement with the pilot, the City placed people on the streets to talk directly to the district citizens and get to know the area's conditions. In addition, a social-economic report was conducted on the district to learn more about the population in the district (residential or commercial? age?).

Once they had this information they could tailor the communication campaign to choose the right messages, the right methodology. For example, during the research, it was found that most of the population was older so the communication changed its focus from online activities to face-to-face events, as this would fit more to that target audience.

Annex B shows communication activities organised in the pre-pilot phase.

The rewarding system was another important factor to increase engagement, since the citizens showed interest in receiving prizes and awards for participating in the pilot. The City of Valencia intends to use this system again with other projects in the future.

“People were very willing to participate and be part of it, they were also very interested in learning how to better sort their plastic waste and were aware that they needed more information because they had a lot of doubts,” Julián Torralba, LAS NAVES, Valencia

During the first days of the implementation, some technologies were not functioning properly, which cause some complaints about the technical flaws (containers, receivers). The City had to explain that this was a pilot (“an experiment”) and problems would arise (see *Lessons learnt*) as part of this learning experience.

c. Success factors and outcomes

- The technical involvement of stakeholders (more specifically SAV and the City Council), which gave them the flexibility .
- They had time to reach the citizens, hear from them what they think about how the collection is being done, what could be improved, what were the main issues.
- They also had time to contact the key actors of the district, the representatives from the City in the district (director of social and cultural centres) and form a collaboration, which allowed the pilot workers to use their premises in the district as a warehouse, information point, etc.
- The rewarding system to give gifts was also important as they triggered people's involvement

4.3.1.2 Utrecht



For the City of Utrecht, the pre-existing waste management conditions were favourable to the pilot implementation. The City had been working in collecting plastic waste separately for about 10 years and has service contracts in place with companies to sort plastic waste further for the post-collection phase. In addition, the City already worked on optimising the routes and

schedule for the drivers transporting plastic waste, which gave them experience on the matter.



Figure 7: Utrecht underground container

Due to local data protection regulations, Utrecht had to adapt the original approach implemented in Valencia, that used labelling systems in the containers to identify and personalise each bag brought to the container by the citizen so this could be traced to him or her. As the country's legislation does not allow tracing back the waste behaviour to the citizen, or to connect the waste to its owner, Utrecht did not use identifiable bags like the other two pilot cities. The solution found in the City of Utrecht was to use container scanned levels, so the container was the reference to assess the impact of the pilot.

a. Technology

The city of Utrecht has a smart route optimisation system in place for the collection of waste in their territory. In this sense, there was no need to implement the technology developed in the city of Valencia for route optimisation. The eco-driving component was adapted to the existing processes and the data generated by the system of route optimisation in the trucks operated by the city were shared with the PlastiCircle data collection repository for assessing the impacts of the route optimisation process.

One of the key drivers to implement the PlastiCircle pilot in the city was linked to city goals to optimise the collection process (filling of containers to 80%), improve recycling rates, and address public concerns on plastic waste management.

As mentioned before, the City faced issues with the transporting of the collected waste to be sorted in Picvisa (Spain), so they decided to take advantage of existing recycling facilities on a local level to finalise the reprocessing stage.

The technical issues were a heavy factor in the selection of the pilot area. The neighbourhood of **Terwijde** was chosen because of the way that the separation was done there, the amount of containers and underground bins. The separation of plastic is different there than in other parts of the city, which made it more appropriate for the pilot. In addition, the containers were already in place and the filling sensors as well.

b. Communication

Before the pilot implementation, communications experts were hired to prepare a strategy to reach and engage citizens. As they had already their technology in place, the main activity before starting the pilot was to communicate with the pilot area. For the pilot's team, Jan Bloemheuvel and Frank Donkers, the most important stakeholders of this approach are the citizens.

The communications team initially set up a recruitment campaign, posting advertisements on social media (Facebook and Instagram), street-recruiting at a local shopping centre with flyers, and sharing the news on Newsletter, among other activities. At the start of the project, the team organised a kick-off meeting at a school in the neighbourhood and set up the distribution of goodie bags with useful information. In addition, they produced [three short films with ambassador Madame Plastique](#) and, once the pilot was over, a [magazine](#) was put together with the main results of the project in Utrecht. The involvement of the participants was very high at the kick-off but lowered in the following weeks of the pilot.

Another difference was that the City of Utrecht did not award prizes to the citizens for having participated in the pilot or for those who separated more plastic. Alternatively, the City had community awards for the neighbourhood where the pilot was implemented, such as a bench and a tap water point.



Figure 8: Recycled plastic bench in Utrecht with PlastiCircle inscription

“People really appreciate practical and factual information about plastic separation. The citizens mainly expect the municipality to create the ideal preconditions for the quantitative (and qualitative) improvement of plastic separation,” Utrecht pilot’s team, Jan Bloemheuvel and Frank Donkers

c. Success factors and outcomes

- The City had started collecting plastic waste separately about 10 years prior to the pilot implementation and had contracts in place with companies that sorted plastic waste further for the post-collection phase
- The pilot area had favourable recycling conditions that fit the project's objectives
- Citizens were willing to participate in the pilot

4.3.1.3 Alba Iulia



Before starting pilot implementation, the City focused both on the technical conditions and the communications activities.



Figure 9: PlastiCircle participant taking plastic waste to dedicated container in Alba Iulia

a. Technology

As the City of Alba Iulia counts on less personnel and specific pilot expertise than the other cities involve in PlastiCircle, work was needed to adapt technical equipment and platforms developed for Valencia with partners' support. An adaptation process of the technology took place, beginning with the transceivers which

needed longer cords, the labelling devices, and testing the areas, among others. A big part of the pre-pilot period was spent analysing what was needed and how to solve the issues.

Another challenge faced before the implementation of the pilot was that participants were questioning about placing the transceivers in their homes. Eventually, some of them accepted as there were not enough public buildings in the area to do so. To solve the problem of where to place the remaining transceivers, the pilot managers asked relatives and friends. Choosing where to place the containers also needed to take into account regulatory frameworks. According to local regulations, containers must be placed in specific locations in order to not have liquids coming into soils, respect the minimum distance to buildings, etc.

The pilot took place in two neighbouring districts of the city: Goldis and Arnsberg. The main factor to choose the pilot areas was a combination of technical and social aspects. The city searched for an area of blocks that was not so large, where recycling was not so good, with a high density of population, and about 20 places to install the smart containers. This was an inter-departmental decision.

Among the main outcomes, Alba Iulia highlighted the acquisition of new data regarding plastic waste management, which can be used in future projects about quantities and composition of the waste, which was not available previously. In addition, the City Council is considering some aspects of the PlastiCircle approach for other projects, like the use of filling sensors in containers.

b. Communications

On the communication front, the COVID-19 pandemic forced a drastic change of plans. The City had originally made partnerships with local universities and prepared a door-to-door approach to promote the pilot, but since the movement and contact restrictions were put in place in March 2020, most of the communication strategy had to go online. In addition, the pilot was postponed from April to July and they were ready to start at the end of June when containers were placed and the material was printed.

The team put the main information on links to the pilot's dedicated website and integrated the Valencian platform into it. Printed materials (around 5,000 brochures, leaflets) explaining how to handle plastics, Facebook Ads, and an info kiosk were also put into place.



Figure 10: PlastiCircle team handing welcome kit to participant in Alba Iulia

c. Success factors and outcomes

- Citizens were more willing to share data, which made possible to use the labelling system in the containers
- The City of Alba Iulia was in the process of migrating from a two-fraction to a four-fraction collection system
- The pilot area had high population density, which represented good chances of high participation

4.4 Lessons Learnt

- The PlastiCircle approach needs to be co-designed with all stakeholders involved in the process but, above all, with citizens who will take part in the initiative. Pre-deciding certain aspects - such as whether prizes are individual or collective, the labelling system, etc. - can lead to low ownership.
- Economic indicators from cities that have already applied the PA can be useful to convince certain stakeholders of potential replicator cities.
- It is important to assess the personnel that will be involved in the initiative and to have a good overview of the working hours that can be put into it. Depending on the number of staff involved, the pilot can be scaled down or up.
- Consider the possibility of offering some training to the personnel involved, as it might be needed.



Collection

PRE-PILOT

- Engage citizens in early stages and map key stakeholders in the local environment. Social services departments should be included in the process.
- Develop and implement communication plans according to local realities. A sociological assessment of the population in the area that will take part in the plastic sorting at home is key, to assess and decide what kind of dissemination activities need to be done. Is it mainly elderly people who prefer face-to-face communication? Is it people who have access to technology? Is there a level of environmental and sustainability awareness?
- Transceivers might cause some opposition by citizens, so it is important to correctly explain to them what they are and that there are no-health-related/associated issues. Otherwise, the City must be aware that only public buildings can be used for this purpose.
- Test the technological devices. The testing environment cannot be different from the real environment, because different aspects can influence the signal, such as the height of the buildings, the location, etc. It is important to allocate 2-3 weeks to test everything before starting the pilot.
- If the goal is to implement the PA as a pilot, it is better to choose a district/area that has previous experience on waste management initiatives.
- Test technologies with real citizens, to hear from them what they missed, what was not clear, what could be improved, etc., so that it can be addressed on time.
- Participants should be informed that technologies are being piloted, if this is the case, so that they are more understanding with possible issues, problems, delays, etc.
- It is important to create a trouble shooter committee that will be in place during the pilot to solve issues and reply to questions as soon as they arise.

PILOT

- Face-to-face communication about the pilot proved to be very important in the three pilot cities, as people would understand it better, feel they had the possibility to ask questions, etc.
- Use ambassadors whenever possible. These are committed citizens or associations that can support the personnel in spreading awareness, supporting the recruitment and contributing to create ownership.

- Investing on a good communications campaign is key to success.

POST-PILOT

- It is important to share results with those who have got involved in the initiative.
- When sharing results, this has to be done in layman terms so that they are clear, understandable and meaningful.



PRE-PILOT

- Explore technology providers for the fleet management service, with commercial solutions already in the market. This could facilitate the adoption process and remove barriers for the technology development and adoption. (Utrecht)
- Train drivers to optimise routes and to learn about eco-driving modes, always protecting their privacy.

POST-PILOT

- Get feedback from the truck drivers to improve future implementations or expansions of the approach.
- It is important to share results with those who have got involved in the initiative.
- When sharing results, this has to be done in layman terms so that they are clear, understandable and meaningful.



PRE-PILOT

- Plastic waste sorting processes have to be evaluated and defined focusing on the type of waste to be processed and available technologies for sorting in the city.
- Waste characterisation is key to identify valuable products to be recycled.

POST-PILOT

- It is important to share results with those who have got involved in the initiative.
- When sharing results, this has to be done in layman terms so that they are clear, understandable and meaningful.



PRE-PILOT

- Work with local/regional recycling companies to avoid risks and environmental regulatory challenges of waste storage and export.

POST-PILOT

- It is important to share results with those who have got involved in the initiative.
- When sharing results, this has to be done in layman terms so that they are clear, understandable and meaningful.

5. A Guide for Replication - Adopting the PlastiCircle Approach

Cities aiming to improve the management of their plastic packaging waste in their territory are invited to evaluate and consider the PlastiCircle Approach as an innovative instrument to advance in this goal, while encouraging citizens participation and supporting the valorisation of such type of waste.



The experience of the pilots' implementation in Valencia, Utrecht and Alba Iulia shows that this approach and its different phases (collection, transport, sorting and recycling) are flexible enough to be adopted and implemented together or separately in one city, district or neighbourhood. In this sense, cities interested in developing a pilot and/or replicate the PA as part of their plastic waste management practices, are invited to follow a step-by-step process consisting of five (5) phases described below.

1. BEFORE

2. INCEPTION, PLANNING & FINANCE

**3. POLITICAL APPROVAL &
STAKEHOLDERS ENGAGEMENT**

4. IMPLEMENTATION

**5. MONITORING AND
PROGRESS EVALUATION**

5.1 Before

The main objective of this phase is to set the basis for the successful adoption of the PA by a local or regional government. Two key activities are proposed under this phase:

a) Policy and regulatory screening: It is important to identify and understand the policy and regulatory framework that could either drive or retard the implementation of the PA. Some of the key frameworks to be evaluated include waste management chain, circular economy or waste valorisations policies, regulations and ordinances. For example, regulations that could affect urban infrastructure developments such as the location of the plastic waste containers in the public space, making the collection and transport process challenging. Besides, an analysis of the data privacy aspects related to the use of personal data from citizens sorting the waste at source, or from drivers from trucks during the waste collection process, could pose risks that need to be evaluated beforehand.

b) Stakeholders identification and roles definition: A specific identification of stakeholders that will facilitate the adoption of the PA has to be made. Each city should define the boundaries and methods for this identification based on their expectations and governance structures, as well as the geographical location where a pilot or programme is to be developed.

This process may vary according to the city, but in general, the key stakeholders to be considered include:

- Local waste management departments, operators or companies (public or private)
- Transport companies operating the waste collection process
- Local departments of environment, smart cities, innovation, urban planning, or communications, that could be supporters of the PA adoption
- Citizens and citizens' organisations testing the sorting technologies and pilots
- Industry partners and ICT companies, including start-ups or local companies that could support the implementation of specific urban (fleet management, gamification, etc.)
- Others.



Once an analysis of the policy and regulatory framework and the key stakeholders to be involved in the process has been carried out, an inception and planning

process has to be defined. The city should work in defining the boundaries of the adoption in terms of location, scope and expected results.

5.2 Inception, planning and finance

The adoption of the PA on a city level and its realisation as a pilot or programme requires several structures to facilitate its understanding development. The adoption of PlastiCircle on a particular district or neighbourhood within the city boundaries will define the feasibility of the approach implementation. Key activities include:

a) Governance designation: A governance model based on city structures for waste management is needed to advance in the implementation of one or all the phases of the PA. Internal collaboration with city areas, companies and service operators that could have a responsibility in the waste management chain is needed, but a leadership figure that could follow up the process should also be defined. There is no magic formula for this implementation, but each city shall define a leadership model that could foster the right adoption of the PlastiCircle approach.

b) Targets and goals setting (short- to long-term): The adoption of PlastiCircle

has to be linked to the achievement of goals and targets of the city. The phases of collection, transport, sorting and recycling have to be tied to improve the operational services of the city, including reduction of transport costs, reduction of emissions, an increase of recycling rates, reduce waste management costs, reduction of personal and energy costs, etc. In this sense, it is important that cities define a baseline scenario and measurable goals and targets to be achieved.



In addition to operational targets, cities should work also in defining social and sustainability goals from the management of packaging plastic waste, including citizens' engagement, job creation, pollution reduction, etc.

c) Technology and infrastructure planning: The PA includes a heavy technological and infrastructure component, especially in the collection and transport phases. Adoption of the approach should include a scoping of the technology needed and to be used in the different districts/areas where the solution is going to be adopted. Experience from the PlastiCircle pilots reflects the importance of understanding the current technologies (smart waste services, urban data platforms, etc.) and infrastructures (i.e. containers, public or private collection fleets, route optimisation,

waste valorisation, etc.) of the city, before making decisions for new acquisitions or processes adoptions.

Cities should work closely with infrastructure and technology providers to understand the different options that could be adopted. The results of this work would be reflected in a clear technology and infrastructure roadmap, to guarantee a correct and sustainable implementation of the different PlastiCircle phases.

d) Definition of key performance indicators (KPIs): Cities should identify different sets of KPIs to define the boundaries of the PA adoption and to evaluate the achievement of the operational goals defined (recycling rates, emissions reduction, citizen engagement, etc.). Based on the experience of the PlastiCircle pilots, some of the KPIs that cities should define include:

- Increased recycling rates for plastic waste (%)
- Reduction of GHG emissions (CO₂-eq)
- Reduction of fuel consumption (lt), road trips (km) and time travel (s)
- Increased collection rates of plastic waste fractions (%)
- Average containers fill level (%)

e) Cost-benefit analysis and business and financial model definition: Before implementing any action at local, regional or national level, stakeholders should develop a cost-benefit analysis to assess useful information on desirable and undesirable effects of projects. This analysis is a systematic process that helps the decision-making in any business and involves adding the benefits of an action and then comparing it with the costs associated with it. Developing a correct CBA will also bring cities the opportunity to access different sources of financing from sustainable innovation streams.



Annex A includes a detailed methodology for cities to develop a CBA in the context of the PlastiCircle approach.

f) Business models and end-of-life applications: It is also important to consider different alternative business models that could support the implementation of the PA and its phases. The added value of this approach is a combination of benefits including reducing environmental impact from plastic waste generation and reduction of waste collection traffic, emissions and costs. However, to fully deploy the benefits of plastic packaging waste reprocessing, the city where one would want to adopt the approach, needs the appropriate infrastructure and business models defined to advance in this process.

Although the existence of a collection system and sorting facility would be beneficial to facilitate reprocessing, it is not critical, as this sorting can be done in

other ways (separate inlets/containers or manual sorting) making the process more efficient based on city practices. On the other hand, what is more relevant to guarantee reprocessing, is the need for a consolidated recycling system with at least one company able to do the recovery of plastics for further use. According to the pilot's implementation, this will help to get even better outcomes, since the recycling system will take care of all types of waste generated and obtain value out of it. Without this, all the efforts in the upper part of the value chain will be diluted.

To complement the business modelling processes for packaging plastic waste management, the end-user engagement is critical. Even with robust systems or infrastructure to transport and reprocess waste, if citizens do not deposit the waste in the containers, the efforts will not be realised and investments in technologies and infrastructure will not be effective.

In this sense, cities are encouraged to think on a value chain basis to run their business models in an efficient manner, including lifetime impacts and operational and maintenance costs. Cities are also called to evaluate the best available technologies and solutions providers on their territories to develop competitive plastic waste management systems that can be scalable.

Lastly, replicating cities can stimulate the update of end-of-life application for plastic packaging waste in their management practices. This can be made either directly through public procurement, or through setting enabling framework conditions that increase the number and value of business models based on reused or recycled plastics valorisation.

5.3 Political approval and stakeholders engagement

Political approval and stakeholder engagement is key for the adoption of the PA. Besides, a correct process of obtaining and maintaining political and stakeholder commitment requires effective planning and governance models.

a) Degree of political commitment: The adoption of different technologies and processes to improve waste management of plastic on a local level, requires also political support of different levels. However, the political focus and priorities can also change throughout different election periods. Therefore, it is recommendable to design structured programmes with financial sustainability schemes and under effective business modelling processes, to provide informed technical suggestions, in case of changes in the political agenda of a city.



b) Strategic intermediaries: The adoption of the PA in the pilot cities, highlighted the importance of finding and working with local industry partners, SMEs or start-ups that can support the transposition, adaptation and/or further development of the selected technologies for plastic waste collection, transport, sorting and reprocessing. The development of effective service contracts or Public-Private Partnerships (PPP) should be evaluated in the cities.

c) Public participation and citizen engagement: The PA adoption success depends a lot on the engagement of citizens in the pilots, especially during the collection phase. Based on the experience from the different pilots, the willingness of residents to partake is crucial to the success of the approach implementation. It is recommended that cities carry out a sociological assessment of the population in the area that will take part in the plastic separation and sorting activities. This will allow the identification and of the dissemination activities that need to be done.

Cities must develop strategic campaigns and engagement processes for citizens' participation along the whole process. Budget should be allocated specifically for the implementation of communication and dissemination activities to key stakeholders.

d) Capacity building: The correct adoption of the PA, suggests the development of specific training and capacity building programmes to key stakeholders and citizens in the use and adoption of the technologies. Besides, a transparent provision of information and tools about the benefits of the PA for them is crucial to advance use. Also, training to city staff and service providers, especially to operational teams or third parties in charge of works in the field (collection and transport) is key to achieve the expected adoption.

5.4. Implementation

The following steps outline key steps to be taken to support PA implementation. In this, it is advised that both the implementation plan and the procurement plan are developed to be complementary. Moreover, a first and second version of both is recommended in order to allow for an initial planning phase, as well as corrections to the plans at a later point, should they become necessary.

a) Implementation plan. A municipality must develop an implementation plan which details how the targets set in the goals will be attained, as well as what resources will be required to attain the targets in the project. In this instance, the implementation plan should be developed in a manner that summarises the entire planning process (see steps 3.1 to 3.3 above) in order to demonstrate how each of the steps fits into each other. Stakeholder engagement is key to the PA

implementation. Hence, a distinction should be made between stakeholder engagement activities undertaken to develop the project (see above) and those that are part of the implementation of the PA. Once the project has been approved, the implementation plan should be a living document that will be used to deliver day to day waste management services so targets set in the project can be met. The implementation plan should hence roughly cover the following:

- Policy and regulatory screening and stakeholder mapping
- Targets and goals setting (short- to long-term)
- Technology and infrastructure planning
- Definition of key performance indicators (KPIs)
 - Alternatively, the definition of key performance indicators could be covered in a separate document on monitoring and evaluation, depending on the situation (see also 3.5).
- Stakeholder engagement and capacity building activities - see also 3.3 above
 - This should cover those stakeholder engagement activities that are essential part of the PA implementation (e.g. continuous residents' dialogues)
- Technical activities for PA implementation
- Finance plan
- Business models and end-of-life applications

b) Procurement plans. A crucial part of the PA implementation is the procurement, operation and maintenance of equipment. To plan and manage these, a procurement strategy needs to be developed. This could either be part of associated strategies in the respective municipal departments, or be developed as a standalone plan, for instance as part of a pilot-like implementation of the PA. In the latter case, innovation procurement can become part of the pilot itself, allowing it to go beyond state-of-the-art concerning procurement practices. An outline of a standard procurement plan is provided below (taken from the [ICLEI Procura+ Manual](#)):



- Pre-procurement
- Deciding on the procurement process
- Defining the subject of the contract (subject matter)
- Selection / exclusion of bidders
- Technical specifications
- Award criteria
- Contract performance clauses and management

In addition, it should be considered, whether approaches such as Life Cycle Costing (LCC) can be taken into account in order to internalise external environmental and social costs, making options with less such costs more appealing and others, perhaps more conventional options, more expensive in the long run.

For more ICLEI procurement resources, visit <https://sustainable-procurement.org/resource-centre/>.

5.5. Monitoring and Progress Evaluation

Monitoring and evaluation help to track and assess the results of the interventions throughout the project's life. Monitoring and evaluation will help decide how to collect data to track indicators, how monitoring data will be analysed, and how the results of data collection will be disseminated. Data alone is not useful until someone puts it into use. Monitoring and evaluation will help make sure data is being used efficiently to make the project as effective as possible and to be able to report on results at the end of its implementation. The following four activities are proposed:

a) Strategic and operational goal setting: In order to make the connection between waste management and the circular economy for plastics with environmental, social and economic benefits, it is important to place the concrete PA interventions within a context of strategic and operational objectives (see also 3.2.2. above). Thereby, the strategic objectives are developed based on the cities overarching development vision. A strategic objective could e.g. be "to be climate neutral by 2050". Building on that, several operational objectives (e.g. reduce emissions from waste by 80% by 2050) can be developed for one strategic objective. Ideally, the PA interventions are placed within such a framework as a measure to support the fulfilment of one or more operational objectives (see also graph below). Indicators (ideally adhering to the SMART framework) need to be developed to measure progress made towards achieving an operational objective through the implementation of PA measures.

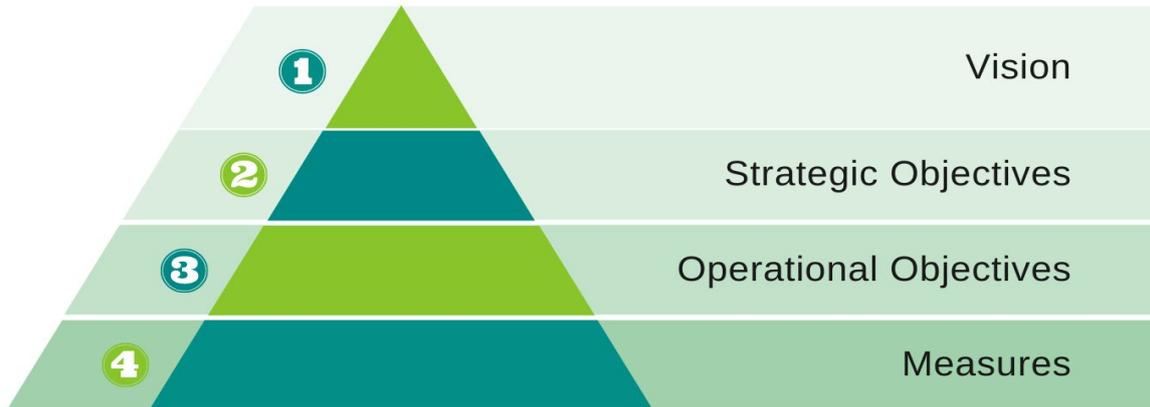


Figure 11: Monitoring and progress evaluation pyramid

b) Monitoring & evaluation: Monitoring and evaluation is a key part of any project cycle. In this context, monitoring and evaluation serve two main purposes: (1) to monitor and evaluate key parameters suitable for providing information on the development of the project, providing also the basis for corrective action if necessary, and (2) to look at the information that gives insights on the contributions of the project to achieve the operational objectives (impact monitoring). Hence, it is suggested to develop two types of indicator sets (if not existing sets are available): one for evaluating the success of the project and justify expenditures, etc. (at project site scale), and another one to evaluate the impact the measures have had towards operational goals and, thus, by implication, towards the strategic goals of the city (sector or city-wide scale).

c) Internal and external reporting: Reporting on progress, outcomes or impact is an important part. Reporting frameworks can be designed around the data and indicators available, or the other way around, but generally content and format largely depend on the requirements set by funding entities, but also on the ambitions set by the city administration. It is recommended to connect the PA implementation interventions as much as possible to the strategic objectives of the city, thereby strengthening a systemic view on them and creating intrinsic motivation for upscaling in case the project is successful at project-level scale.



6. Conclusions

6.1 First conclusions

The experience of the PA implementation in the pilot cities Valencia, Utrecht and Alba Iulia shows that the PlastiCircle model for circular economy in plastics is flexible enough in the different phases (collection, transport, sorting and recycling) to be adopted and implemented together or separately in one city, district or neighbourhood.

The implementation of the PA has been affected due to existing regulatory frameworks that impede specific actions especially in the reprocessing phase (waste exports, waste handling and storage, location of containers in the public space, etc.). These framework conditions either lead to higher transaction costs for generating value from this type of waste or freeze an advancement of activities. In this sense cities should work on an early planning stage to identify the regulatory changes that could influence the adoption of new technologies.

The governance structure for solid waste management (including plastic waste) on a local level has direct influence in the implementation of the PA. In cities where waste collection is done by subcontractors or service providers, PlastiCircle would need to be embedded into the procurement processes in close collaboration with city services operators in order to have meaningful results. In cities where waste collection and transport is part of the city operations itself, the approach focus should be mainstreamed into local planning activities in coordination with responsible departments. For both cases, the business and financial models should be sustainable and aligned with local realities and governance structures.

6.2 General recommendations

- Although acquiring the PlastiCircle technologies means more expenditure, it also means more benefits (when selling the recovered material). Cities should identify alternatives of infrastructure and technology providers and local governments should work closely with them in planning processes to guarantee the correct and sustainable implementation of the different PlastiCircle related technologies.
- Cities should take advantage of existing policy and regulatory instruments that facilitate urban infrastructure renovation or upgrade, in order to embed waste plastic management technologies and initiatives in the core of urban infrastructure development programs. Smart city or climate innovation initiatives or programmes could also facilitate the adoption of the different phases of the PA.
- The city should strive to integrate the PA interventions into a wider framework of city-wide strategic objectives, such as climate mitigation efforts, biodiversity, economic resilience, well-being and health. This should also be underpinned with

a monitoring and evaluation framework, in addition to monitoring the progress of the PA intervention at project-scale.

- Most of the KPIs related to waste and plastic waste management commonly used by cities are mainly operational. It is recommended that cities should define other KPIs beyond these operational goals, to leverage the impact of the PA on citizens' quality of life and the overall sustainability of the city.
- It is important that cities take advantage and use the data generated by the smart infrastructure solutions used for plastic waste collection, transport and processing to build new and effective KPIs that feed monitoring and reporting systems as well as urban decision-making processes.
- Innovative public procurement is key to advance on the adoption of technologies to enhance smart plastic waste management. The governance realities for the deployment and operating the infrastructure requires the involvement of more than one municipal department or different service contractors. Therefore, it is very important to explore a significant change in the design of public procurement, with faster procedures for innovative and advanced infrastructures such as the ones embedded in the PlastiCircle approach.
- It is important to set clear expectations
- It is key to study very well the cost-benefit of each approach
- Choose the pilot area based on your objectives (i.e. you might want to go for an area with low recycling rates, you might prefer to go for an area that is already experienced in recycling...)
- Allocate the necessary resources
- Manage risks
- Identify the appropriate area, district and public space and conduct a pre-analysis of the location to decide what aspects of PlastiCircle can be applied or make sense (i.e. in areas where there is no automotive industry, it does not make sense to apply)
- Set up clear indicators to be measured before and after the project, to quantify results that can be then explained to all stakeholders

7. References

Franco, J., Miranda, B., Escobar, P., Ample, P., Chapí, E., 2018, Truck traceability system. D3.3 PlastiCircle

Mavrič, P., 2020, Initial replication guide. D9.8 PlastiCircle

McKinlay, R., 2018, Sorting Requirements. D4.1 PlastiCircle

Picvisa, 2018, Sorting system definition. D4.2 PlastiCircle

Webpages:

ICLEI Procura+ Guide: <https://procuraplus.org/manual/>

8. Annexes

Annex A: Cost-benefit analysis

It is paramount that the CBA report is transparent and all information addressed is available and easily accessible. The methodology should be sound and consistent, as the CBA refers to methods, tools and all the hypotheses used and mentioned throughout.

When preparing your CBA on the PlastiCircle approach, we suggest to follow the steps below:

1. Goal Setting:



Clearly define PlastiCircle's objectives and its expected results in your city, taking into consideration the variables that can be affected by the project and how to measure them. It is particularly important to identify if and how PlastiCircle can help your City achieve specific objectives of EU regional or cohesion policy.

With the objectives, answer the following questions:

- Can it be said that all the improvements obtained are supposed to be resulting from a project worth the costs incurred?
- Have all the most important direct and indirect socio-economic effects of the project been taken into account?
- Have other indicators related to the defined objectives been identified if it is not possible to measure all direct and indirect social effects due to lack of data?

2. Project identification



Present PlastiCircle's general concept and logical framework, with all the costs and benefits identified on the previous step, and compare with your local regulations and legislation to assess if any restrictions may arise to the full execution of the project.

The goals must be:

- Clearly defined purpose of the project
- The definition of the project must comply with the regulations
- The financial constraints set by the regulations must be observed

3. Financial analysis



Provide information on how to analyse the financial aspect of PlastiCircle, including tables of financial flow which contains the whole investment rate, costs and income; identify different sources of financing that can cover the investment costs; provide an analysis of financial flow. The starting point is to work on the basic tables, complementing them with text explanation and definition of the most important elements included in the tables and calculations of return on investment and capital.

From the technical point of view, the following are especially important for the preparation of the analysis (must be part of financial analysis):

- Choice of time period;
- Definition of total costs (total values);
- Determination of total revenues;
- Definition of the residual value of the project in the last year;
- Setting the inflation rate;
- Providing sources of funding (financial coverage);
- Selection of an appropriate discount rate;
- Method of calculating financial and economic rates of return and their application in project evaluation.

4. Economic analysis



This comes from the financial analysis and the cash flow table in order to determine the standard methodology for the three steps required to produce the final table in the economic analysis.

Economic analysis must include:

- Tax/subsidy adjustments;
- Corrections due to the influence of external factors (externalities);
- Determination of converters (correction factors) (for instance the conversion of market prices into accounting prices and thus the integration of benefits and costs in society).

This analysis focuses on how to calculate costs and benefits from a societal perspective and how these can affect to the results. It provides a guide on how to calculate the economic rate of return and helps us understanding its economic significance in the project evaluation

5. Multicriteria analysis



This methodology is particularly effective when costs and benefits cannot be expressed in monetary terms. Address the various possible situations where the rate of return is too low as a decisive indicator, and therefore an in-depth analysis and presentation of key factors needs to be made.

In the case of the PlastiCircle approach, consider, for example, scenarios with low citizen engagement, difficulties to access the required technologies, issues with collecting materials or transportation routes, and so on. These losses or problems may result on a negative net present value that cannot be specifically defined in

numbers but can be predicted by the project evaluator. To compensate that, this analysis needs to include also the sustainability impact of the project.

For example, assuming that this analysis shows a negative net present value of EUR 1 million at a 5% discount rate, the project evaluator anticipates that the project could be financed from the Funds, as it “has significant positive effects on the environment” which cannot be expressed in money.

6. Comparison of alternatives



Compare the alternative solutions to treat plastic waste with PlastiCircle, illustrating with tables and graphs so as to facilitate the decision-making process. When the costs and benefits for each competing alternative have been discounted, compare and rank the discounted net value (discounted benefit minus discounted cost) of the competing alternatives.

The option with the lowest costs and highest benefits is clearly the best alternative.

7. Sensitivity analysis



Define and investigate how sensitive PlastiCircle would be to different variables, such as the positive or negative changes that can directly affect costs and benefits whose definition is not straightforward or is not easy to be exactly defined. The sensitivity analysis considers those input parameters that have the greatest influence on the outcome, repeats the analysis with different input parameter values, and evaluates the results to determine which, if any, input parameters are sensitive.

On the PlastiCircle approach, for example, a sensitivity analysis should consider the different citizens' and stakeholders' role in the whole process, separately evaluating each one of them and identifying if any can be more sensitive than the other, so the analysis can predict how to deal with it if a problem arises.

Annex B: Some events organised before the pilot started:

Workshop at an Elementary School

- Date: 11th April
- Target Groups: Kids (parents by extension)
- Actions: Information and training about right waste sorting



Info-Stand in Medical Centre

- Date: 17th April 2019
- Target: housewives, elder people
- Actions: Information, registration and training about waste sorting



Info-Stand at Rambleta's Parc

- Date: 24th April
- Target Groups: Families
- Actions: Information, registration and training about waste sorting




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