Intelligent Waste Management System

Cascais, Portugal 🇵🇹

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Equipping underground waste containers with remote fill-level sensors

The smart waste management system implemented in the municipality of Cascais combines the use of underground waste containers with a technology of remote fill-level sensors. While underground waste containers reduce visual impacts and maximize the use of urban space, remote fill-level sensors installed in these containers enable to trigger and manage a smart collection when these are nearly full. The sensors read the level of waste in each bin and transmit the data to a central management platform, which then allows to determine when and how the collection vehicles should start their route. This management platform can be accessed remotely in any web browser. Installing underground waste containers and equipping them with remote fill-level sensors resulted in cost reductions for municipal waste services of Cascais, while simultaneouly improving the services [1].

Country/ City Profile

	Country		City	
Population (2014)		10,401,100 [2]	Population (2014)	208,945 [3]
Land area (km²)		92,225 [4]	Land area (km²)	97.4 [5]
GDP per capita (2015, current international $, at purchasing power parity)		29,214 [6]	GDP per capita (2015, current international $, at purchasing power parity)	n/a
Region		Southwest Europe	Region	Inland
City's physical geography	Location	✓ Cascais is located on the western coast of Portugal, just 30 kilometres far from the capital, Lisbon.		
	Climate	✓ Mild climate with high number of hours of sunshine; ✓ Average annual temperature: 15.8°C; average annual rainfall: 752 mm. [7]		

Initiating context

Underground waste containers were installed in response to the objectives set for the city in 2007. Objectives were set as i) to optimize solid urban waste management systems based on the performance of a cost benefit analysis; ii) to identify and evaluate the cost benefits of alternative solutions compared to the existing waste management model; and iii) to assure sustainability of general city services while taking full advantage of existing infrastructure.

To achieve these objectives the project first proposed the installation of 465 underground rubbish bins grouped in 107 'ecological islands' (one bin for each type of recyclable material - cardboard, plastic, glass and other generic waste). These underground rubbish bins were estimated to increase the collection of recyclable material by 274% and the capacity to collect general waste by 40%. Further the project promised the removal of 350 street rubbish bins and around 240 eco-points to generate more space for pedestrians [8]. As a next step, installed underground waste containers have been equipped with remote fill-level sensors to not only increase waste disposal capacity and public space but also to guarantee smart and efficient waste collection.

Project description

Project implementation and construction of underground recycle bins began in 2011. In 2013 some of these containers (only paper and plastic containers) got equipped with remote fill-level sensors for testing purposes. In

2015 the sensors were also installed in further bins, making the whole waste management system fully operational [9].

As first city in Portugal, Cascais set up its waste management system using data generating technologies, thus making the system one of the most advanced waste management systems in the country and also in the European territory.

Additionally to the installation of sensors in the underground waste containers and the development of an online management platform also further features were included in the city's waste management system. E.g. green residues, electronic waste, etc. are/is characterized and recorded at collection, thus enabling the establishment of a large data pool making smart management possible [9]. Over time, such a large data pool allows for further improvement of services, e.g. a continuous optimization of collection routes, optimization of frequency and personal required in each route, reduction of paper work, etc.

Further the city developed a mobile app through which citizens are able to report illegal or abandoned waste incidents and locations.

Technological Innovations [8]:

1. Collection vehicles with integrated bin washing systems.
2. Adapted Vehicles Chassis – collection vehicles with a lowered cabin (eases the entrance of the personal) and a collection setup compatible with a high variety of bins and containers.
3. Waste level sensors (ability to detect when the containers are below 40% and above 80% capacity).
4. Integrated web platform (collects and analyses data for smart management).

Underground rubbish bins [12]

Waste collection vehicles [13]

Implementation process

The intelligent monitoring solution was seamlessly integrated to overhaul Cascais' current waste management practices.

Sensors were easily retrofitted to the underground bins located across the municipality. Mounted to the movable ceiling above the underground bins, the sensors were positioned directly above the recyclable material thrown into the bins. These sensors report via cellular networks to the management platform and the municipal company's control centre (Cascais Ambiente's control centre) simply monitors the fill-levels of their bins and plans optimized collection routes for their drivers [10].

Through an application, route details are also sent directly to the collection trucks fleet management system, enabling drivers to focus on routes containing most bins with optimal fill-levels for collection.

| Projects implementation details [11]	
Process/ Leadership	EMAC - Empresa Municipal de Ambiente de Cascais (Cascais Environmental Municipal Company), owned by Cascais Municipality.
Financing	Lisbon's Regional Operational Programme (POR Lisboa) supported the project with 650,000 €. EMAC invested 2.5 million € in the modernisation of Cascais' waste management system.
Partners	Sotkon Waste Systems.

Results

Main Operational Results [8]:

- ✓ Reduction of operational expenditures.
- ✓ Automation and optimization of daily activities.
- ✓ Real time monitoring.
- ✓ Data collection on route performance and fleet.
- ✓ Generation of daily productivity key performance indicators (KPIs).
- ✓ 40% reduction in collection trips.
- ✓ Between 2013 and 2014, 145,043 € savings on fuel costs and 520,087 € savings on vehicle repair and maintenance costs.
- ✓ Avoidance of street bins over-filling.

Key results by March 2015 [8]:

- ✓ 13% cost reduction on waste collection services.
- ✓ Between 2011 and 2014 direct costs for collection services decreased about 900,000 € (from 7,090,731€ to 6,194,363 €).
- ✓ Investment recovery time of six months.
- ✓ 264 tons of CO_2 emissions have been avoided, thus due to the reduction of the number of kilometres driven.
- ✓ Undifferentiated waste collection decreased significantly.
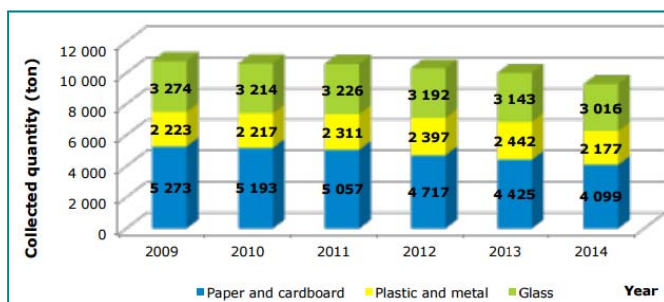
Municipal waste selective collection [8]
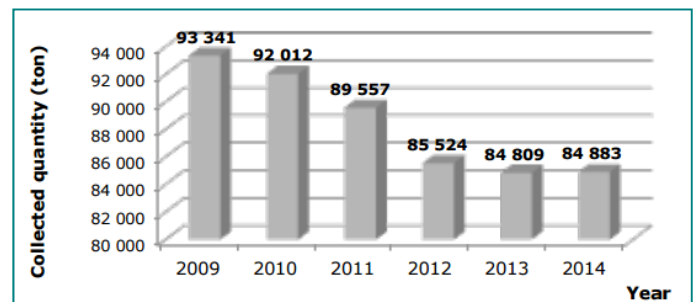
Undifferentiated municipal waste collection [8]

Project benefits

Main project benefits [9]:

- ✓ Waste collection services improved.
- ✓ Optimized collection routes for drivers.
- ✓ Reduction of municipality costs for collection.
- ✓ Reduction of carbon emissions.

Lessons learned [8]

- ✓ Using the best available technology is not enough for implementing a successful project; relevant stakeholder groups must be integrated in the implementation process.
- ✓ When introducing a new technology, old procedures must be reviewed and the ones not taking full advantage of the technology must be updated.
- ✓ Not updating procedures may reduce the return on investment (ROI) and result in an unprofitable investment.
- ✓ A detailed data collection in real-time and of high quality is crucial for smart waste management systems.
- ✓ Cameras and classic surveillance are not preferable to waste management systems when compared to sensor based management systems, as their use is more expensive and complex.

Awards

2015: The project was honored with the "A Smart Project for Smart Cities" label under the category "Sustainability". The "A Smart Project for Smart Cities" award recognizes innovative projects under the field of urban development.

2014: The project was honored with the "Urban Waste Management Quality Service Award" given by the Regulator of Water and Waste Services [8].

References

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