Gemma Nohales | ENT Environment & Management

MedCities WG on Integrated Solid Waste Management

Wednesday 9th of July 2025, 10:30 – 12:30 CET (UTC+1)

Webinar I

Introduction to the application of technology on municipal waste management

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Degree in Environmental Sciences from the Autonomous University of Barcelona.
Master's in Environmental Intervention: person, society and management by UB-UAB.
Specialized in Waste Management and Prevention and Circular Economy with more than 20 years of experience.

Expert in prevention strategies and plans, EPR and waste management, biowaste management, packaging and textile fraction, individualized collection models and identification systems, design and monitoring of collection systems, simulation models, indicators and environmental analysis, advice to public administrations, management of grants and European projects.
She has knowledge in communication, fair fees, and personal data protection applied to waste management, and experience in public administration.
Worked for 16 years at the Urban Ecology Agency of Barcelona – BCNecologia and 4 years at the Catalan Waste Agency.
Since 2023, she has worked as a consultant at ENT Environment and Management and coordinates the LIFE BIOBEST project on biowaste policy and management within the EU framework.
She has participated as a speaker in seminars and conferences, and coordinated training activities with the College of Environmental Scientists of Catalonia.

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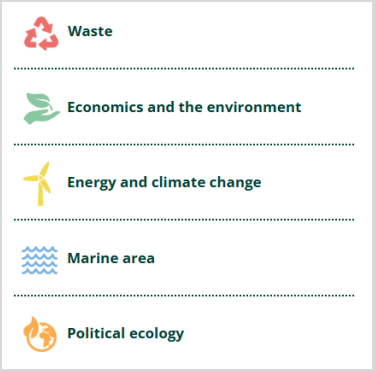

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BLOCK 1 | The concept of efficient management models and appropriate technologies and their application in the field of waste management

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BLOCK 3 | Management platform. Functionalities

- Fleet and street furniture control
- Route planning and optimization
- User management
- Incidence management
- Calculation of indicators and reports
- Service APP

Questions and comments

CONTENT

PART II

BLOCK 1 | Key elements to be considered for the implementation of technology

- Criteria for contracting technology
- Services involved and integrated management
- Staff and coordination needs
- Contract management and service monitoring linked to technology
- Other complementary actions
- Challenges, efficiency and resources needed

BLOCK 2 | User (waste producers) identification and monitoring. Application of technology to door-to-door and containers with electronical access control collection models

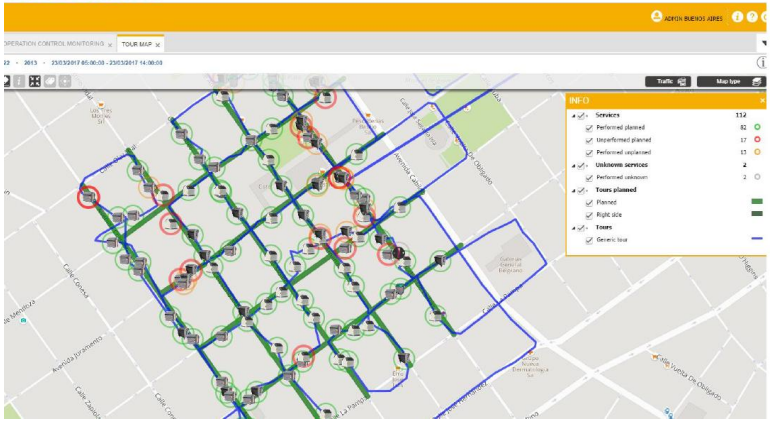
Questions and comments

PART I - BLOCK 1

The concept of efficient management models and appropriate technologies and their application in the field of waste management

DEFINITION OF TECHNOLOGY

TECHNOLOGY is the application of conceptual knowledge to achieve practical goals, especially in a reproducible way. The word *technology* can also mean the products resulting from such efforts, including both tangible tools such as utensils or machines, and intangible ones such as software.



TECHNOLOGY, the application of scientific knowledge to the practical aims of human life—or, as it is sometimes phrased, to the change and manipulation of the human environment.

WASTE COLLETION MODELS

Door-to-Door collection (DtD)

(kerbside collection)

Surface containers

Underground containers

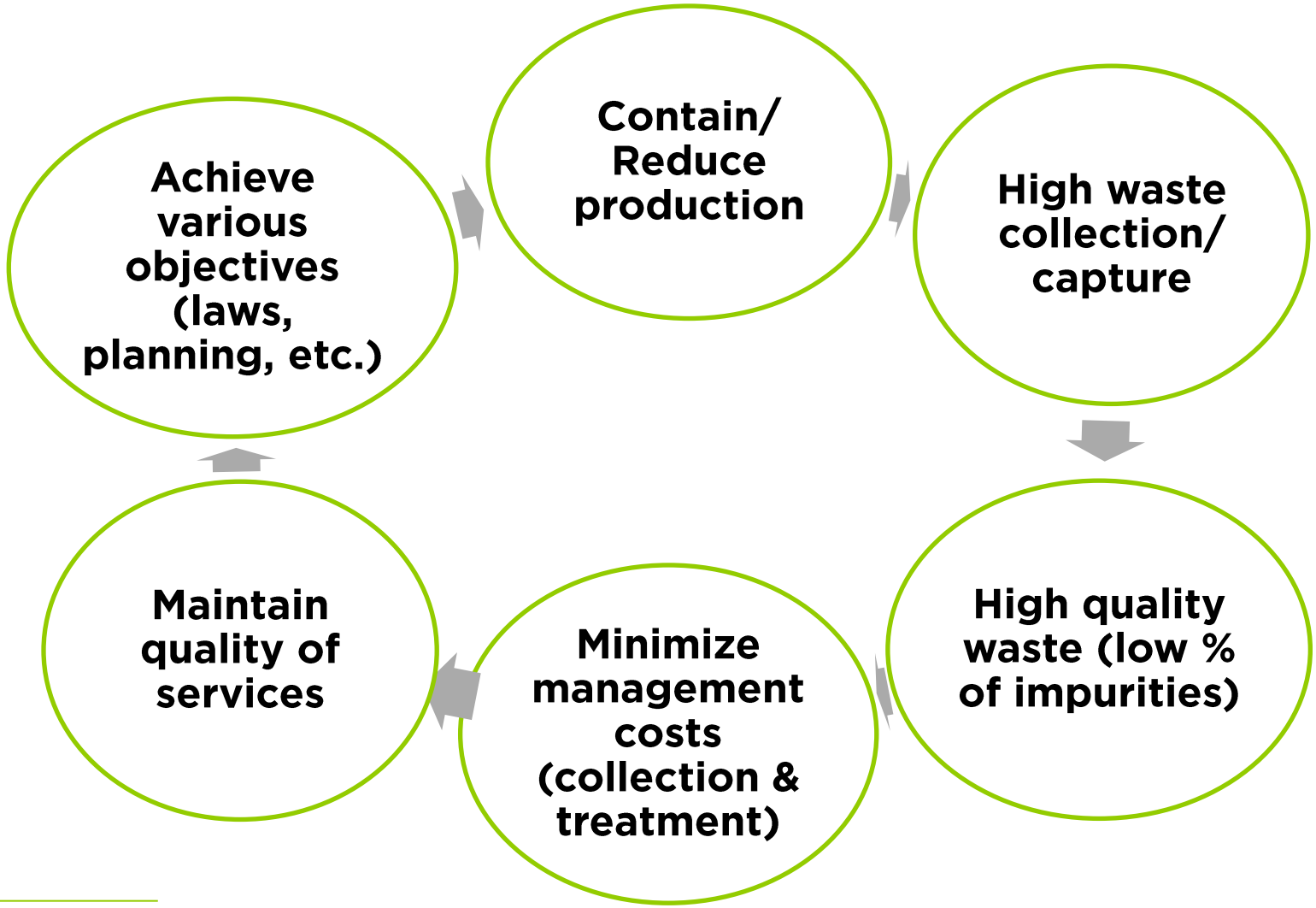
(!! investment, maintenance, location not flexible…)

Pneumatic collection

(!! investment, maintenance, energy consumption, location not flexible…)

Other systems: on demand, recycling centers, points in stores, etc.

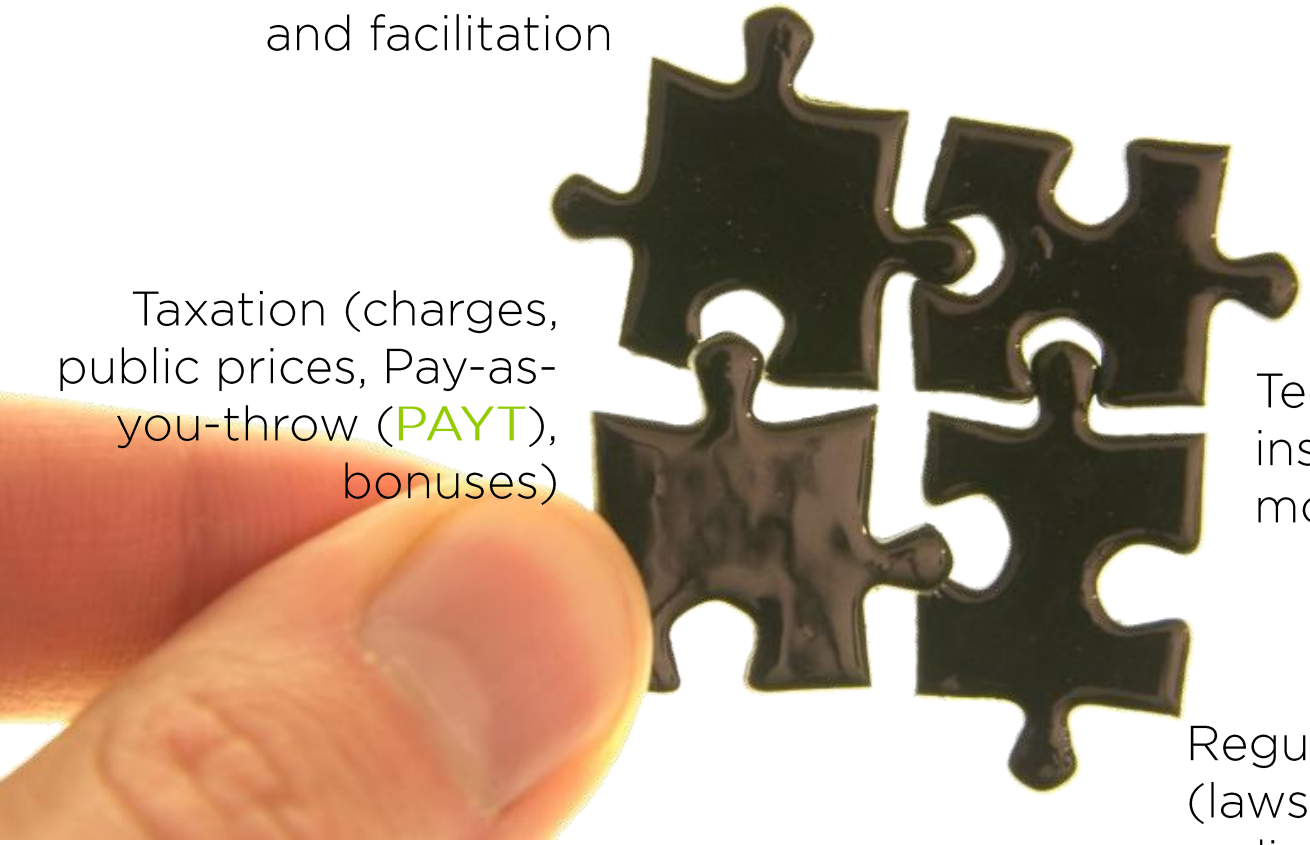
NEED FOR COLLECTION MODEL OPTIMIZATION



COMBINATION OF INSTRUMENTS

Environmental education, information, communication and facilitation

Need for a long-term strategy to get all the benefits, with consistency and transparency



Taxation (charges, public prices, Pay-as-you-throw (PAYT), bonuses)

Technical instruments, service, monitoring, ICT

Regulatory framework (laws, regulations, ordinances)

OPTIMIZATION GENERAL STRATEGIES

Integral collection systems (not additive), adapted to each context.

Systems capable of adapting to changes and each context.

Permanently optimize collection (and cleaning).

Detailed study of collection needs (supply delivery and collection element, frequency of emptying and cleaning, seasonality, routes, schedules, staff, etc.).

Effective system to capture greater quantity and quality.

Make separation and user deliveries comfortable.

Collection models verified according to other experiences.

Co-responsibility and linkage of all actors (citizens, Economic act., collection company and council, personnel, etc.).

Enough human resources: Internal or external waste technicians/inspectors.

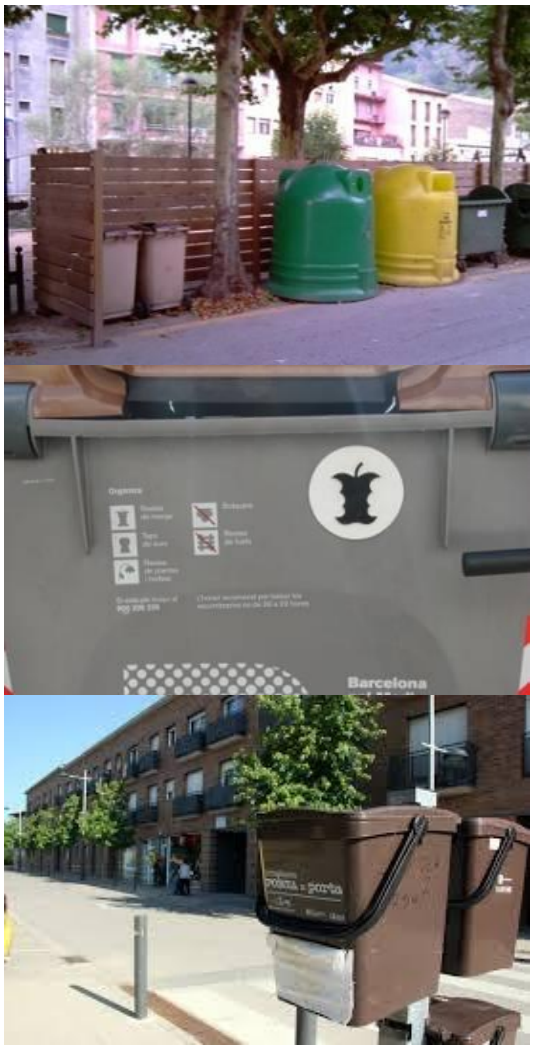
OPTIMIZATION STRATEGIES

Appropriate design of the service, material assets and revision	Bio-waste management, maximum capture and quality Garden waste/pruning	Introduce differentiated commercial/large producer collections (integrated/specific route)
Management of complementary collections (bulky elements, recycling centers, ...)	Logistics optimization: routes, transfers, types of vehicles, ICT	Monitoring and control of the service and users with ICT
Contract management Collection company co-responsibility (tenders, coordination)	Communication, participation, facilitation, continuos strategy, change management	Taxation – variable taxes, PAYT, bonus

ICT=Information and Comms technologies

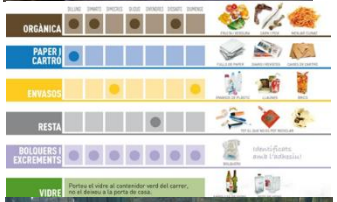
DESIGN - GENERAL ELEMENTS

- Ease of access and use for users
- Clarity of information and identifiability
- Minimal impact of the collection system on public space and people
- Unified image of the service
- Quality of service and personal attention
  Flexibility of the collection service and coordination with street cleaning

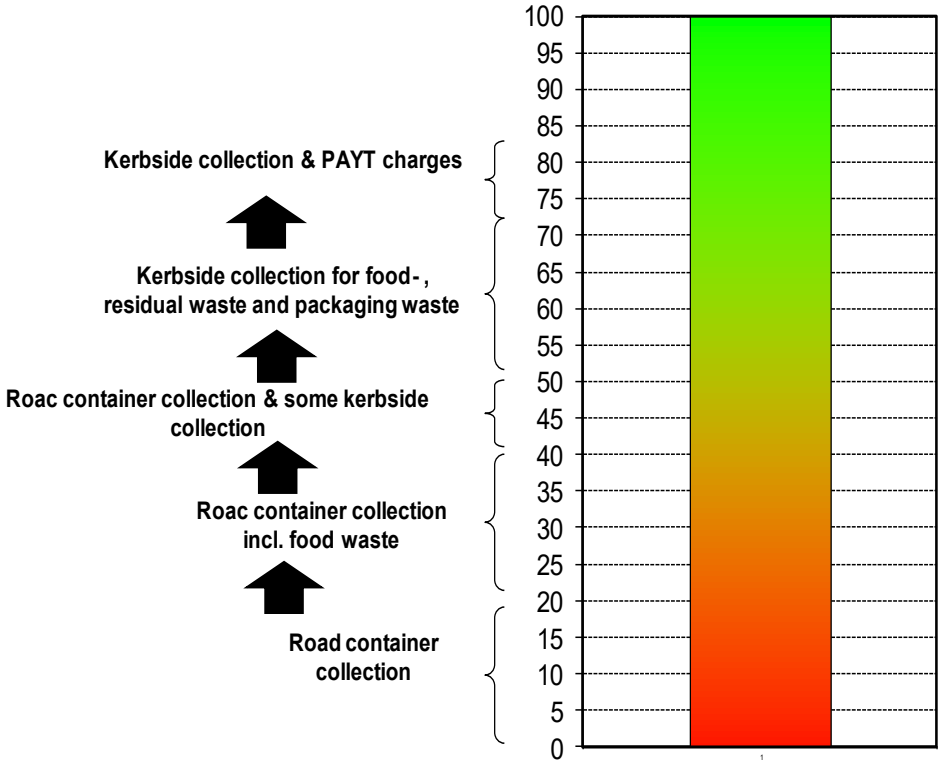


DESIGN - GENERAL ELEMENTS

- Select the most appropriate EFFICIENT systems according to urban morphology, dispersion, economic act., seasonal population, etc.
- Mixticity of collection systems (if necessary). Consider commercial pickups
- Facilitate the contribution of recyclable fractions vs residual waste collection (distance, equipment, frequencies)
- Reduce the frequency of residual waste contributions as much as possible (physical limitation: few times and volume)
- Strategies to avoid impurities: small caddies/bags and sizing delivery entry in containers, user control with DtD services
- Mandatory space reservation for at source separation/setouts in dwellings/economic act.; community areas (DtD)

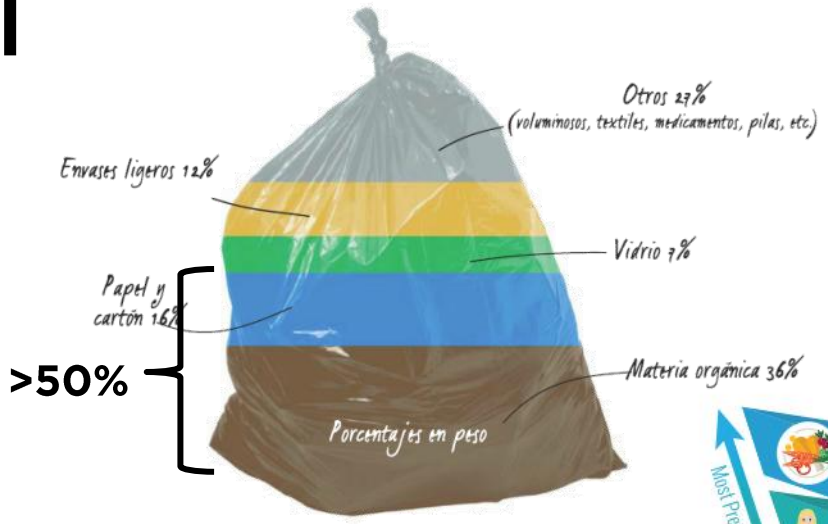


SELECTION OF EFFICIENT MODELS

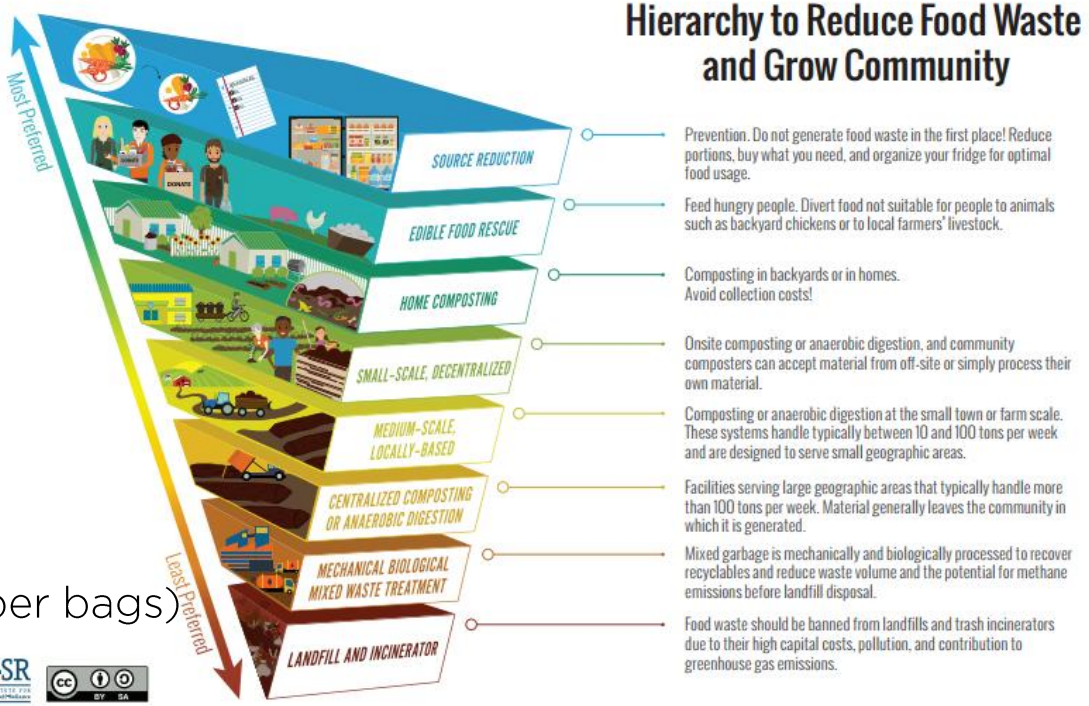


Source: CIC

IMPORTANCE OF BIO-WASTE



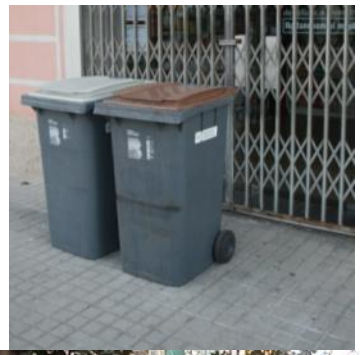
- Bio-waste (food waste+garden waste) is the largest MW fraction
- Cross-cutting flow with benefits for other topics/policies



- Use of vented caddies+ certified compostable plastic bags (or paper bags) to facilitate source separation

IMPORTANCE OF COMMERCIAL COLLECTION

- Commercial streams are very important (high % in MW). There is a lot of potential for improvement in the collection of businesses and other large generators (public facilities) waste.
- Obligation for businesses to have authorized managers (this practice needs to be controlled) or adhere to the collection system offered by the City Council.
- With the application of DtD systems, good results are obtained in terms of quality and quantity of materials that increase the overall levels of separate collection.
- If they have their own bins, overflows of road containers are avoided.

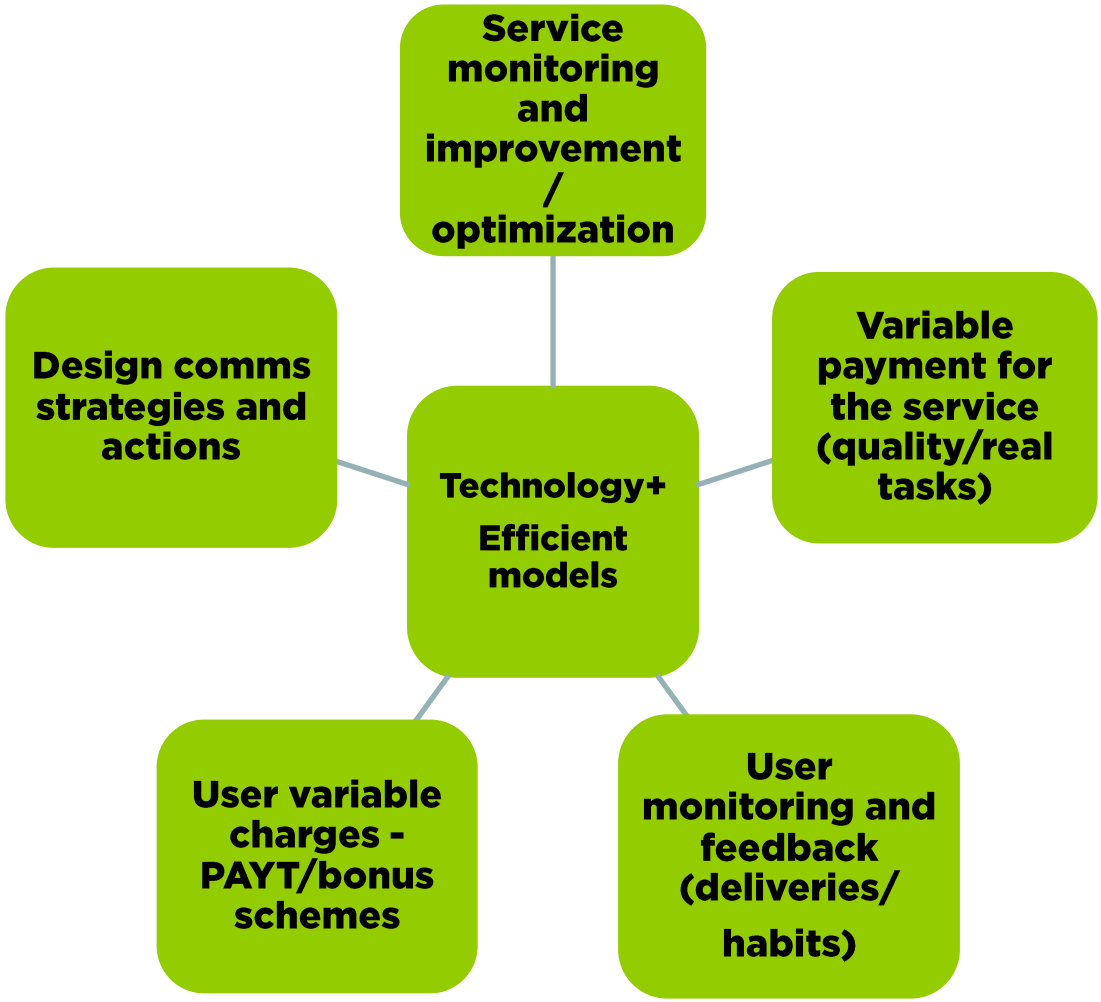


BIO-WASTE IN SITU TREATMENT

- Home composting in dispersed/rural areas turns out to be the most successful mechanism for managing bio-waste. Community composting in rural areas can be an appropriate system to replace the bio-waste collection system (locate nearby waste collection points, monitoring staff).
- Home composting for large producers/single generators.
- Small-scale composting facilities (low-cost/low tech solutions).

•The implementation of a bio-waste collection service would be very costly economically, energetically and environmentally, due to the dispersion level.

COMBINE EFFICIENT MODELS WITH TECH



PART I - BLOCK 2

Technological elements in 2-wheeled bins/small caddies, containers, vehicles and other machinery for waste management

OVERVIEW OF THE TECH ELEMENTS

RFID= Radio Frequency Identification

ID ELEMENT FOR RECEPTACLES

ID in containers with user access control

ID in container boxes with user access control

User identification

ID in delivery sites with user access control

ID in containers with delivery volume control (chamber)

ID in DtD collection with standardize bags

ID in DtD collection with small caddies

ID in DtD collection with bins (domestic/commercial)

ID in street cleaning equipment

ID in industrial waste collection (large containers)

ON BOARD IDENTIFICATION-BAGS+CADDIES FOR DtD

UHF RFID TAG in caddies
UHF RFID TAG adhesive or integrated in the bags

DISCOVERY
UHF

C5K - POCKET
HDX / FDX / UHF

MOBA
MOBILE AUTOMATION

- Automatic UHF RFID reader with antenna/s in the hopper or on the side of the vehicle
- On-board computer with GPS/GPRS to send collected information and position
- Rear incident button panel
- Wrist RFID reader with 2 incident entry or handheld terminal for RFID reading and incident entry. Ideal to avoid the displacements towards the vehicle

ON BOARD IDENTIFICATION-CONTAINERS

LF RFID TAG in 2- & 4-wheel containers

- Automatic LF RFID reader with 1 antenna (optional, 2 or 3 antennas)
- On-board computer with GPS/GPRS for sending collected information and position
- Rear incident button panel

FILL LEVEL SENSORS FOR CONTAINERS

- Ultrasonic fill detection (40 kHz)
- Accuracy ±2 cm
- Measuring range: 25 cm - 300 cm
- Configurable color
- Standard protection index IP66
- 3-year battery (replaceable)

eGarbage

Source: LIFE EWAS Project

FILL LEVEL SENSORS FOR CONTAINERS

- Detection of possible overflows, include alerts
- Route planning and optimization, Service audits
- Very useful for disperse areas, remote points


De: Egarbage Alert Manager <notify.egarbage@wtelecom.es>
Para: Jose Antonio Cabo
CC:
Asunto: [EGARBAGE][pre] 867622013846541 - Alarma Desbordamiento de carga

Alarma por desbordamiento en el nivel de residuo

Datos del contenedor

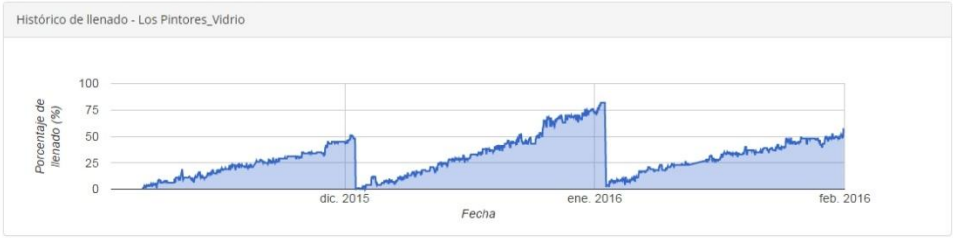
- **UID:** Contenedor Demo
- **Localización:** Calle Leonardo da Vinci, 1, 41092 Sevilla, Sevilla, España
- **Descripción:** Contenedor virtual para pruebas de medición
- **Tipo residuo:** vidrio

Datos del dispositivo

- **IMEI:** 867622013846541

Nivel reportado: 69% (63cm)

Bio-waste: daily collection



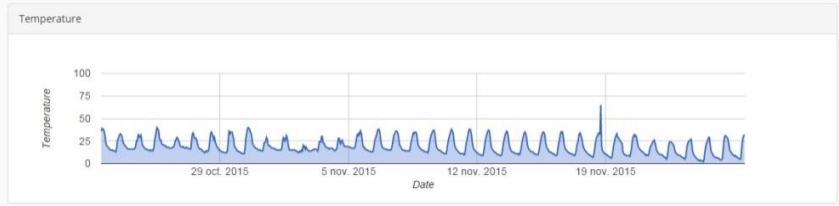
Glass: 1 time/month collection

eGarbage

Source: LIFE EWAS Project

FILL LEVEL SENSORS FOR CONTAINERS

- Vandalism Detection: Fire (temperature sensor and alert)



Alert	Container	Description	Date
High temperature	Bar Funes_Papel	High temperature overflow alarm	26/11/2015 - 03:23 PM
High temperature	Bar Funes_Papel	High temperature overflow alarm	18/11/2015 - 06:00 PM

eGarbage

Source: LIFE EWAS Project

WEIGHING SYSTEMS IN WASTE COLLECTION VEHICLES

Rear-loading vehicle with on-board weighing system.

Load cell installed on vehicle chassis.

- Production data of each container based on specific municipalities or areas and the different fractions
- Detailed and individual statistics per municipality or area
- Service charge assignation/calculation per municipality or area, implement variable payment per generation within shared routes
- Importance of robustness of the system and an experienced technical service capable of solving any incident

DISTROMEL

STUDY CASE: EL PRAT (CAT)

- El Prat del Llobregat
- Baix Llobregat, Metropolitan Area of Barcelona
- 65,000 inhabitants
- Port, airport, river, industry, beach, agricultural park, Natura 2000 Network protected areas and ZEPA

Source: El Prat Council

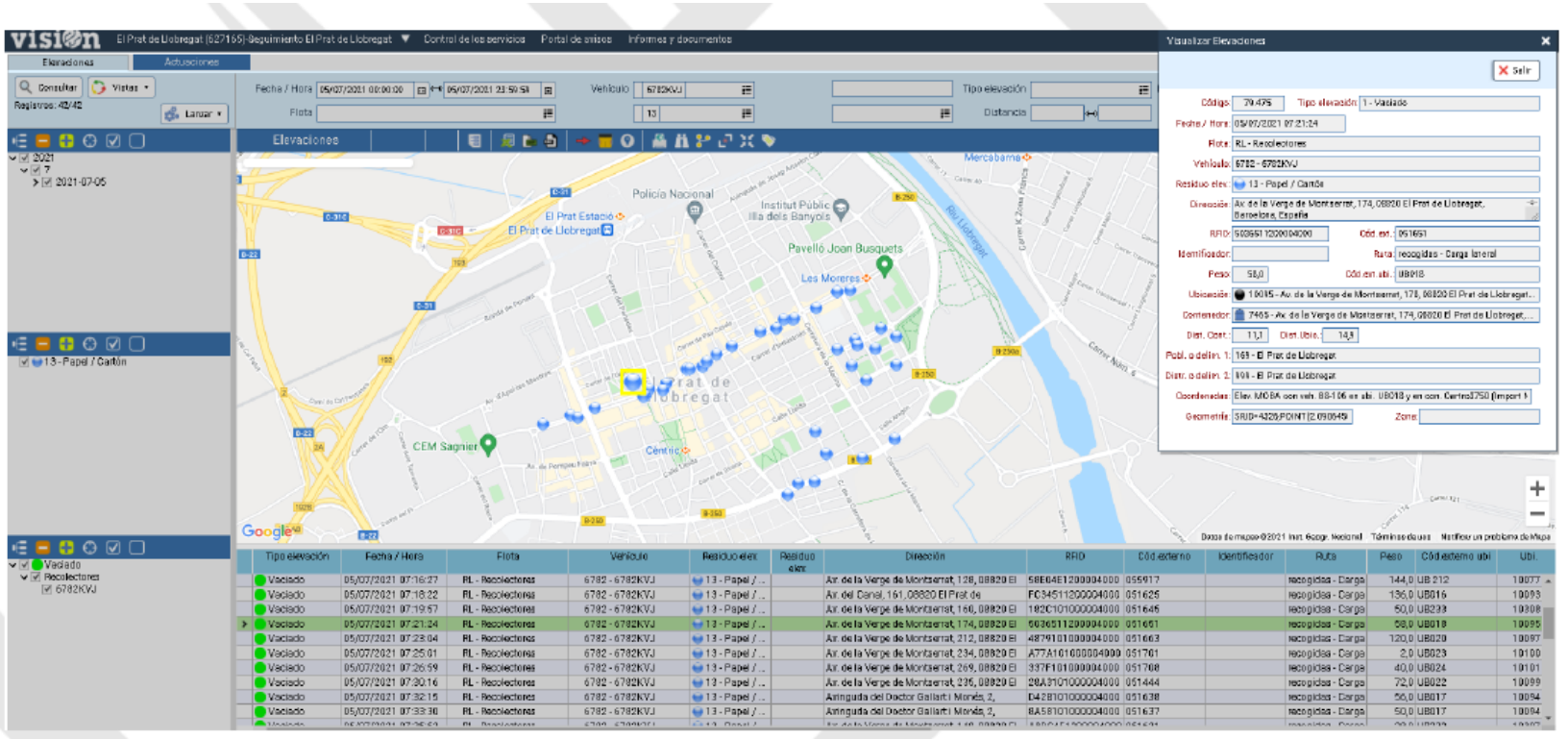
STUDY CASE: EL PRAT (CAT)

Technology implemented in the collection service:

- **GPS** in all vehicles for tracking.
- **RFID tags** for container identification to know when a vehicle collects or washes the receptacles.
- Information management **Platform**.
- **Email alarm** management modules (key to success).
- **APP for all workers** to detect service incidents, GPS positioning and filling out worksheets (1 mobile per worker). Information on incidents such as graffiti, posters, bottles, etc.
- **Container fill level sensors** with a fleet of 500 units of sensors to detect the fill level of the receptacles (**paper, packaging, peripherals and problematic points**) and temperature sensor.
- **Weighing system** in collection trucks: fleet of 9 units of weight sensors in each collection truck.

Source: El Prat Council

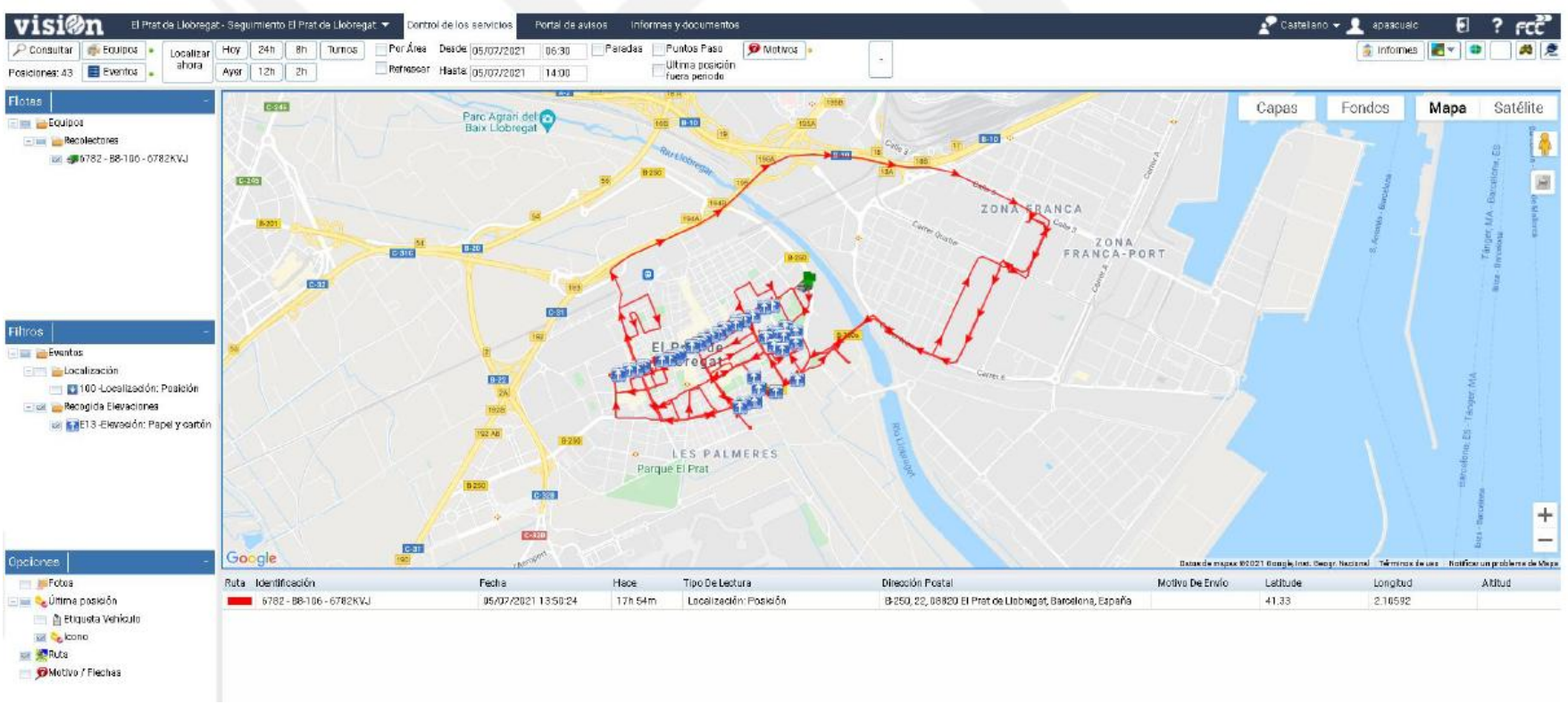
STUDY CASE: EL PRAT (CAT)



- Assets' data: Location/address collection points, coordinates/route for vehicles, etc.
- Service performed: Emptying/washing data/time/incidents (maintenance under study).
- Service timetable: Starting/ending, intermediate stops, plant delivery stop, etc.
- Weight: Kg of waste collected per container and fraction.

Source: El Prat Council

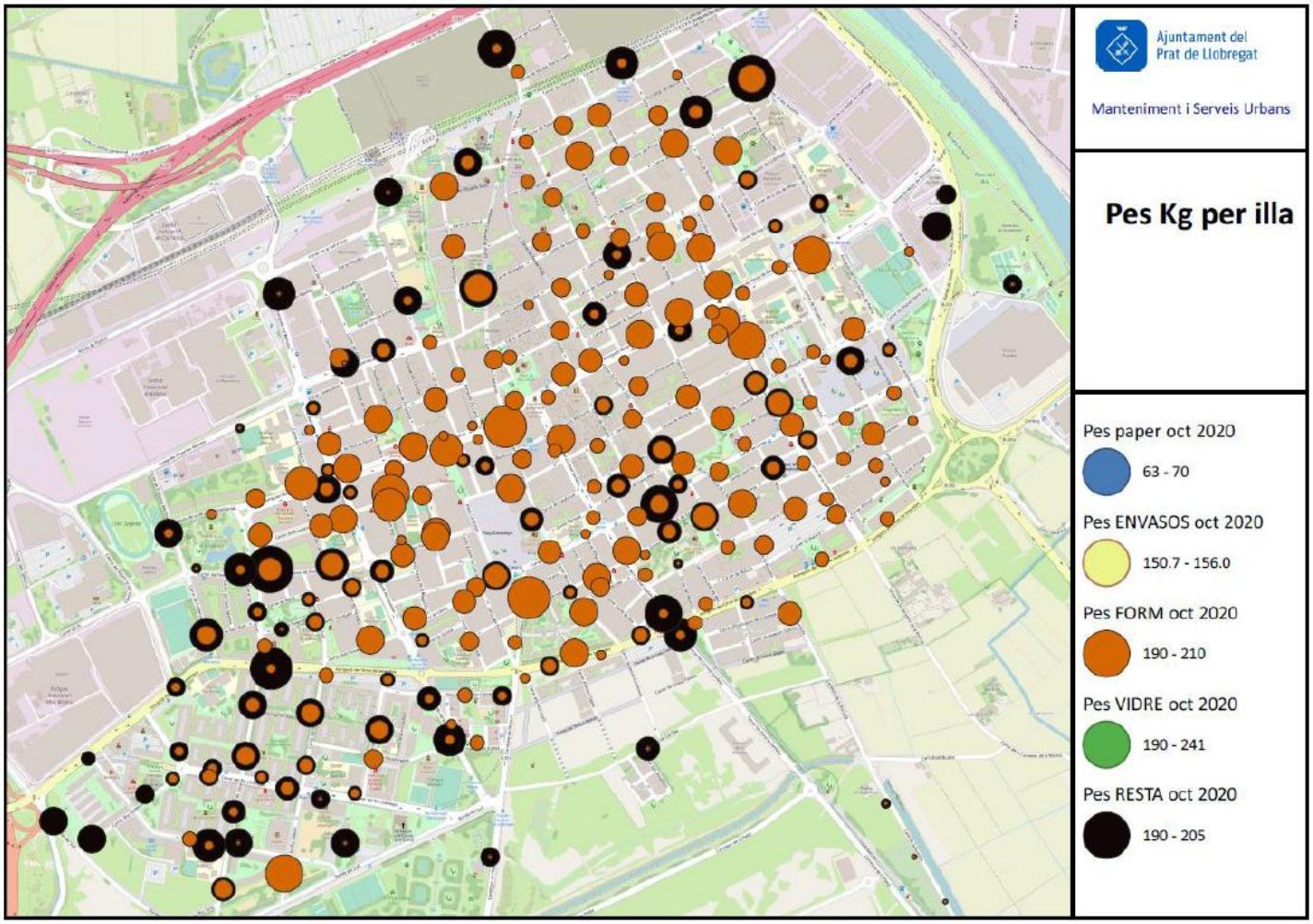
STUDY CASE: EL PRAT (CAT)



Map of the collection route with start/end, emptying stops, plant delivery stop, etc.

Source: El Prat Council

STUDY CASE: EL PRAT (CAT)



Map of the kg per collection point for bio-waste and residual waste

Source: El Prat Council

STUDY CASE: EL PRAT (CAT)

The main conclusions of the experience:

- The **weighing system** is one of the new technological tools with the highest degree of satisfactory operation (along with GPS and RFID ID).
- The weight of the containers has allowed a **redesign of the container park** to better adapt to citizen needs and annual variations. Removal of 18 residual waste containers not useful. Addition of 12 glass containers.
- The impact of **quality control** of the service is essential to achieve correction. Continuous **improvement plans** are needed.
- Better **unified/integrated management system** for different services/activities (ideally own system, adapted to specific needs).
- **Alarm management module** (key success factor), expedite resolution actions.
- Effective management system to improve performance: from **data to information** and knowledge, and effective action plans.
- **Big Data requires Big Administration**.

Source: El Prat Council

STUDY CASE: SANT CUGAT (CAT)

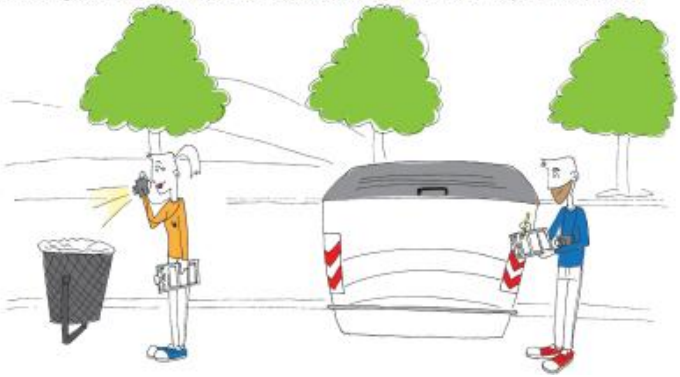
Continuous control and improvement plan since 2013

1 Tech: vehicles & containers

Diàriament es realitza a la ciutat el servei de neteja viària i recollida de residus amb maquinària d'última generació: vehicles amb sistema de control (GPS, sensors d'escombrat...), menys contaminants, amb tècniques d'aprofitament d'aigües reciclades, etc.

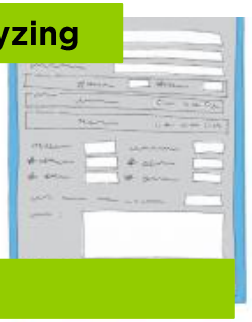
2 Street inspections

Primer es verifica que els serveis s'hagin donat tal i com està establert en la concessió.
Després un equip de dos inspectors, un de l'Ajuntament i l'altre de l'empresa concessionària, avalua diàriament, segons uns criteris prèviament establerts, la qualitat de la neteja a la via pública.



3 Data management and analyzing

Les informacions recollides pels inspectors (a través de fitxes i fotografies) s'introdueixen en una plataforma informàtica, anomenada Qualinet, que valora de forma objectiva la prestació global del servei.



4 Citizen satisfaction surveys

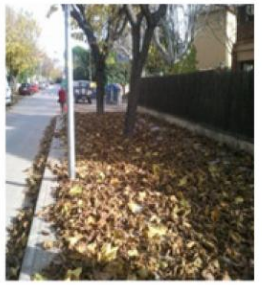
Als indicadors, s'hi afegeix el grau de satisfacció ciutadana obtingut mitjançant l'enquesta d'opinió ciutadana que es realitza telefònicament tres cops l'any.

5 Variable payment based on real services and quality

El programa elabora un informe en funció dels diferents indicadors que determina quina ha de ser la factura mensual que ha de generar l'empresa concessionària, ajustada als serveis que hagi prestat i a la qualitat dels mateixos.

Source: Sant Cugat Council (88.921hab)

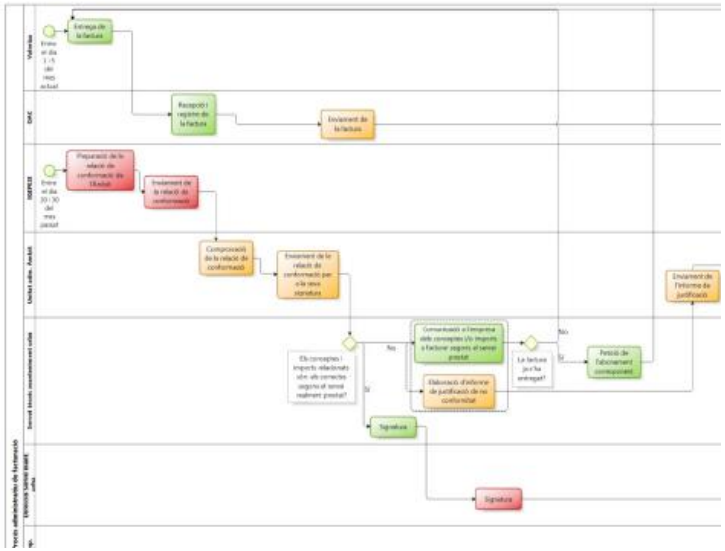
STUDY CASE: SANT CUGAT (CAT)



Technology implemented in the collection service:

- Position **GPS**/GPRS in all vehicles & street cleaning carts.
- **Weighing system** for containers, underground & surface.
- **Work sensors** to know if the machines are working or not.
- **Comparison of planned routes** with routes performed.
- **Incident insertion display** in all vehicles.
- Six Sigma/Lean Management, **methodology for process improvement**.

NO



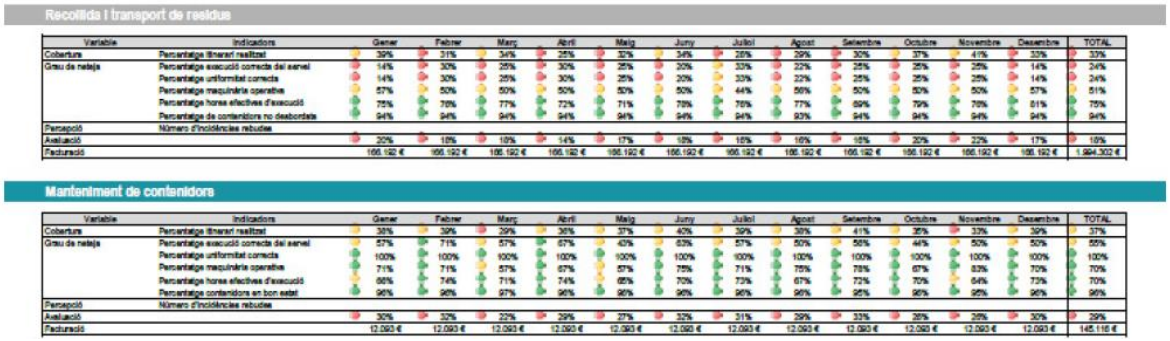
Source: Sant Cugat Council (88.921hab)

STUDY CASE: SANT CUGAT (CAT)

The main conclusions of the experience:

- Inclusion of continuous improvement in the **tender specifications**.
- **City Council system** (owning data), not in hands of the service company.
- **Flexibility, dynamic services**. Service always adapted to the reality of the municipality.
- More service ≠ Better service.
- Knowledge and control of services by **municipal technicians**.
- **Internal team sizing**: technical and inspection team.
- **Involvement** of management and political levels.
- Not everything is technology. **Common sense and data analysis** must be applied.
- Communication and training to promote a **change in culture**.

Analysis and evolution follow up of each **performance indicator** for each of the services:



Recollida i transport de residus

Variable	Indicadors	Gener	Febrer	Març	Abril	Maig	Juny	Juliol	Agost	Setembre	Octubre	Novembre	Desembre	TOTAL
Cobertura	Percentatge itinerari realitzat	39%	31%	34%	25%	32%	34%	26%	29%	30%	37%	41%	33%	33%
Grau de neteja	Percentatge execució correcta del servei	14%	30%	25%	30%	25%	20%	33%	22%	25%	25%	25%	14%	24%
	Percentatge uniformitat correcta	14%	30%	25%	30%	25%	20%	33%	22%	25%	25%	25%	14%	24%
	Percentatge maquinària operativa	57%	50%	50%	50%	50%	50%	44%	56%	50%	50%	50%	57%	51%
	Percentatge hores efectives d'execució	75%	76%	77%	72%	71%	78%	78%	77%	69%	79%	76%	61%	75%
	Percentatge de contenidors no desbordats	94%	94%	94%	94%	94%	94%	94%	93%	94%	94%	94%	94%	94%
Percepció	Número d'incidències rebudes													
Avaluació		20%	18%	18%	14%	17%	18%	16%	16%	16%	20%	22%	17%	18%
Facturació		166.192 €	166.192 €	166.192 €	166.192 €	166.192 €	166.192 €	166.192 €	166.192 €	166.192 €	166.192 €	166.192 €	166.192 €	1.994.302 €

Manteniment de contenidors

Variable	Indicadors	Gener	Febrer	Març	Abril	Maig	Juny	Juliol	Agost	Setembre	Octubre	Novembre	Desembre	TOTAL
Cobertura	Percentatge itinerari realitzat	38%	39%	29%	38%	37%	40%	39%	38%	41%	35%	33%	39%	37%
Grau de neteja	Percentatge execució correcta del servei	57%	71%	57%	67%	43%	63%	57%	50%	56%	44%	50%	50%	55%
	Percentatge uniformitat correcta	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	Percentatge maquinària operativa	71%	71%	57%	67%	57%	75%	71%	75%	78%	67%	83%	70%	70%
	Percentatge hores efectives d'execució	68%	74%	71%	74%	68%	70%	73%	67%	72%	75%	64%	73%	70%
	Percentatge contenidors en bon estat	96%	96%	97%	96%	96%	96%	96%	96%	95%	96%	95%	96%	96%
Percepció	Número d'incidències rebudes													
Avaluació		30%	32%	22%	29%	27%	32%	31%	29%	33%	28%	28%	30%	29%
Facturació		12.093 €	12.093 €	12.093 €	12.093 €	12.093 €	12.093 €	12.093 €	12.093 €	12.093 €	12.093 €	12.093 €	12.093 €	145.116 €

Source: Sant Cugat Council (88.921hab)

PART I - BLOCK 3

Management platform. Functionalities

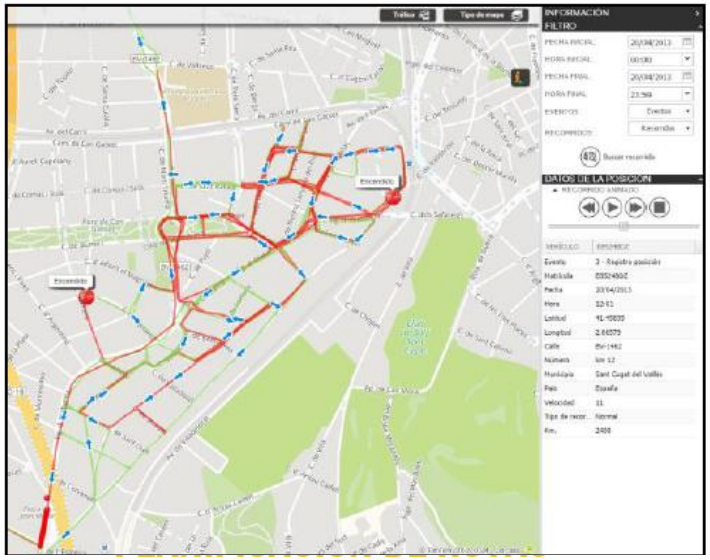
SERVICE MANAGEMENT PLATFORM

Features:

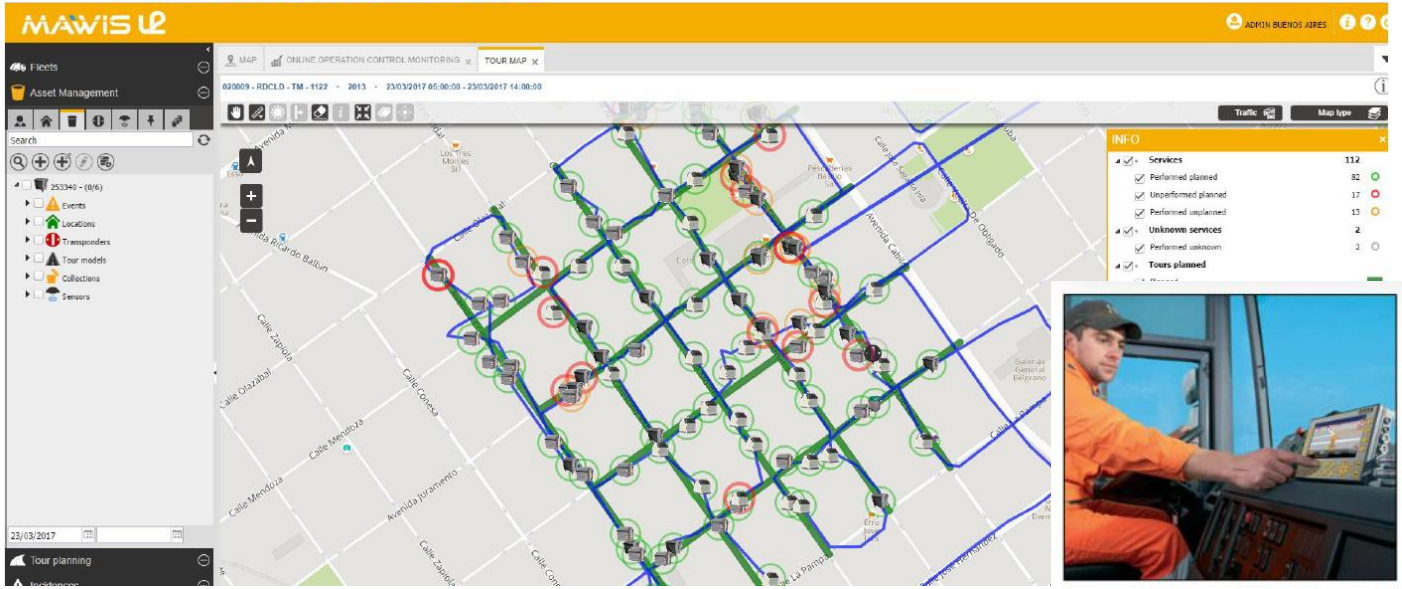
- Online software (SaaS) platform
- Modular structure
- Maps
- Billing module
- Reports and dashboards
- Integration with other platforms

- Fleet and street furniture control
- Route planning and optimization
- User management
- Incidence management
- Calculation of indicators and reports
- Link to Service and User APP

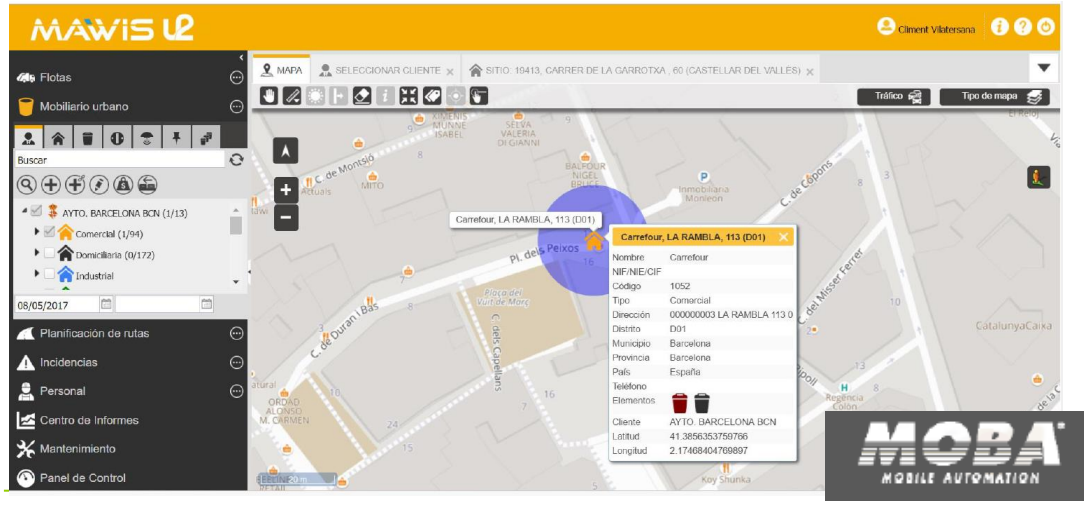
VEHICLE FLEET MANAGEMENT/ROUTE PLANNING



- Management through maps
- Location and tracking of vehicles in real time
- Detailed historical records
- Monitoring-comparative with theoretical routes
- Planning and optimization of routes
- Recalculation of routes if there are incidents on public roads or events

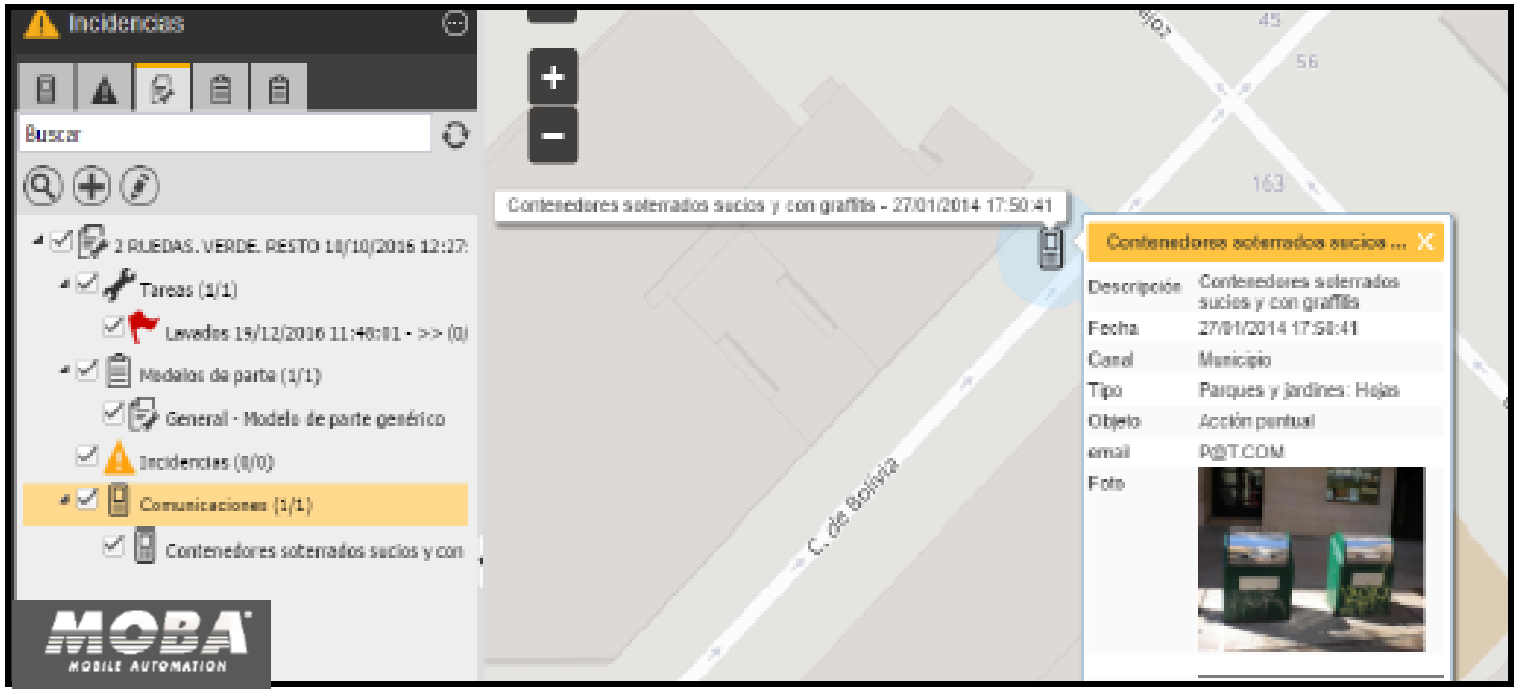


STREET FORNITURE MANAGEMENT



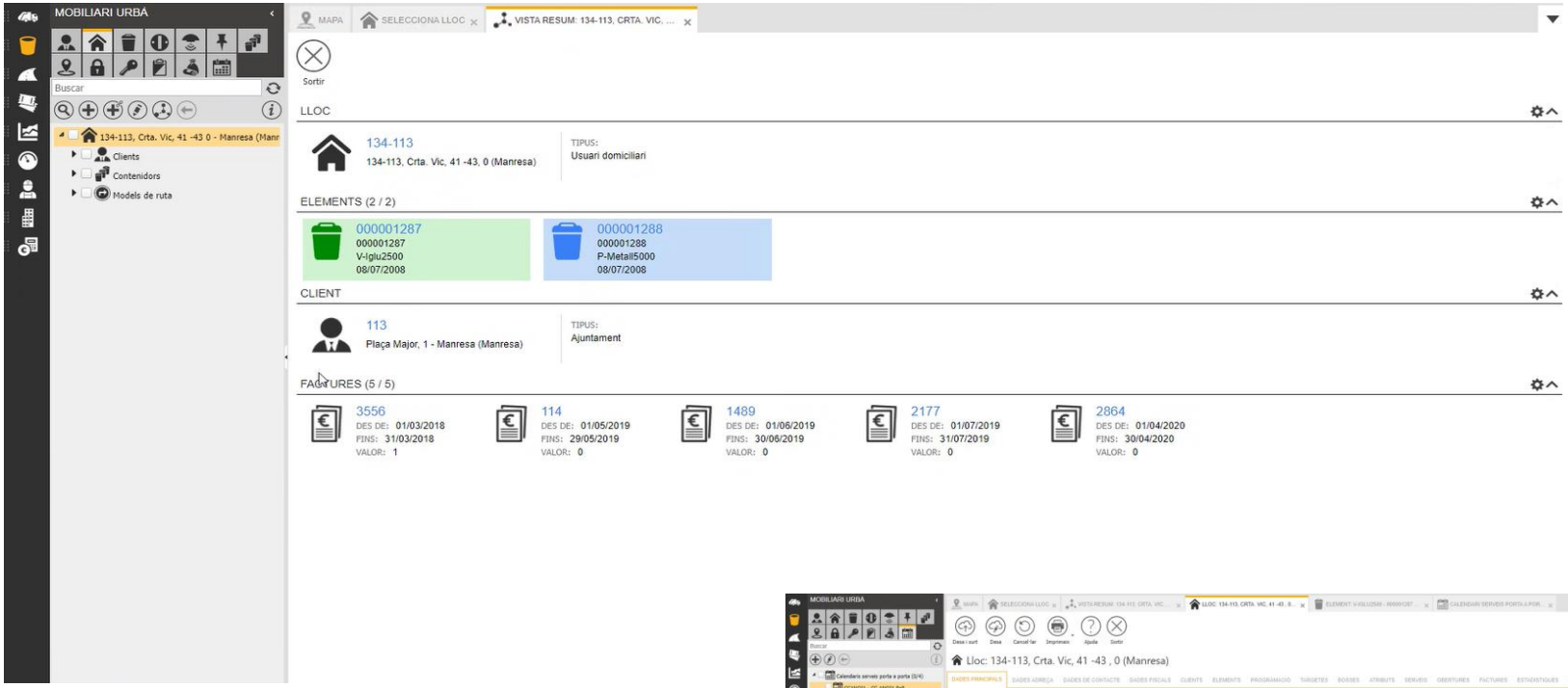
- Accurate inventory, state and location of all elements through the registration of operations with electronic equipment and mobile Apps
- History of services, actions and waste generation: collections, washes, incidents, maintenance, levels of filling…
- Electronic management of containers (fill level sensors, access control, user ID)

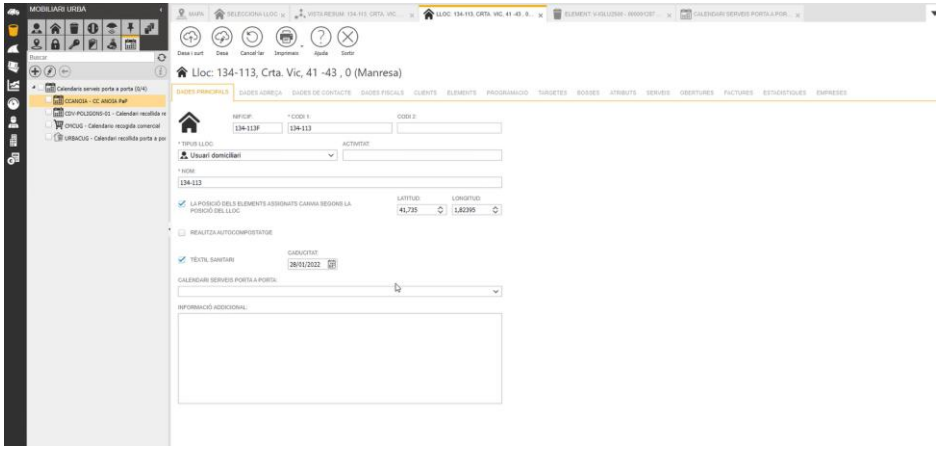
INCIDENCE MANAGEMENT



- Registration and record of incidents, including photographs.
- Incidents are registered in real time, through various channels: onboard computer, keypad or a smartphone with photographs.
- Possibility to create service routes and work orders associated with the incidents and send them to the mobile teams.
- Control and monitoring of the resolution, response time.

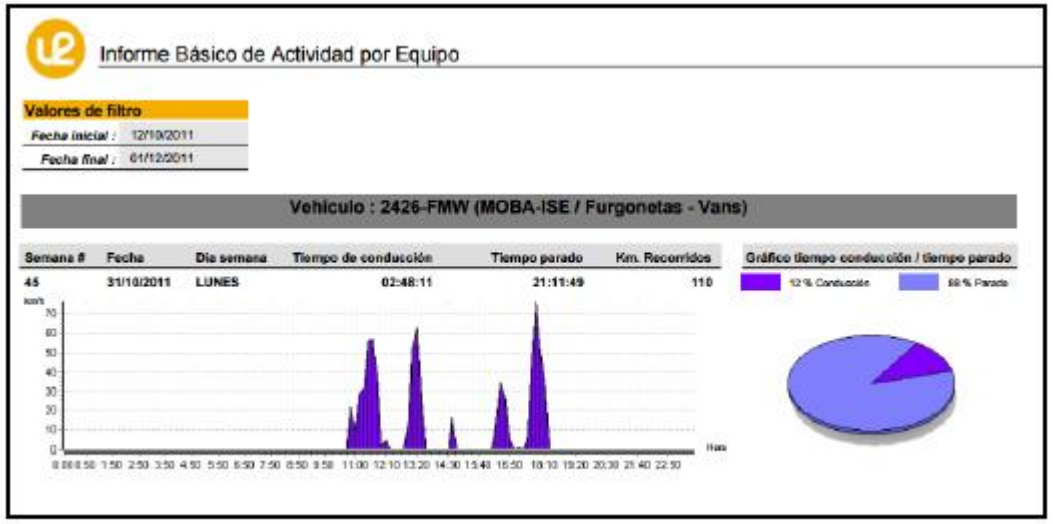
USER MANAGEMENT





- Personal information from users: name, address, assigned bins/bags, etc.
- Performance information from users linked to identification system (containers or DtD): deliveries per fraction and day/hour, incidents, etc.
- Billing information from users linked to charges - PAYT schemes

REPORTING & DASHBOARDS



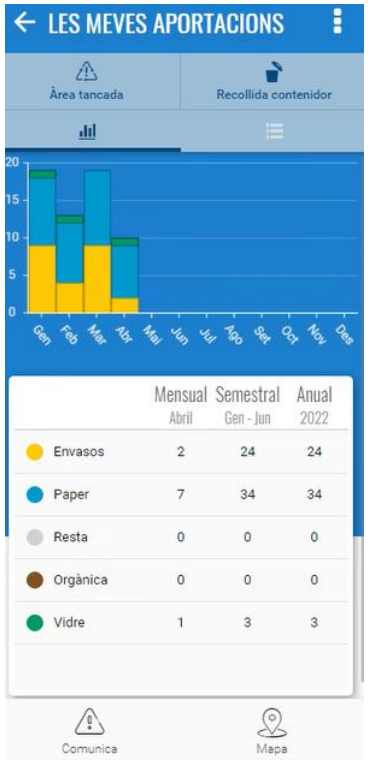
- Dashboards, graphics, statistics
- Wide variety of indicators
- Automatic report delivery by email
- Customed reports and KPI
- PDF and Excel output formats
- Invoice issuance and sending

SERVICE APP

- Inventory of urban furniture and sending information in real time to the Platform
- Record and report incidents found on the street/service: Joint and unified reception, better organization, work orders, faster response and transparency
- Maintenance and/or inspection tasks recording
- Repeated task recording: emptying trash cans, washing bins, etc.

USER APP

- General info about the service (calendar, updates, etc.)
- Specific info about the user deliveries (per fraction, day, etc.)
- Incidences reporting to the service (including photo)
- Collection material (bins/bags) requests
- Historical and statistics info
- Service charge data/invoice



Questions and comments

PART II - BLOCK 1

Key elements to be considered for the implementation of technology

CRITERIA FOR CONTRACTING TECHNOLOGY

Contents of the tenders:

- Detailed definition of **technology functionalities**: machinery, urban furniture, other material assets, etc.
- Detailed definition of **technology user identification** elements, functionalities and quantities.
- Definition of the **Platform and Apps** features, including reporting needs, data management and KPI requirements.
- Technology **maintenance requirements**, spare parts, response times and action protocols.
- **Certifications**: ISOs, IP (protection index), periodic calibrations, software updates, training.
- Detailed **budget** for investment, installation, and especially maintenance and update.

CRITERIA FOR CONTRACTING TECHNOLOGY

Contents of the tenders:

- Technology **tested on similar equipment or collection models,** warranties, reference requests, testing periods, and even field visits.
- Definition of **personal data protection requirement** (PDP), PDP commissioner/subcontractor contract, PDP certifications (in the case of user data).
- **Coordination** between council, service company and technology company.
- **Pre-contract** between service company and technology company, if needed.

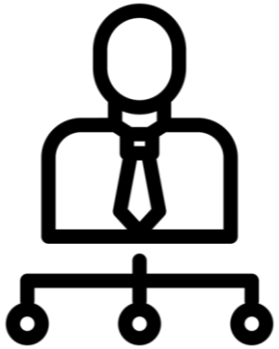
SERVICES INVOLVED & INTEGRATED MANAGEMENT+ STAFF & COORDINATION NEEDS

- Staff dedicated to preventive and corrective **maintenance** of technology:
  - Maintenance of hand devices and onboard equipment. Especially high coverage of access control containers.
  - **Communications** and data transmission (needs and costs).
  - Management of spare parts and reserve containers/equipment.
- Staff dedicated to **software/platform** and data management.
- Staff dedicated to **incident** management and inspection.
- Staff dedicated to **service monitoring**, application of specifications, and evaluation of results.
- **Coordination** with technology and service companies. Consider the context of subcontractors.

SERVICES INVOLVED & INTEGRATED MANAGEMENT+ STAFF & COORDINATION NEEDS

User identification elements:

- Staff dedicated to the **delivery and replacement** of identification elements for service users.
- Staff dedicated to monitoring compliance with the **PDP** in the case of user data.
- Staff dedicated to **managing charges** and any objections, in the case of variable fees.
- Staff dedicated to **communication** and feedback to users.
- Staff dedicated to **inspection** and processing of **sanctions**.



Elements:

- ID Cards/keychains/mobile App
- Distribution of tagged caddies/bins/bags
- Maintenance and replacement of commercial container tags

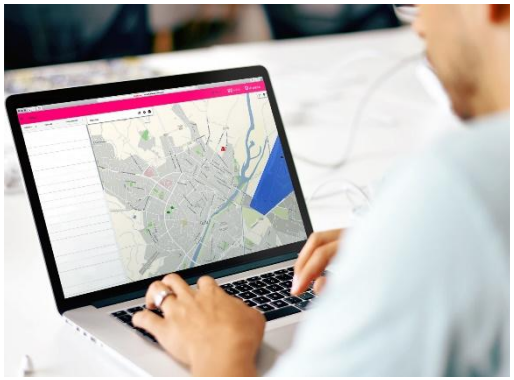
INTEGRATED SERVICES-DATA MANAGEMENT

Local authority or collection company

- Service planning/ operation
- Municipal charge register
- Register of bins or ID cards
- Management of the recycling center, other services

Two-way communication

Software/Platform to manage the waste service and user



Two-way communication

Users of the collection service

- Record of service users (personal data, performance)
- Registration of additions and cancellations, and possible incidents
- Register of entries to the recycling center
- User App inputs/outputs

The software could be managed by the local authority or management company

Important to have a data management guarantee/certificate, data protection/integrity measures

CONTRACT MANAGEMENT AND SERVICE MONITORING

Quality protocols and service monitoring system:

- Improves service performance, maintenance tasks, and information management and integrity. Tenders may include elements such as:
  - Service and quality **definition and standards**.
  - **Information management** and coordination protocols.
  - **Maintenance** conditions/technology status-maintenance.
  - **Incident management**, response times/priorities.
  - **Recording/reading** effectiveness and data integrity.

CONTRACT MANAGEMENT AND SERVICE MONITORING

Continuous Improvement Programs:

- Include **measures to improve and optimize** technology and information management.
- Include **KPIs to track** related improvements.
- Proposal of improvement **specific measures** to be implemented **with calendar**.
- Possibility of conducting **external audits** of the service.

CONTRACT MANAGEMENT AND SERVICE MONITORING

Compensation based on service provided (effectively), quality (protocols), and targets (% SC, % impurities, participation, etc.):

- The services actually provided are certified, and penalties are applied based on compliance with quality protocols and/or the achievement of targets.
- The company is incentivized to perform the service as defined in the specifications and with minimum quality standards (according to established quality protocols).
- This is more necessary in individualized models that have a user ID used to calculate the charge (to ensure good operator practices and the proper functioning of the technology and readings).
- Potential savings derived from the application of penalties or services not provided can be reinvested in service and user monitoring or system improvements.
- Clear payment certifications including details of services provided, additional services, penalties, etc. Review/validation of work records and billing certifications.

OTHER COMPLEMENTARY ACTIONS

Governance instruments

Organization

Cascading down EU and national targets and obligations

Mutual accountability

Strategic waste management plans

Capacity

- Human Capital
- Enforcement & monitoring/penalties
- Financial solvency & funds

Public Confidence

- Transparency
- Participatory decision-making
- Results & investment info returns

Empowerment

Trainings and skillset support for managers and policy makers

Comm. campaigns for users (domestic and commercial)

Data Management

- Periodic bio-waste & residual waste characterizations
- Collection, integrity & homogenous data management for PAYT calculation

Source: LIFE BIOBEST project

OTHER COMPLEMENTARY ACTIONS

Communication, participation, and facilitation tools

Implementation and regular reinforcement campaigns, continuous info service: educators, online and mobile information, furniture information, feedback on results, etc.

Information / communication

Facilitation

Provide materials for sorting waste at home and in businesses, and deliver waste to the service (bins, bags, containers, informational materials, etc.). Resolve questions and issues.

- Citizens and businesses are the first "waste managers."
- Mentors within communities who deliver the message continuously and locally.
- Surveys, customer service, staff training.
- Annual and specific budget dedicated to environmental education in the contract.

Participation and change management

Gather insights to integrate into service and specifications, spaces for debate and resolution of doubts, visits to services, containers, satisfaction surveys, etc.

CHALLENGES, EFFICIENCY AND RESOURCES NEEDED

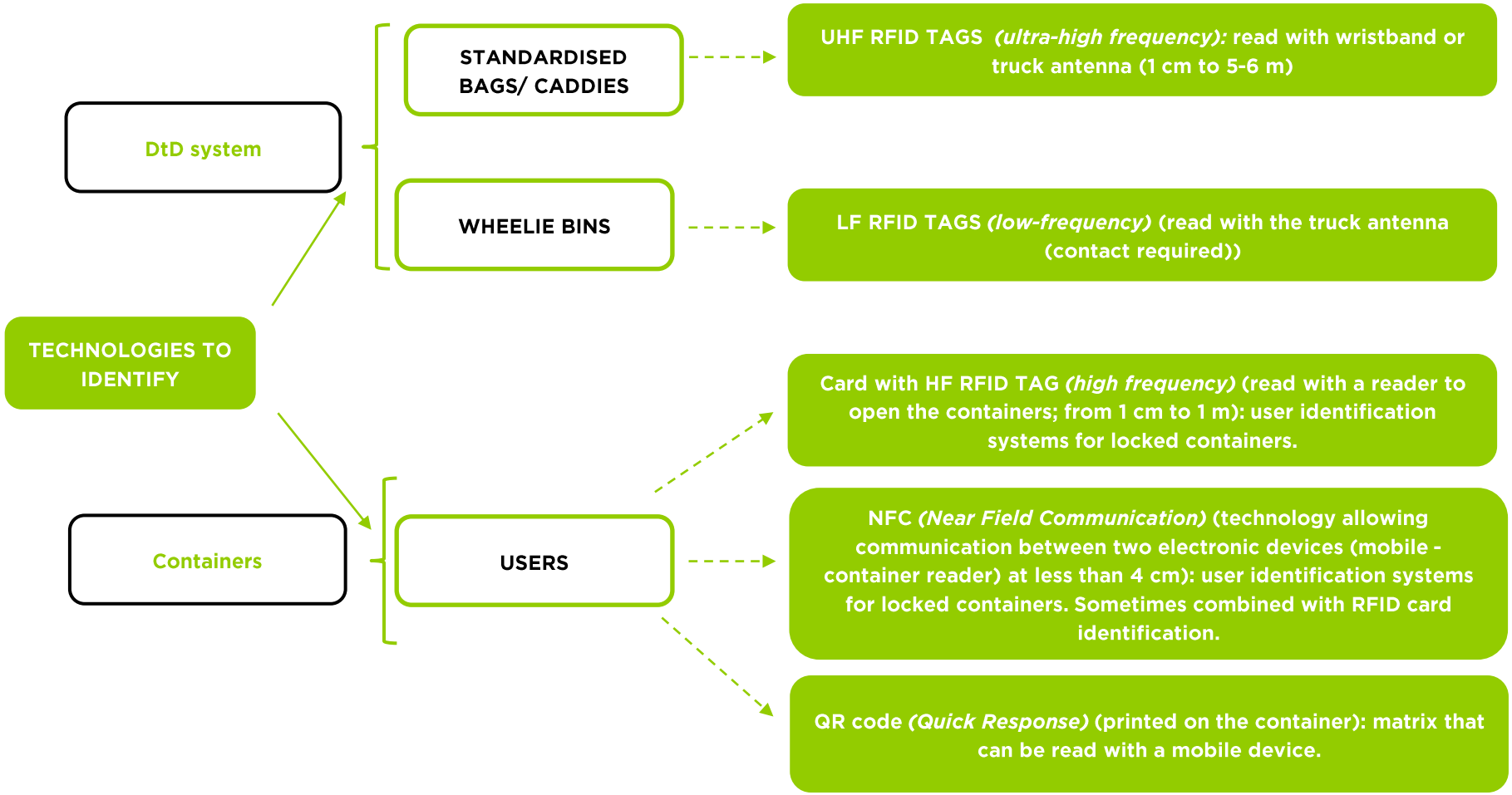
- Technology maturity and errors. Adaptation to the council needs.
- Good practices and training of the staff using tech.
- Large amount of data/reports to manage. From data to knowledge.
- Integration of all the services into a unique Platform.
- Initial investment and maintenance costs.
- Additional staff needs (data, maintenance, user assistance, etc.).
- Real coordination with the service and tech company.
- Service user acceptance and proper interaction with the tech and service. Deal with groups with digital gap.

PART II - BLOCK 2

User (waste producers) identification and monitoring. Application of technology to door-to-door and containers with electronical access control collection models

Technologies to identify the user

USER IDENTIFICATION TECHNOLOGY



RADIO FREQUENCY IDENTIFICATION 1/4

The minimum requirements for **radio-frequency identification (RFID)** are an **antenna, a reader, and a tag**. The reader sends a signal to the tag by the antenna, and the tag responds with its information.

RFID tags may be active or passive:

- **ACTIVE RFID tags** have their own source of energy, giving them the capacity to emit readable waves up to a distance of 100 m (such as *teletag* toll systems). They are substantially more expensive than passive tags.
- **PASSIVE RFID tags** do not have their own source of energy, are powered by the **electromagnetic energy transmitted from the RFID reader** (e.g. those fitted to the bins, read by the truck antenna or wristband). As they require fairly powerful radio waves to power the passive tags, the reading range is shorter, from near-contact to 25 metres.

RADIO FREQUENCY IDENTIFICATION 2/4

- **Ultra High Frequency (UHF):** a very short wavelength allows a long RFID tag reading range: from 1 to 5-6 m. Applications of the use of this wavelength would be for **identification of tags fitted to waste bins (or bags) using the truck antenna or wristband**.

Source: Contarina (Veneto), ID-Waste.

RADIO FREQUENCY IDENTIFICATION 3/4

The wavelength emitted by the RFID reader determines its application:

- **High Frequency (HF):** frequency with a typical reading range between 1 cm and 1 metre. The typical use of this frequency range would be to identify users by means of **passive RFID smartcards for containers with ID system** (normaly locked but also open/voluntary ID), which would contain the reader. Each use would be registered.

Source: Twente Milieu; Styria (Austria), ID&A

RADIO FREQUENCY IDENTIFICATION 4/4

- **Low Frequency (LF):** a wavelength which requires **contact between the truck antenna and the RFID tags fitted to the wheelie bins** when the hook lifts the bin to the truck. Use in commercial DtD collection (or for registering the collection of 4-wheel street containers collection).

NEAR FIELD COMMUNICATION
1/2

NFC technology allows **communication between two electronic devices**, one of which is typically a portable device, such as a **smartphone**. The two devices must be at a distance of under 4 cm.

NFC-equipped devices can act as either reader or key, or as an electronic ID document.

NEAR FIELD COMMUNICATION
2/2

CONTAINERS WITH LOCKING SYSTEM

Waste deposited in collective containers can be controlled by installing **locking systems with NFC technology**. When an approved NFC device, , normally a smartphone, is brought close to the locking system, the container opens and allows the waste to be deposited. Each use is registered.

CONTAINERS WITHOUT LOCKING SYSTEM

Voluntary use systems can also implement NFC technology, and monitor the usage habits of collective containers. When an NFC device, normally a smartphone, is placed near the NFC panel, use of the container is registered.

QR code
1/2

A **Quick Response or QR code** is a square two-dimensional matrix which acts like a barcode. Its main purpose is to register and **transmit information, typically to smartphones.**

QR CODE
2/2

BAGS OR BINS WITH QR CODES

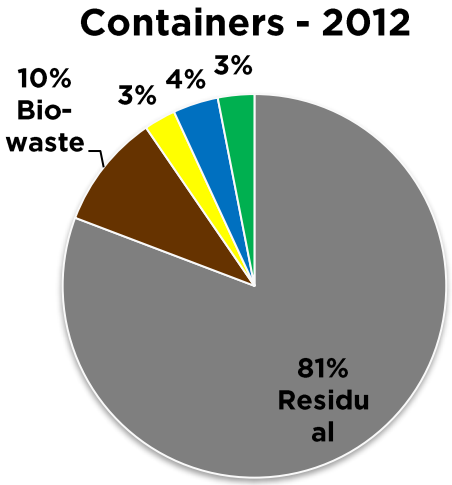
Bags, caddies and bins can include a QR code. The service operator can scan the QR code with a mobile device/ handheld terminal to register the collection of receptacle content.

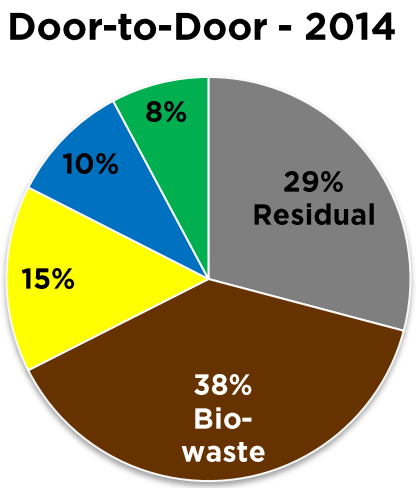
CONTAINERS WITHOUT LOCKING SYSTEM

In contexts without locks, users can identify themselves when they dispose of waste, by scanning the QR code on the container with their mobile. These readings are registered.

CASE STUDY: DtD WITH ID CADDIES, SERVICE MONITORING

- Population: 5,053 inhabitants
- Foreign population: 18.9%
- 4 fractions collected DtD
- Residual waste collected every 15 days





Source: Celrà Council

CASE STUDY: DtD WITH CADDIES ID & SERVICE MONITORING

- Caddies with tag+ user database
- Trucks antenna/control panel
- Monitoring platform

- At the time of collection:
  - Registration of the participating caddies when its contents are emptied in the collection vehicle
  - Registration of incidents by the operator
- Monthly participation report
- Emptying report by period

- DtD Office
- Support telephone
- Web
- Home visits, building community meetings

Source: Celrà Council

Measurement of waste generated: quantity/volume

MEASUREMENT OF WASTE GENERATED 1/2

A1. DOOR-TO-DOOR SYSTEMS (VOLUME)

The receptacles used for collection have a known volume, whether standardised bags or bins/caddies.

A2. DOOR-TO-DOOR SYSTEMS (WITH WEIGHT SYSTEM ON THE TRUCK)

B1. ACCESS CONTROL CONTAINERS (NUMBER OF DEPOSITS)

Locked containers, unless they are fitted with a *chamber system* (see next slide) do not have a system to measure the volume/weight quantity of each deposit.

Only the average volume or weight per deposit can be calculated by the software. If user sectorisation is in place for container islands, the average value per user group can be ascertained.

MEASUREMENT OF WASTE GENERATED 2/2

B2. ACCESS CONTROL CONTAINERS (CHAMBER SYSTEMS - VOLUME)

Volumetric drawer or chamber systems mainly comprise a rotating cylindrical half-drum or drawer, anchored to the lid of the container, with an opening system linked to user identification. These systems have a limited deposit volume (e.g. 20, 30 or 50 litres).

Case of Zamudio – Sant Pere de Ribes – volumetric drawer adaptable to 2 volumes

C. WASTE WEIGHING POINTS/CONTAINERS

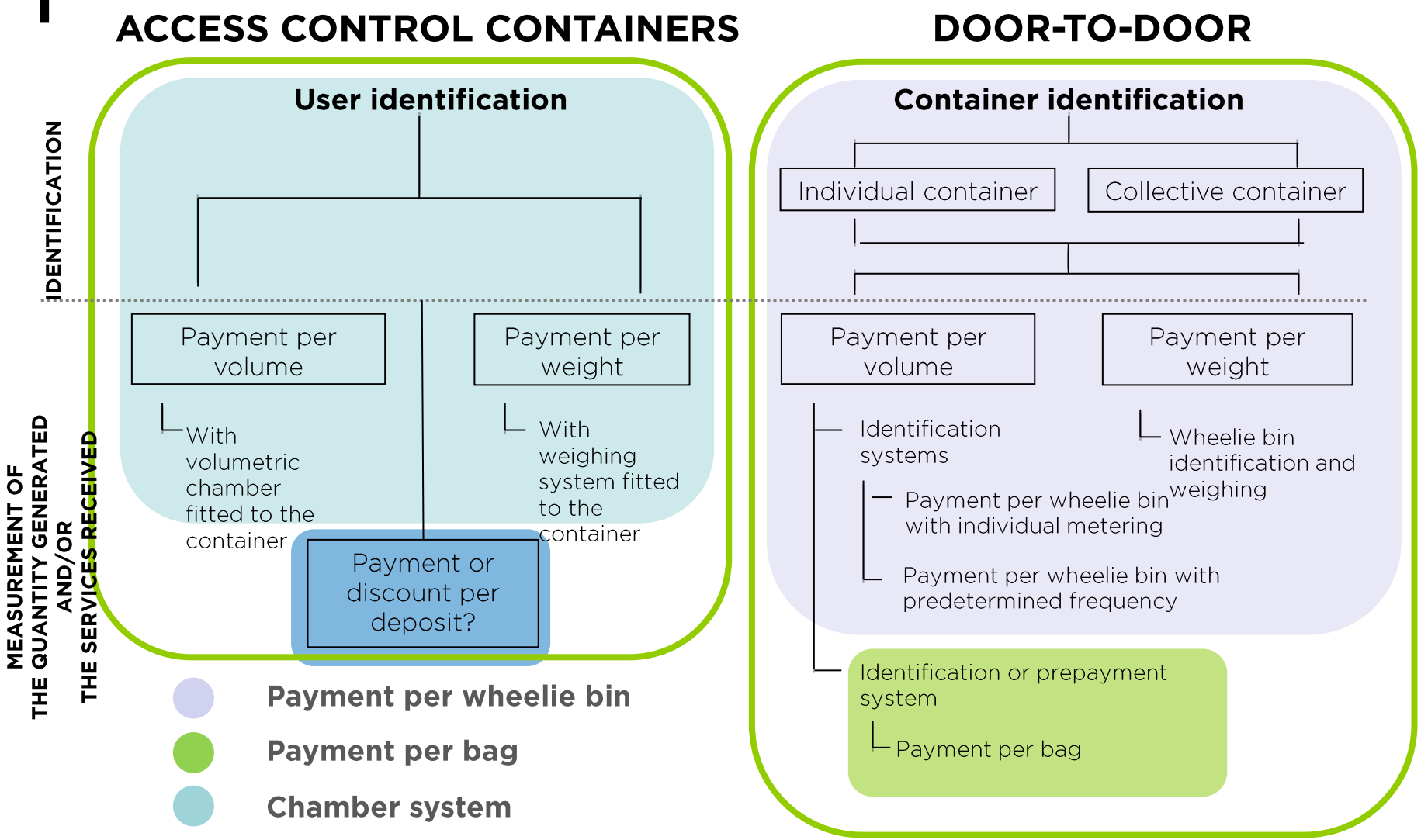
The waste collection points could be fitted with computerised scales, measuring the weight of waste deposited by each user. To dispose of waste, the user must weigh the bag and select the corresponding fraction. Once this step is complete, the corresponding container unlocks and opens.

Introduction of Variable Charges - PAYT

WHAT IS A VARIABLE CHARGE?

- Payment of a waste management charge in accordance with the **waste actually generated** and the service received.
- **Identify the waste producer and measure the quantity** of waste.
- The **incentive created** will depend on the choice of **taxable base** (fractions subject to levy) and the **structure of the charge**:
  - Fractions: **Residual waste fraction** (incentive for reduction and selective collection) / **other fractions** (incentive for reduction)
  - Structure: **General part** (same or different per user; certainty, collect fixed costs) + **Variable part** (tied to actual waste generation/deliveries, intensity of incentive)

PAYT SYSTEM FORMATS



PAYT SYSTEM FORMATS- SUMMARY

a) WITH DOOR-TO-DOOR COLLECTION (receptacle identification)

Pre-payment systems

- STANDARDISED BAGS (without charge)

Post-payment systems

- STANDARDISED BAGS WITH TAG
- CADDIES, WHEELIE BINS or CONTAINERS (with or without TAG):

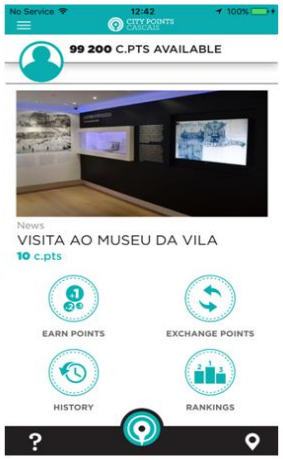
  1) BY VOLUME ASSIGNED **2)** BY VOLUME + FREQUENCY OF EMPTYING, **3)** BY WEIGHT

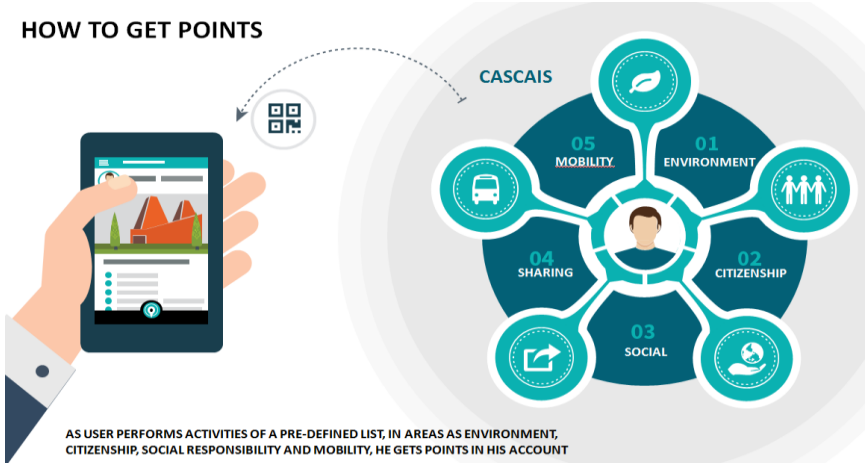
b) WITH ACCESS CONTROL CONTAINERS (waste producer/user identification)

(by ID key, ID card, mobile, etc.)

- NUMBER OF DEPOSITS (with possible limit on access days)
- NUMBER OF DEPOSITS + LIMITED VOLUME **(CHAMBER SYSTEM)**
- WEIGHT MEASUREMENT **(CHAMBER SYSTEM+WEIGHT)**

AWARDING SYSTEM





EXAMPLES OF AWARDS

01

ENVIRONMENT

- Waste separation
- Reuse of goods
- Green events
- Environmental awareness

City Point App (Cascais)

Questions and comments

Q&A session

Q1: Ghassan Tayoun: Is the requirement for a Mandatory Space imposed as part of an urban ordinance or regulation (for example as a pre-requisite to obtain a construction permit?)

A1: Gemma Nohales:

The requirements for waste storage areas in the Spanish Technical Building Code (CTE) are outlined in the Basic Document HS – Health (Salubridad), specifically in section HS 2: Waste collection and disposal.

This section establishes the necessary conditions buildings must meet to ensure proper management of solid urban waste, including:

- Location and accessibility of the waste storage areas.
- Minimum dimensions based on the number of users or dwellings.
- Ventilation, cleanliness, and pest control requirements.
- Compatibility with municipal waste collection systems.

Access to the full document on the official CTE website here: CTE – Salubridad

The Waste Agency of Catalonia has developed a template for a local waste management ordinance, which outlines the spatial requirements, both private and public, for each type of collection or service. You can consult the full text at the following link (in Catalan):
https://residus.gencat.cat/web/.content/home/ambits_dactuacio/recollida_selectiva/eines_recursos/14_model_ordenanca_reguladora_residus.docx

Q&A session

Q2: Ghassan Tayoun: We acknowledge that making households pay a flat rate for SWM services is not equitable nor conducive to responsible behavior among citizens. Do you have a pro-con comparison (at least qualitative) between flat rates and rates that are more volume or weight dependent?

A2: Gemma Nohales: More information in the following reports:

REthinkWASTE PAYT and KAYT Catalogue. Collection of experiences about pay as you Throw (PAYT) and know as you Throw (KAYT)

LIFE BIOBEST Guideline on governance and economic incentives for bio-waste separate collection and treatment

Fair waste charging in the Mediterranean region. Key aspects that can support the implementation of efficient waste management solutions

Q&A session

Q3: Ghassan Tayoun: Do you recommend the implementation of small scale "pilots" to mobilize citizens, experiment and create a positive momentum? Any examples?

A3: Gemma Nohales:

LIFE BIOBEST Guideline on the separate collection of bio-waste (including annex with BEST PRACTICES)

LIFE BIOBEST Country Factsheets on the analysis of communication and engagement practices for bio-waste separate collection and treatment

Pilot for the implementation of Door-to-Door collection in Barcelona (Sant Andreu del Palomar neighborhood)

Efficiency of a pilot scheme for the separate collection of the biowaste from municipal solid waste in Spain

Assessing a Pilot Door-to-Door Municipal Collection Program in Greece: Implementation Insights and Evaluation Outcomes

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ENT Environment
& Management

Thank you for your attention!