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A circular economy approach for lifecycles of products and services

Development of the ICT system for reuse/recycling

Deliverable 2.3

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Executive Summary

The development of the ICT-based system for recycling and reusing is reported in this deliverable. Within this system, the existing intelligent bin is utilised, which has been further developed based on remote communication technique using online connectivity to control unit software.

The intelligent bin with the enhanced Web communication capability provides the following functions: consumer log-in with QR code, data I/O control (barcode printing, product status input, and door switch), and the communication with the remote data centre. The major aspects considered during the system development includes:

- Set up of the major components within the system, and re-configuration of parameters of the components, such as email, server, sensor, etc.
- The means to access the data resource, such as data repository of the control unit;
- The means to extract the raw data from the control unit, and to handle the data to adapt the standard communication interface.
- Interaction with the data centre via the specific communication interface to fulfil the functions of CIRC4Life environment.

In this document, the methods to implement the above functions are illustrated with relevant description and images. At the end of this document, the system developed is demonstrated with a case study of recycling electronic product at Indumetal facility, which shows how the intelligent bin system works to collect and transmit recycling information data in order to further tracking and monitoring of recycling processes. The software will be further developed based on the interaction with the traceability data centre, which will be applied to implement recycling/reusing of real products at the demonstration stage.

The system developed for electronic products will be adapted to the meat waste, adapting the interface to the needs of the waste manager. In this document, recycling of electronic products has been utilised as an example to verify the ICT system developed, which will also further be applied to the case of meat waste recycling at the demonstration stage.

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List of Abbreviation

Abbreviation	Description
HTTP	Hyper text transfer protocol
ICT	Information and communications technology
ID	Identity
JSON	JavaScript Object Notation
PVC	Polyvinyl chloride
QR	Quick Response
REST	Representational state transfer
RF	Response function used in programming language
URL	Unified Resource Location Address
XML	Extensive Markup Language

1. Overview of the ICT-based recycling/reuse system

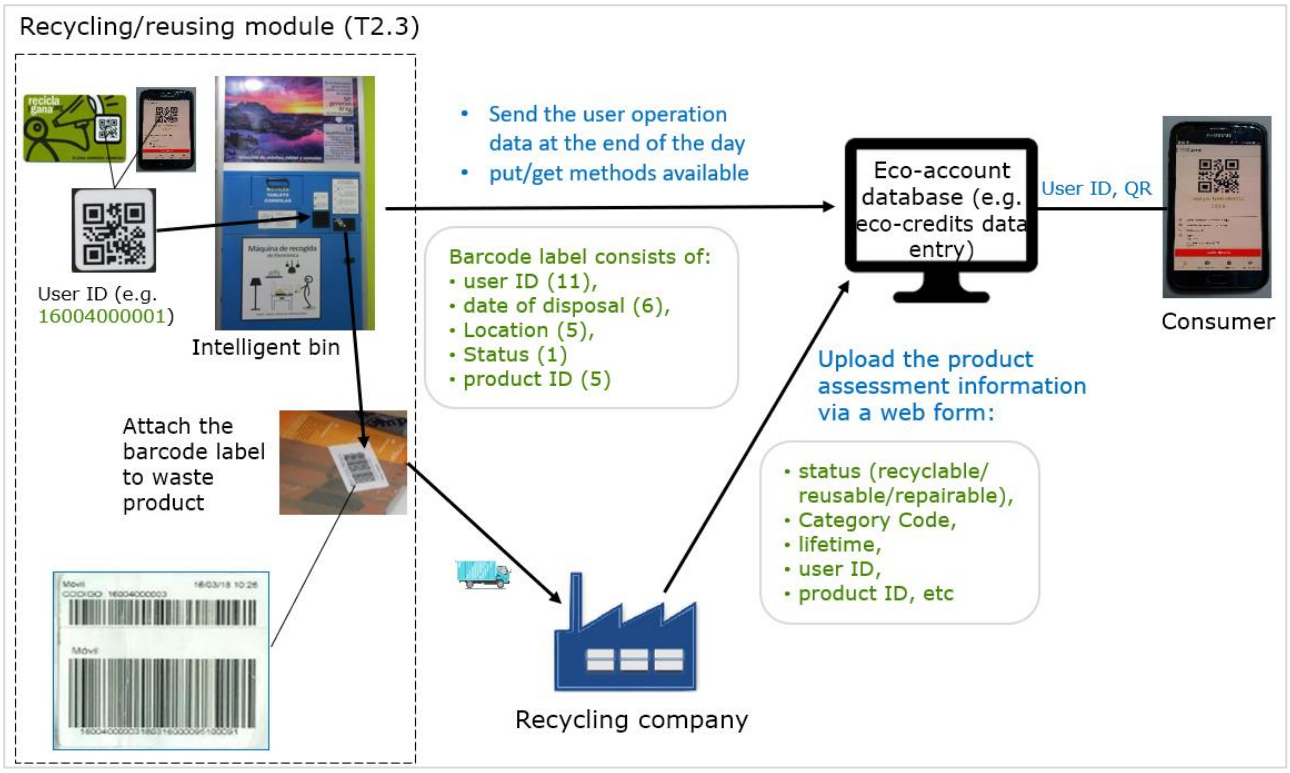


Figure 1 ICT-based recycling/reuse system

Figure 1 shows the overview of the ICT-based system for recycling and reusing electronic/electrical products. The system consists of the following modules: recycling/reusing module, waste collection, and traceability. In the recycling/reusing module, the intelligent bin is utilised to identify the consumers' identity and to collect their end-of-life electronic products, such as tablets. Consumer identification is based on a QR code which is shown on a card or a smartphone. To do so, the consumer needs to register a personal account on the ICT platform, in order to get a unique QR code. The consumer scans the QR code with a code reader and provides the input to the product status via selecting a status button (i.e. working or damaged) on the intelligent bin. Then the intelligent bin will print out the following two barcode labels: one is attached to the product to be recycled, and the other is used as a receipt for the consumer. The consumer puts the waste product attached with the barcode label into the container of the intelligent bin, and all consumer's operation information will be transmitted to the traceability data centre. When the container is full, the recycling company will be informed to collect wastes, and further processing will be conducted, such as classification and assessment. The information of product assessment will be sent to the eco-account system with the Web form/tool developed by Task 5.3, in order to calculate eco-credits. This deliverable presents the development of the ICT software for recycling/reusing module. For the information about the development of traceability module, please refer to the technical reports related to traceability system developed by WP5 tasks.

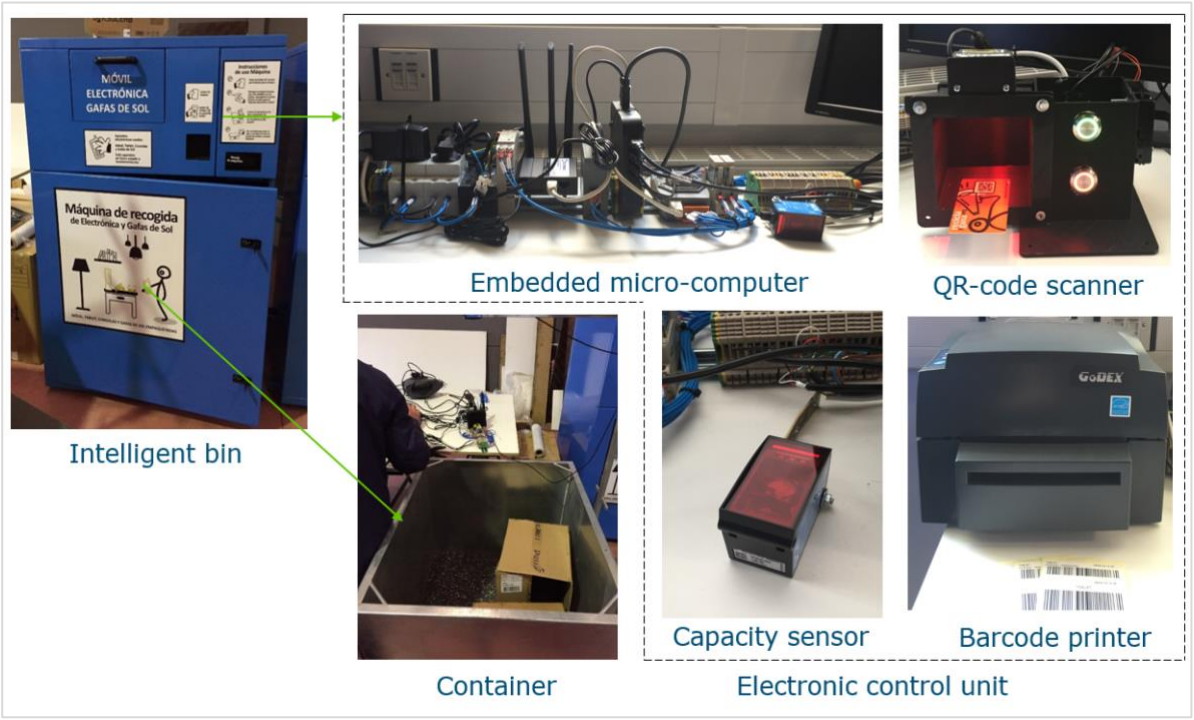


Figure 2 Components of the Intelligent bin

Figure 2 shows the structure of the intelligent bin, which consists of an electronic control unit and a container. The container is used to collect the waste products recycled by consumers.

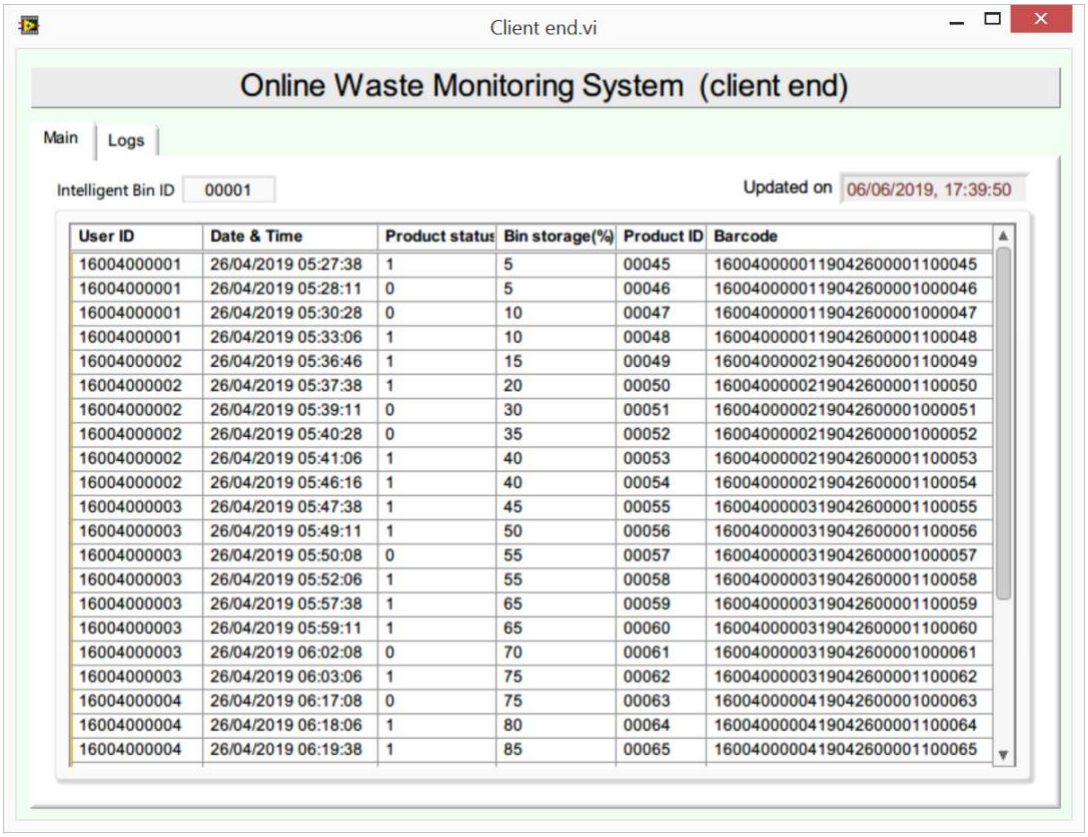
As the core of the intelligent bin, the electronic control unit has the following features:

- The electronic control unit internally carries a QR code reader, which enables the identification of consumers. Consumer's identification is based on a QR code shown on a PVC card or a smartphone. The consumers registered will be assigned a QR code, which can be recognised by the control unit. If the QR code doesn´t match the user´s data identified by the control unit, then the intelligent bin will not open the door for further operation.
- When the consumer identity (ID) is validated, the barcode printer prints two bar-code labels (stickers): one label will be attached to the product to be recycled, and the other will be for consumer receipt. The barcode label can ensure that the waste product is tracked throughout the recycling process and allows the recycler to process the waste information according to the label.
- The electronic control unit includes a micro-computer with flash memory, which provides the capacity of daily data storage for consumer operations. Using the online communication software developed by Task 2.3, the information of consumer operation will be sent to the data centre in real time. The communication module of the software is adapted to the standard communication protocols indicated by the traceability data centre, such as Hyper Text Transfer Protocol.
- The electronic control unit is installed with a digital control module for collecting and processing digital signals from the code reader, and to transmit analogue signals to the control components for opening the pouring gate and printing labels. The digital control module is based on C++ programming language, by which the control parameters can be configurable.

- The electronic control unit includes a capacity sensor, which is used to measure the filling status of the intelligent bin. The relevant information will be emailed to the recycling company in order to inform about the status of filling capacity.
- The intelligent bin provides an option for the consumer to enter the product status, in order to identify if the product is working. The bin does not check the working status of products, which will be checked by the recycling company instead.
- For more information about the specification of the intelligent bin and associated electronic control unit, please see Appendix 'Specification of the intelligent bin with electronic control unit' at the end of this document.

2. Development of ICT software for electronic control unit

2.1 Overview of real-time online transmission software



User ID	Date & Time	Product status	Bin storage(%)	Product ID	Barcode
16004000001	26/04/2019 05:27:38	1	5	00045	160040000011904260000110045
16004000001	26/04/2019 05:28:11	0	5	00046	160040000011904260000100046
16004000001	26/04/2019 05:30:28	0	10	00047	160040000011904260000100047
16004000001	26/04/2019 05:33:06	1	10	00048	160040000011904260000110048
16004000002	26/04/2019 05:36:46	1	15	00049	160040000021904260000110049
16004000002	26/04/2019 05:37:38	1	20	00050	160040000021904260000110050
16004000002	26/04/2019 05:39:11	0	30	00051	160040000021904260000100051
16004000002	26/04/2019 05:40:28	0	35	00052	160040000021904260000100052
16004000002	26/04/2019 05:41:06	1	40	00053	160040000021904260000110053
16004000002	26/04/2019 05:46:16	1	40	00054	160040000021904260000110054
16004000003	26/04/2019 05:47:38	1	45	00055	160040000031904260000110055
16004000003	26/04/2019 05:49:11	1	50	00056	160040000031904260000110056
16004000003	26/04/2019 05:50:08	0	55	00057	160040000031904260000100057
16004000003	26/04/2019 05:52:06	1	55	00058	160040000031904260000110058
16004000003	26/04/2019 05:57:38	1	65	00059	160040000031904260000110059
16004000003	26/04/2019 05:59:11	1	65	00060	160040000031904260000110060
16004000003	26/04/2019 06:02:08	0	70	00061	160040000031904260000100061
16004000003	26/04/2019 06:03:06	1	75	00062	160040000031904260000110062
16004000004	26/04/2019 06:17:08	0	75	00063	160040000041904260000100063
16004000004	26/04/2019 06:18:06	1	80	00064	160040000041904260000110064
16004000004	26/04/2019 06:19:38	1	85	00065	160040000041904260000110065

Figure 3 User-interface of the control unit software

The ICT software for the control unit has been developed for transmitting user's daily recycling information data to the traceability data centre. Because the control unit of the intelligent bin produces a large number of data every day, it is demanded to transmit the consumer's recycling information data to the remote data centre, which achieves monitoring and tracking the status of daily recycling processes.

Figure 3 shows the software developed, which provides the functions to collect the raw data from the control unit, process data (e.g. convert data in the format adapted to the standard web communication interface) and transmit the data online.

Among the data produced by the control unit, the product barcode is the most important data, which contains five different information types: user ID, date, bin ID, product status, and product ID, which are detailed as follows:

- **user ID:**
  User code is 11 digits, which is formed by 5 digits of zip/post code and 6 digits of user code generated sequentially when the user registers on the system (e.g. 000001, 000002, 000003…)

- **date:**
  Date of the operation, composed by 6 digits (from number 12 to number 17) in the format of year, month, and day (yymmdd), such as 181122
- **bin ID:**
  Machine ID is 5 digits (from number 18 to number 22). Each container has a unique number that is generated in the sequential format (e.g. 000001, 000002, 000003…) to identify the place where the disposal takes place.
- **product status:**
  Check digit is either be 0 (if the waste doesn´t work) or 1 (if it works).
- **product ID:**
  Product ID is the last 5 digits standing for the product, e.g. 00001, 00002…

Figure 4 barcode attached to the product

The barcode '16004000001190429000001000059' shown in Figure 4 represents the following information:

- user ID (11 digits): 16004000001
- date (6 digits): 190429
- bin ID (5 digits): 00001
- product status (1 digit): 0 (it is not working)
- product ID (5 digits): 00059

2.2 Communication interface

As a standard application programming interface, the REST-based web service (Representational State Transfer), is applied to establish a communication connection between the client-end computer in the control unit and the host computer on the web server. The web service enables the client-end computer to transmit the recycling information data to the server computer, and hence the server computer is able to retrieve the data over the internet whenever the client-end computer requests the transmission. The web service provides the capacity of the communication between the web server and the client, and ensures the compatibility of different computer languages/platforms.

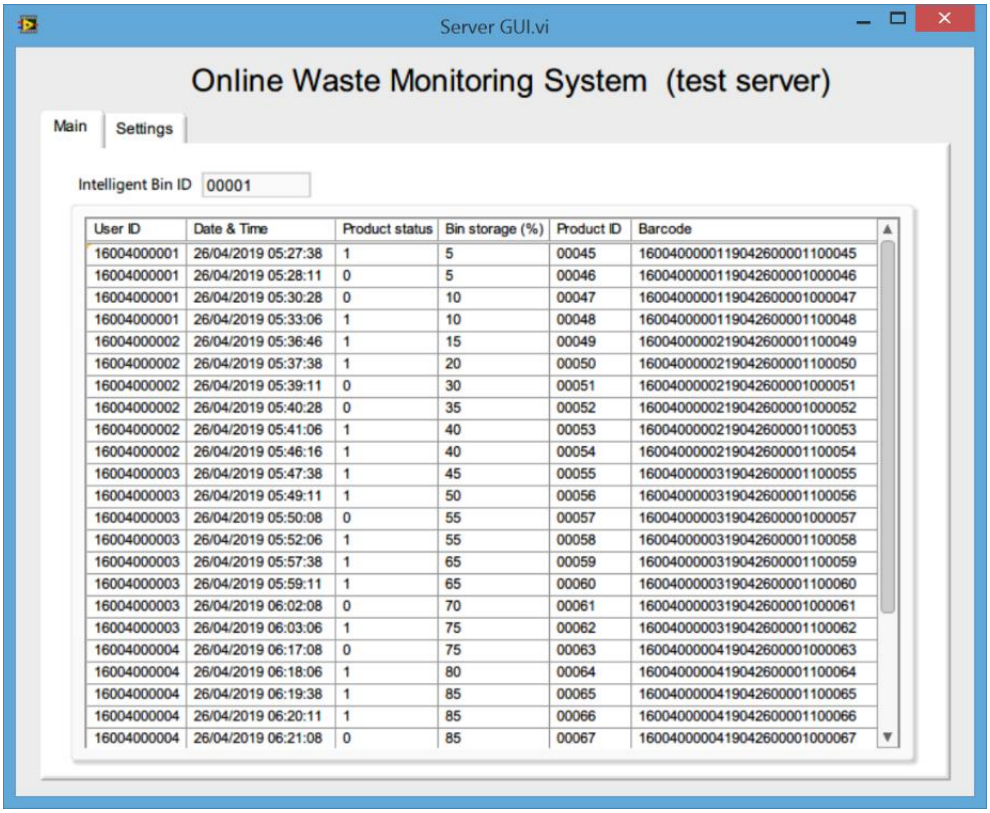
The implementation of the REST-based web service starts by processing the data to the JSON (JavaScript Object Notation) form. Using the following syntax, the information data, such as the

barcode attached to the product, date and time, and storage capacity of the bin, can be encoded in the JSON, for example:

```
{
  "binBarcode":
      {"string":"160040000061904260000l100073"},
  "eventTime":
      {"string":"26/04/2019 06:37:37"},
  "fillingLevel":
      {"double":100}
}
```

Within the above code, the records '160040000061904260000l100073' and '26/04/2019 06:37:37', and '100' refer to barcode, date/time, and storage level of the bin. The tags 'string' and 'double' are used to specify the formats of the record. The start bracket and the end bracket are used to define a complete code including all the records.

With the above syntax, the information data are encoded to the JSON, which is then transmitted as a response to a data buffer in the memory using the Response function of G language based on .NET. When the client computer triggers a transmission request to the server, the response (i.e. the JSON code), which remains in the data buffer, will be transmitted to the server computer. Figure 5 shows the test of the transmitting the data from the client-end software to a local mock-up server.



User ID	Date & Time	Product status	Bin storage (%)	Product ID	Barcode
16004000001	26/04/2019 05:27:38	1	5	00045	160040000011904260000l100045
16004000001	26/04/2019 05:28:11	0	5	00046	160040000011904260000l000046
16004000001	26/04/2019 05:30:28	0	10	00047	160040000011904260000l000047
16004000001	26/04/2019 05:33:06	1	10	00048	160040000011904260000l100048
16004000002	26/04/2019 05:36:46	1	15	00049	160040000021904260000l100049
16004000002	26/04/2019 05:37:38	1	20	00050	160040000021904260000l100050
16004000002	26/04/2019 05:39:11	0	30	00051	160040000021904260000l000051
16004000002	26/04/2019 05:40:28	0	35	00052	160040000021904260000l000052
16004000002	26/04/2019 05:41:06	1	40	00053	160040000021904260000l100053
16004000002	26/04/2019 05:46:16	1	40	00054	160040000021904260000l100054
16004000003	26/04/2019 05:47:38	1	45	00055	160040000031904260000l100055
16004000003	26/04/2019 05:49:11	1	50	00056	160040000031904260000l100056
16004000003	26/04/2019 05:50:08	0	55	00057	160040000031904260000l000057
16004000003	26/04/2019 05:52:06	1	55	00058	160040000031904260000l100058
16004000003	26/04/2019 05:57:38	1	65	00059	160040000031904260000l100059
16004000003	26/04/2019 05:59:11	1	65	00060	160040000031904260000l100060
16004000003	26/04/2019 06:02:08	0	70	00061	160040000031904260000l000061
16004000003	26/04/2019 06:03:06	1	75	00062	160040000031904260000l100062
16004000004	26/04/2019 06:17:08	0	75	00063	160040000041904260000l000063
16004000004	26/04/2019 06:18:06	1	80	00064	160040000041904260000l100064
16004000004	26/04/2019 06:19:38	1	85	00065	160040000041904260000l100065
16004000004	26/04/2019 06:20:11	1	85	00066	160040000041904260000l100066
16004000004	26/04/2019 06:21:08	0	85	00067	160040000041904260000l000067

Figure 5 Test of the communication of the control unit software with a local mock-up server

2.3 Interaction with the traceability web server

The ICT software for the control unit has been verified via the interaction with an online traceability server. The following is the input parameters and response results obtained via connecting the traceability server within three steps (1) – (3) shown below:

(1) URL (the Internet address of the traceability web server):

http://circ4life.eecc.info/api/capture/bin-disposal-event

(2) The information data obtained through the recycling activity:


```
{
"binBarcode":"160040000031909120000 1000058",
"eventTime":"2019-09-12T15:49:08+00:00",
"fillingLevel":65
}
```

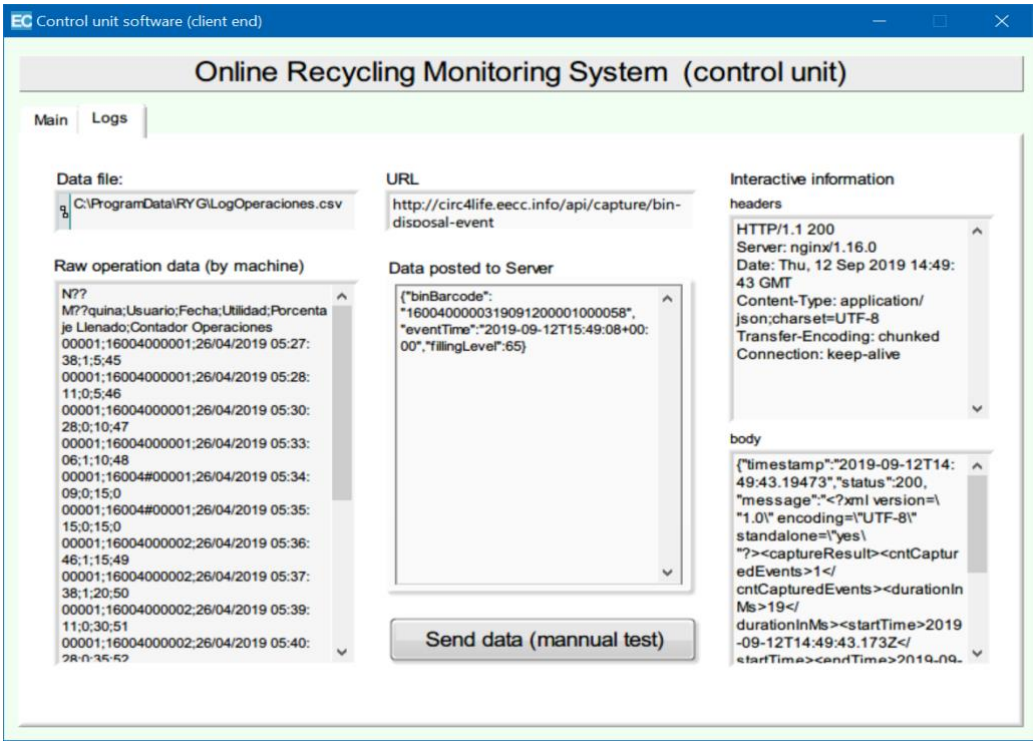

(3) Response returned from the traceability server at the moment the control unit transmits the information data online:

- Header of response:

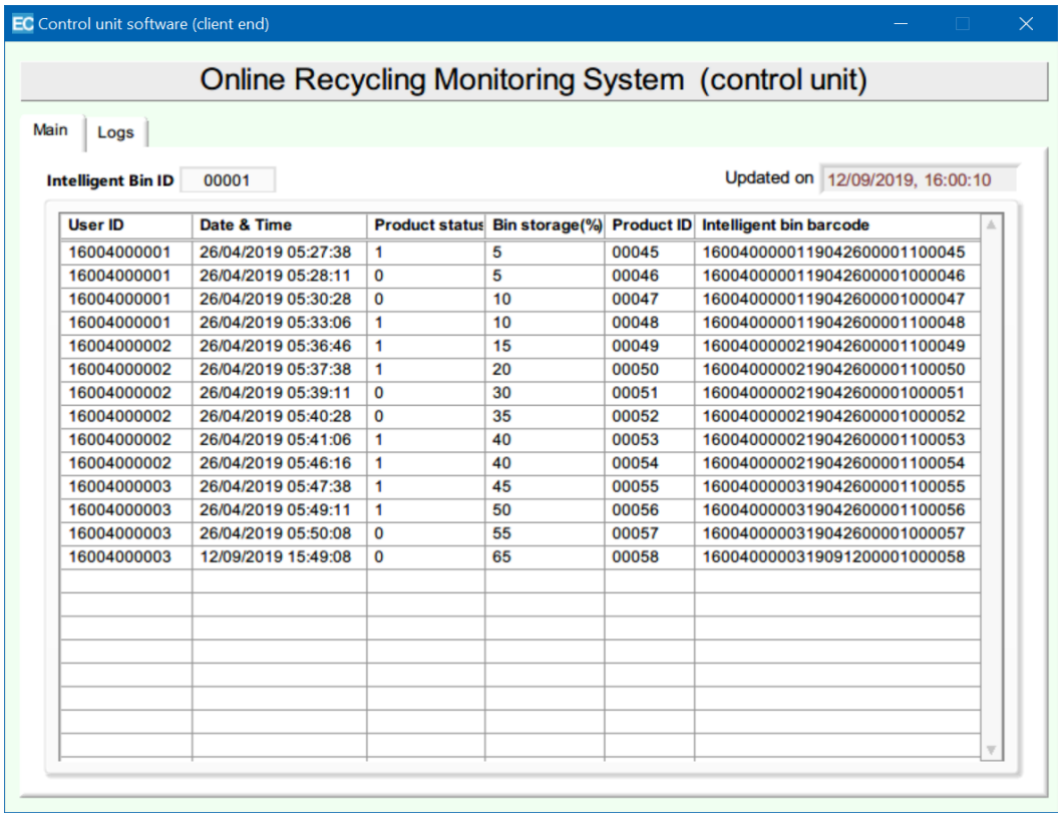

```
HTTP/1.1 200
Server: nginx/1.16.0
Date: Thu, 12 Sep 2019 14:49:43 GMT
Content-Type: application/json;charset=UTF-8
Transfer-Encoding: chunked
Connection: keep-alive
```


- Body of response:


```
{"timestamp":"2019-09-12T14:49:43.19473","status":200,"message":"<?xml version=\"1.0\"
encoding=\"UTF-8\"
standalone=\"yes\"?><captureResult><cntCapturedEvents>1</cntCapturedEvents><durationI
nMs>19</durationInMs><startTime>2019-09-12T14:49:43.173Z</startTime><endTime>2019-
09-12T14:49:43.192Z</endTime><capturedEventIds><eventId>c33aeba1-162b-4140-a815-
b0702df0387f</eventId></capturedEventIds></captureResult>","path":"/api/capture/bin-
disposal-event","reason":"OK"}
```



(a)



User ID	Date & Time	Product status	Bin storage(%)	Product ID	Intelligent bin barcode
16004000001	26/04/2019 05:27:38	1	5	00045	16004000001190426000011000045
16004000001	26/04/2019 05:28:11	0	5	00046	16004000001190426000010000046
16004000001	26/04/2019 05:30:28	0	10	00047	16004000001190426000010000047
16004000001	26/04/2019 05:33:06	1	10	00048	16004000001190426000011000048
16004000002	26/04/2019 05:36:46	1	15	00049	16004000002190426000011000049
16004000002	26/04/2019 05:37:38	1	20	00050	16004000002190426000011000050
16004000002	26/04/2019 05:39:11	0	30	00051	16004000002190426000010000051
16004000002	26/04/2019 05:40:28	0	35	00052	16004000002190426000010000052
16004000002	26/04/2019 05:41:06	1	40	00053	16004000002190426000011000053
16004000002	26/04/2019 05:46:16	1	40	00054	16004000002190426000011000054
16004000003	26/04/2019 05:47:38	1	45	00055	16004000003190426000011000055
16004000003	26/04/2019 05:49:11	1	50	00056	16004000003190426000011000056
16004000003	26/04/2019 05:50:08	0	55	00057	16004000003190426000010000057
16004000003	12/09/2019 15:49:08	0	65	00058	16004000003190912000010000058

(b)

Figure 6 Sending the consumer operation data online

EECC's traceability server user-interface is used to retrieved the data from the control unit, which is shown in the below figure:

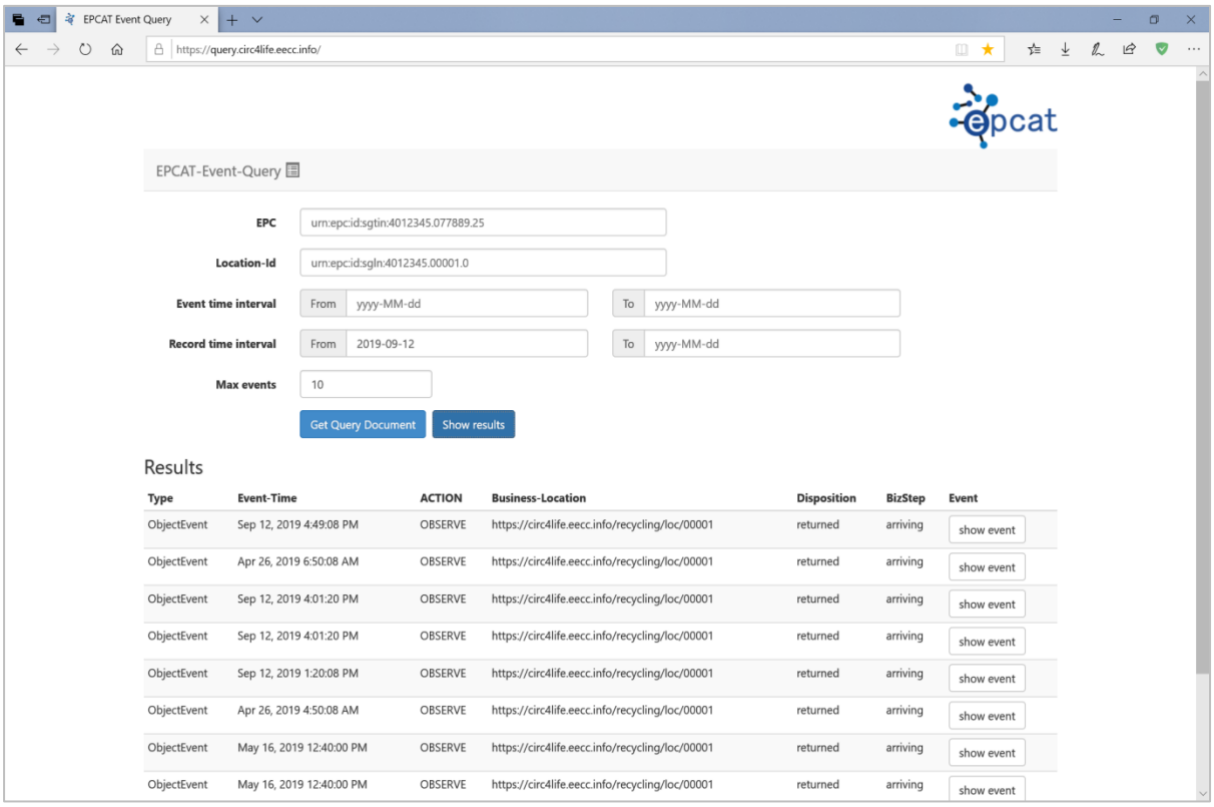


Figure 7 The data records added to the traceability server

Figure 6 – with parts (a) and (b) – shows the user-interfaces displayed in the control unit computer, which are used for transmitting the data to the traceability server. Figure 7 shows the data records which are retrieved by the traceability server.

2.4 Notification for waste collection

The control unit will send an e-mail attached with the information of the storage capacity of the intelligent bin (container) every day, which will help the recycling company (Indumetal) to schedule the collection of waste products.

To this end, the parameters of the electronic control unit need to be configured, such as IP address, port, SMTP server, schedule to send email, etc. The SMTP server provides a function of transmitting an email to the recycling company, which can be achieved in the following interface:

Email address: circ4lifebin@hotmail.com

Server: smtp.office365.com
Port: 587
user name: circ4lifebin@hotmail.com
Password: circ4life
Security: STARTTLS

POP server: outlook.office365.com
Password: circ4life
Security: SSL/TLS

Figure 8 shows the parameters required for configuring the communication interface of the control unit. Figure 9 shows the email received for the notification of bin's filling level.

```
<?xml version="1.0" standalone="yes"?>
<dsDatosLocales xmlns="http://tempuri.org/dsDatosLocales.xsd">
  <Configuracion>
    <NMaquina>1</NMaquina>
    <TextoProducto>TABLET</TextoProducto>
    <ValorAnalogicaContenedorLleno>9048</ValorAnalogicaContenedorLleno>
    <ValorAnalogicaContenedorVacio>19319</ValorAnalogicaContenedorVacio>
    <TiempoPuertaAbiertaMilisegundos>1000</TiempoPuertaAbiertaMilisegundos>
    <TiempoMaximoCicloSegundos>60</TiempoMaximoCicloSegundos>
    <PorcentajeAvisoEmailDepositoLLeno>90</PorcentajeAvisoEmailDepositoLLeno>
  </Configuracion>
```

(a)

```
<LectorCodigos>
  <Puerto>COM6</Puerto>
  <Velocidad>9600</Velocidad>
  <Paridad>Ninguna</Paridad>
  <Parada>1</Parada>
  <Datos>8</Datos>
</LectorCodigos>
<ICPCON>
  <IP>192.168.250.2</IP>
  <Puerto>502</Puerto>
</ICPCON>
<Etiquetadora>
  <NombreImpresora>Godex G500</NombreImpresora>
</Etiquetadora>
<EMail>
  <emailOrigen>CIRC4LifeBin@gmail.com</emailOrigen>
  <emailDestinatarios>CIRC4LifeBin@gmail.com;egarcia@recyclia.es</emailDestinatarios>
  <ServidorSMTP>smtp.gmail.com</ServidorSMTP>
  <Usuario>CIRC4LifeBinInfo</Usuario>
  <Contraseña>circ4life</Contraseña>
  <PuertoSMTP>587</PuertoSMTP>
  <SSL>true</SSL>
  <AsuntoNotificaciones>Tablet Control %M</AsuntoNotificaciones>
  <CuerpoNotificaciones>Registration List</CuerpoNotificaciones>
</EMail>
<HorasNotificacionesEmail>
  <Hora>PT12H</Hora>
</HorasNotificacionesEmail>
<HorasNotificacionesEmail>
  <Hora>PT0H</Hora>
</HorasNotificacionesEmail>
</dsDatosLocales>
```

(b)

Figure 8 Configuration of the communication interface parameters of the control unit system

Figure 8: Configuration of the communication interface parameters of the control unit system

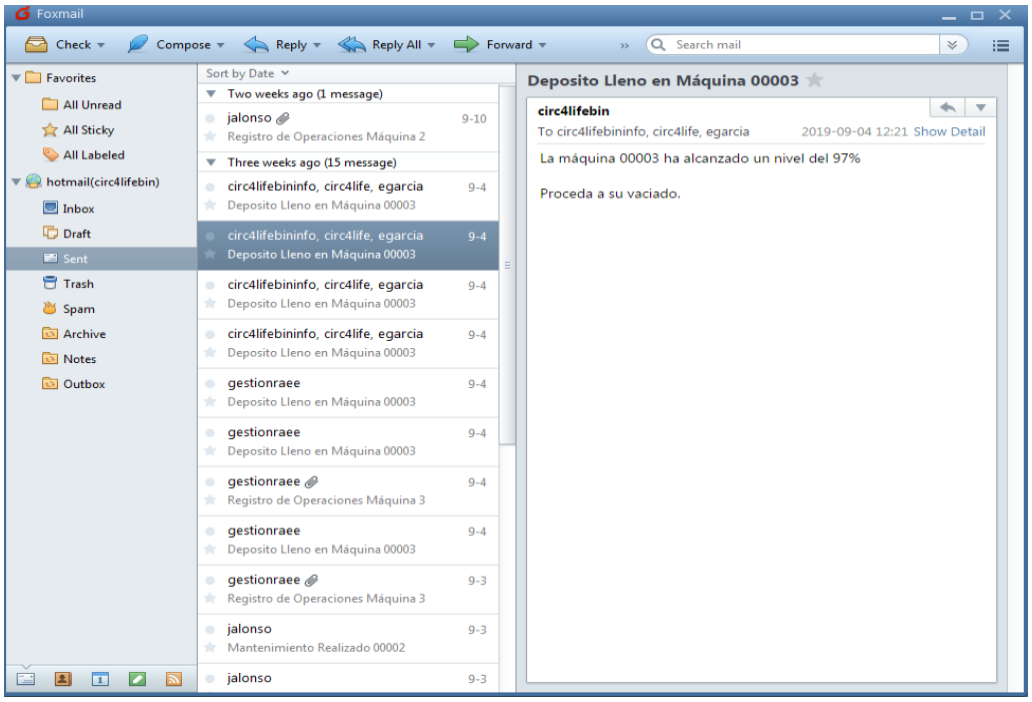


Figure 9 Notification received for the warning of full storage of the bin

3. Case study

A case study for verifying the system developed has been conducted at Indumetal facility in Bilbao. This case starts with the installing ICT software on the computer in the control unit.

The software can be used to implement the communication between the control unit, the mobile app and the database server deployed in the ICT platform by adopting the API services that are undertaken by the ICT platform, such as

- Get product information: https://circ4life.iccs.gr/EndUserModule/resources/ecoshopping/product/info/{gtin14} ,
- Get eco-credits: https://circ4life.iccs.gr/RecycleModule/resources/ecocredits/

In the actual operation, we found that the control unit is mounted in the intelligent bin and does not have a display monitor connected to the control unit, which causes problems when installing the software. With the help of Indumetal and Recyclia, the external devices (e.g. monitor, mouse, cables…) are connected to the control unit, which ensures the success of software installation. Figure 10 (a) shows the external devices connected with the control unit, which are utilised for installing the control system software.

a) Intelligent bin with control unit software installed

b) Consumer logs in via scanning an ID card

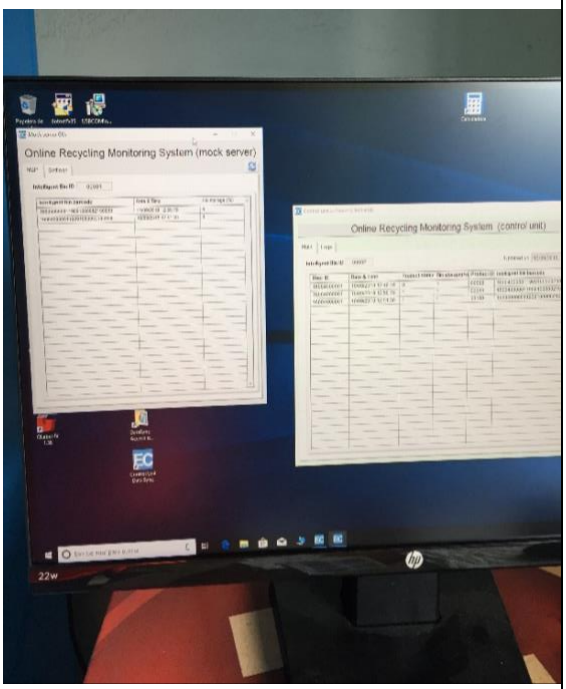
c) Consumer select a LED button to input the product status (i.e. working or damaged)

d) Print the two barcode labels: one is attached to the waste, and the other is used for a receipt.

e) Door is unlocked and open

f) Attach the label (sticker) to waste.

g) Put the waste to the bin and close the door



h) The software transmits the information data to the data centre.

Figure 10 Operation procedure of the intelligent bin

Figure 10 shows the operation procedure of the intelligent bin system, which is detailed in following sections.

3.1 Scanning the QR code

A QR code is a unique identifier, which represents the identity of a consumer. The consumer will get the QR code by registering an account. This code can be printed to a card or shown on a smartphone. Figure 11 shows an example of the consumer card with QR code. Consumers can scan the code through a code reader embedded in the intelligent bin. Only when the code matches with the user data, the consumer can proceed to operate.

Figure 11 Consumer ID card

3.2 Selecting the status of the electronic waste

There are the two buttons on the intelligent bin, which are used to report the status of the electronic waste.

According to the actual status of the waste, the consumer selects one from the two LED buttons:

- Red LED light button: the item doesn´t work, such as damaged.
- Green LED light button: the item works.

3.3 Printing the barcode labels.

When the consumer enters the product status, the intelligent bin prints out the two barcode labels (stickers), as shown in Figure 12. As stated, the two barcode labels are identical: one label will be placed on the waste product, and the other is used as a receipt.

The barcode label consists of the following information:

- user ID
- date and time of disposal
- location where it is disposed.
- Product status
- product ID (serial number).

Figure 12 Barcode labels printed by the Intelligent bin

3.4 Attaching the barcode label to the waste product.

Then the consumer attaches the barcode label to the waste that is packaged. The waste product is required to be packaged in order to ensure that the item is not damaged when it is thrown into the bin.

3.5 Open the door of intelligent bin.

The lid/door of the intelligent bin is unlocked and opens to enable the item loaded, which is based on the following criteria:

- The lid of the intelligent bin is open only when the user's QR code is verified.
- The specified size of waste is allowed to be put into the bin.
- The intelligent bin does not check the status of the waste. When consumer selects a status button (red or green button), the bin will record the status value (0 or 1). (The wastes will be further checked by the recycling company, which will identify their actual status).

3.6 Transmission of consumer's operation data

The online transmission software, which is installed at the control unit, achieves the data transmission with a local mock-up server, as shown in Figure 10 (h). Through the incorporation of the connection with the traceability server, the update version of the software is able to transmit the consumer's operation data to the traceability data centre over the Internet.

The operation data transmitted contains: consumer ID, product ID, specific date and time of disposal, intelligent bin ID (location), working status of product, storage capacity of bin's container, and barcode of the waste.

Then the recycling company is informed on the storage level of the intelligent bin via the email. They will collect the waste for further processing, such as classification and quality assessment. The product assessment information will be uploaded via a web user-interface developed in WP5 tasks,

for example, state (recyclable/reusable/repairable), lifetime, etc. Based on the product's assessment information and eco-points, the eco-credits will be calculated. To this end, the eco-credit method developed in Task 2.4 will be applied, and then the resulted eco-credits will be added to the consumer's eco-account located at the ICT platform.

There is only one account, namely the consumer's eco-account at the ICT platform. Each eco-account has an ID that associates with a QR code. Consumer can log in the intelligent bin by scanning the QR code shown on the ID card or the mobile phone. With the ID, the data of the intelligent bin can be transmitted to the consumer's eco-account.

4. Concluding Remarks

This deliverable presents the development of the ICT-based system for recycling and reusing. The system consists of recycling/reusing module, waste collection, and traceability. Within the recycling/reusing module, an existing intelligent bin is utilised, which has been further developed with real-time online transmission software system.

The system developed has been demonstrated through a case study of recycling electronic product with the intelligent bin, which is conducted at Indumetal in Bilbao. The test confirms that the system works fine and collects the required data for further monitoring of recycling process.

The system developed for electronic products will be adapted to the meat waste case, adapting the interface to the needs of the waste manager, depending on the proposal finally developed in Task 2.2.

References

[1] Recicla y Gana, “TECHNICAL SPECIFICATIONS OF INTELLIGENT CONTAINER”, www.reciclaygana.org

Appendix

Technical Specifications Intelligent Bin with Electronic Control Unit

Smart Recycle and Win containers are exclusive, manufactured and developed by the brand and not marketed for other Business. The waste identification system is protected under national patent U2012000367.

URL video link operation (machine oil collection used vegetable).

https://youtu.be/qBhp5Y_akOc

1) Smart operating system and user recycling

The user is registered on the web platform or downloading the related APP and he/she will be provided a card with a QR code shown.

The user card or the QR code shown in the APP can activate the intelligent bin by transferring the intelligent commands to the code reader of the control unit.

QR code download APP:

When the smart container reads the user's code, it prints a sticker to identify the user's waste and provides the following information:

- User
- Date of dumping/disposal
- Container where it has been deposited.
- If the equipment works or does not work.
- Product ID / serial number

The label format is as shown in the figure. It takes two parts, the upper one is the receipt that the user remains and the lower one is the one that sticks on the residue.

Example of collection with this format:

2) Advantages of the control system with intelligent bin

The main advantages of identifying electrical and electronic waste are as follows:

- The risk of fraud is reduced in waste management by providing a 100% traceability from the discharge to the final management. The Manager must pass information to the central once managed labelled waste.
- Reusability of electrical products is facilitated to have the information provided by the owner of the operation or not. An important part of European legislation.

"Directive 2012/19 / EU, emphasizes preparation for reuse as a key element in preventing generation of waste electrical and electronic equipment (WEEE), granting a privileged position in the hierarchy of waste, and as a strategic measure to boost production and sustainable consumption.

Contribution to the achievement of objectives set by the European waste management regulations by 2020. Possibility encourage owners in the management of electrical products and electronic, increasing recycling ratios.

3) Hardware requirements of intelligent bin

- The identification system WEEE must have printer stickers. The label should provide information code user, date pouring machine which has been deposited and if the device

works or does not work.

- The system must allow reading QR codes, PVC cards or Smartphone screens.
- Selecting the option of whether to work through the buttons on the panel of the machine.
- Electrical door locking system will only be open by reading a user code.
- Dimensioning system for detecting the storage capacity of the container. The user operation information will be sent to the central platform at the end of the day.
- The container will have a router / modem to send data by connection to network or SIM card, to the platform to daily inform about users that have used the machine.
- Door system extraction stop anti-dumping prevent theft in containers.
- Incorporating solar panels on top of the machine to enable installation in locations without electrical current outdoor (reception area sunlight to recharge the batteries Machine).
- Application of the hardware control and identification of waste can expand the incentive system to the collection of a range of wastes in different collection points, without the need for operators to manage the collection.
- The system can be replicable to be installed in the intelligent bins placed at public places, where a wide range of wastes are liable to manage. This system provides incentives for general wastes (e.g. organic waste), which will help achieve the recycling target set by the EU in 2020.
- The hardware equipment must be able to feed electrically by solar panels avoiding the need for electrical connections for the operation of the equipment.

4) Software requirements of intelligent bin

- WEEE must be individually identified by an adhesive barcode label (sticker) at the moment of the delivery. The recycling company utilises the necessary software to read this label and send the recycling information, such as the treatment of the WEEE, to the central platform. This is a closed loop, which starts from the waste discharge until the treatment of the recycling plant, via tracking the recycling status/processes.
- The administration must have general and total reports management of WEEE, which should prove that the WEEE has been correctly managed in the treatment plant. To do this, you must issue reports where you can set the amount of WEEE collected at a point, the amount of processing in the WEEE plant, the average period of treatment from being deposited until final processing and estimating the losses in quantities.
- There should be a web platform where the user can see the contribution he has made at

any WEEE collection point and if the administration provides incentive information, the user will be able to see his incentive reflected immediately by the contribution made.