This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 776503
- CIRC4Life-H2020-IND-CE-2016-2017/CIRC-2017/TwoStage

A circular economy approach for lifecycles of products and services

Development of eco-shopping and eco-account tools

Deliverable 3.1

PROJECT INFORMATION	
Type of Project	European Commission Horizon 2020
Topic	CIRC-01-2016-2017 Systemic, eco-innovative approaches for the circular economy: large-scale demonstration projects
Grant Agreement No.	776503
Project Duration	01/05/2018 – 30/04/2021 (36 months)
Project Coordinator	Nottingham Trent University (NTU)
Project Partners	Enviro Data (ENV), Jonathan Michael Smith (JS), Kosnic Lighting Limited (KOS), Centre of Research for Energy Resources and Consumption (CIR), European EPC Competence Center GmbH (EECC), The Institute for Ecology of Industrial Areas (IETU), SWEREA IVF AB (RISE), Make Mothers Matter (MMM), ONA PRODUCT (ONA), INDUMETAL Recycling (IND), GS1 Germany GMBH (GS1G), Laurea University of Applied Science (LAU), Centre for European Policy Studies (CEPS), Institute of Communication and Computer Systems (ICCS), Recyclia (REC), S.A.T. Alia (ALIA)

DOCUMENT INFORMATION	
Title	Development of eco-shopping and eco-account tools
Version	V1.0
Release Date (dd.mm.yy)	30/10/2019
Work Package	WP3
Type	Other
Dissemination Level	PU

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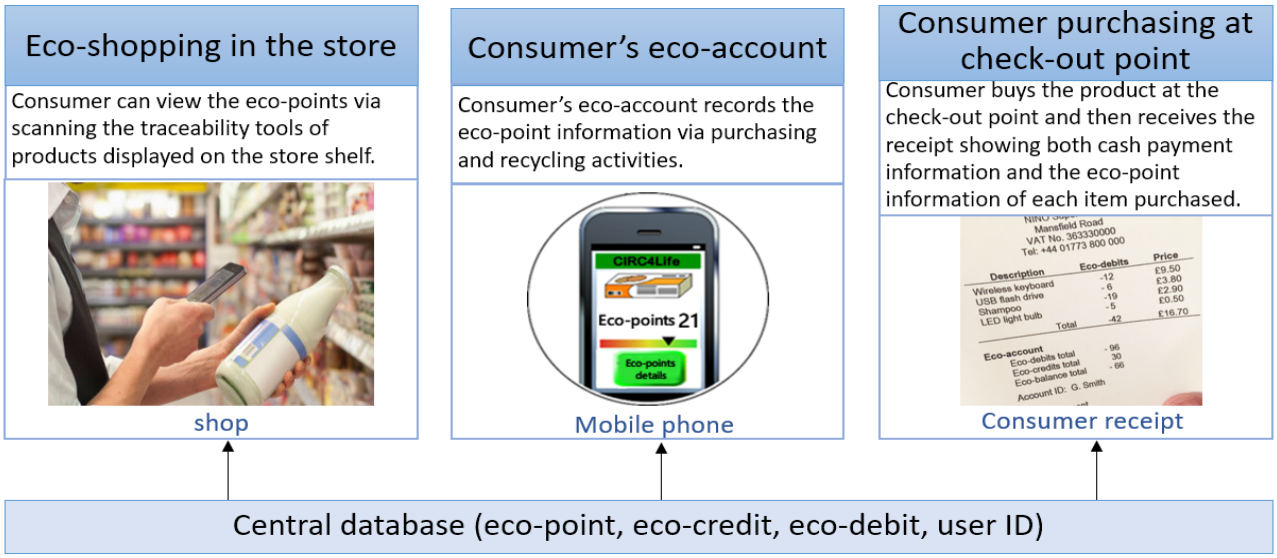
DOCUMENT HISTORY			
Version	Date (dd.mm.yy)	Description	Implemented by
V0.1	11/10/2019	First draft	Hua Huang, Longfei Yu, Wenjie Peng
V0.2	29/10/2019	The document was revised based on the ALIA's comments.	Wenjie Peng
V1.0	30/10/2019	Final version	NTU

Executive Summary

This document details the development of eco-shopping and consumer eco-account tools. The eco-shopping tool provides the function for consumers to obtain the product eco-information, such as eco-points and sustainable manufacturing information of products, via scanning the traceability tool (e.g. barcode) embedded in the product with mobile phone. Eco-account is applied to enable consumers to view the information of their eco-account, including eco-debits obtained via purchasing, eco-credits earned via recycling/reusing, and eco-balance reflecting the consumer's overall impact on environment. The retailer tool for accounting of consumer purchasing is developed for consumers to obtain the receipt showing both cash payment information and the eco-point information of each item purchased when purchasing the product at the check-out point. The information related to the product and consumer's eco-account will be retrieved from the central database located in the ICT platform, as shown in the below diagram.



The test version of consumer mobile phone app is developed, which has been uploaded to the project sharepoint. The major functions that are considered during the app development include: the integration of eco-information into the traceability tools, access to the eco-information via mobile phone app, specification of consumer account, and displaying the eco-information in the consumer account. The offline test of mobile app has been carried out with an example of scanning product attached by the traceability tool, utilising proxy data (test data) from a mock-up web server developed, which shows that the system works and provides necessary eco-information for consumer to select sustainable products. The mobile app will be further developed/refined through the integration with the ICT platform. The final version of the mobile app will be ready at the demonstration stage, which will be applied to be demonstrated with real product data, via the connection with the central database.

The offline version of the retailer tool for accounting of consumer purchasing is developed, which is separate with the shop's existing cashing system. The retail tool is not included in the DoA, however, it will be implemented for accounting of consumer purchase in a local store at the demonstration stage. The integration with the ICT platform will be conducted, allowing the retail tool to print the

receipt showing both the eco-points of each product purchased and the cash payment information, through the connection to the central database.

Table of Contents

List of Abbreviation

API	Application programming interface
CSS	Cascading Style Sheets
EoL	End of life
ICT	Information and communication technology
ID	identity
JS	Java script
PHP	Hypertext preprocessor
SDK	Software development kit
QR code	Quick response code
REST	Representational state transfer
SQL	Structured query language
AR	Augmented Reality

1. Progress

1.1 Development of the Eco-shopping and Eco-account tools

- **Functions of eco-shopping/eco-account mobile app**

The mobile app provides the following functions: (1) Customer can register an individual eco-account, and sign in the account to view the personal information (user ID, gender, phone, email). (2) Customer can obtain the product details, such as product name, eco-points, product description, price, sustainability, product lifespan, and so on, by scanning the barcode attached to the product. (3) The eco-account shows the information of the consumer's eco-debits total (via purchasing), eco-credits total (via recycling/reusing), and eco-balance total reflecting consumer's overall environmental impacts. (4) The consumer can access the information list of his/her purchasing and recycling activities, and view the graphical chart showing the monthly eco-balance of each user.

- **The status of the app development and communication with the server**

(1) The data model of the eco-shopping/eco-account mobile app for the local test is established, and the APIs for accessing the data models and interacting with a mock-up web server are developed. (2) The first version of the mobile app is developed, which has been successfully tested using the mock-up web server developed. (3) Considerable discussions were made with regards to the standard of data exchanging and communication with the ICT platform. Further, a number of APIs were updated in order to adapt the requirements of the standard of the ICT platform. (4) Through the integration with the ICT platform, the mobile app will be further developed, based on the amended database scheme and APIs, in order to fulfil the implementation of eco-shopping at the demonstration /showcase stage.

- **App download and demo video**

The first version of the eco-shopping/eco-account mobile app has been uploaded to the project SharePoint:

https://myntuac.sharepoint.com/sites/CIRC4Life/Shared%20Documents/Forms/AllItems.aspx?id=%2Fsites%2FCIRC4Life%2FShared%20Documents%2F04%5FWork%20Packages%2FWP3%5FSustainable%20Consumption%2FTask%203%2E3%20Consumer%20eco%2Daccount%2FMobile%20app&viewid=30c3caa0%2D555d%2D459e%2Db8a5%2Dcde1b61aca5d

Consumers can download the mobile app via the Google play store, where they will find out the installation file of the mobile app by inputting the keyword 'circ4life' with mobile phones.

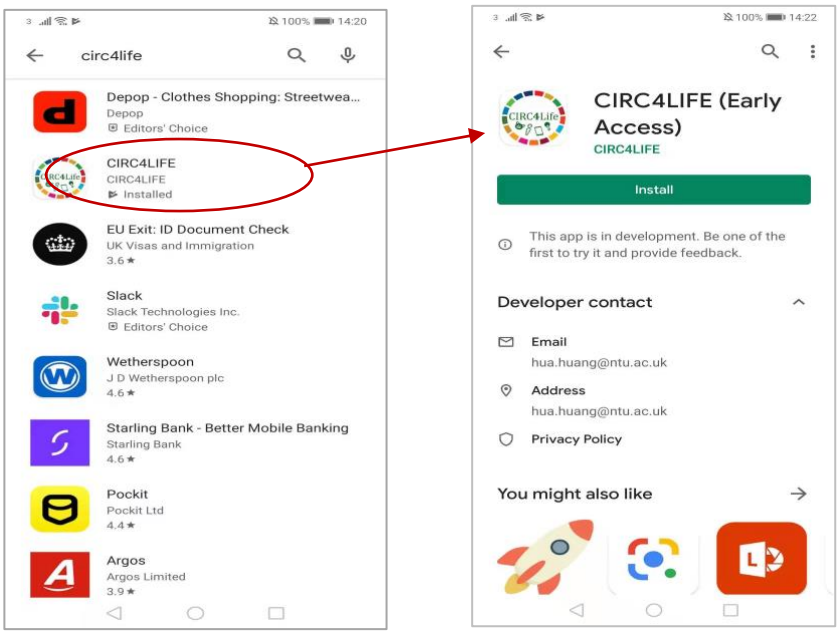


Figure 1: CIRC4Life mobile app published in Google play store

Alternatively, consumers can get the mobile app by scanning the QR code shown in Figure 2 (a).

Figure 2 (a). The QR code for the mobile app download

Regarding the use of the mobile app, a video has been made for demonstrating the functionality of the mobile app, which is accessible via the below link:

http://bs.cifuwu.com/api/pages/download/demovideo.mp4

The video can also be obtained by scanning the QR code from the below figure:

Figure 2 (b). The QR code for the demo video

1.2 Development of the Retailer tool for accounting of consumer purchasing

The retailer tool for accounting of consumer purchasing is developed, which is separate with the shop's existing cashing system. At the demonstration, a shop assistant is needed to use the two systems to complete the purchase process. The cash payment is implemented by the local existing cash payment machine, and the retail tool developed is used to print the receipt reflecting the eco-point information of products purchased.

At the check-out point, the retailer can gain access to the eco-account information of the consumer, by scanning the QR code shown on the consumer ID card or mobile phone though the reader. The retailer scans the barcode attached to the product using the reader, and then the printer prints out the receipt which will show both cash payment information and the eco-debits related to each item purchased. The retailer tool will record the eco-debits of products purchased into the consumer's eco-account located at the ICT platform.

The retailer tool is currently in development, which will be implemented to access the information of the eco-account and product information via connecting to the central database of the ICT platform over the Internet.

The retailer tool provides the following functions:

- Retailer can access the consumer's eco-account information by scanning the QR code shown on the consumer ID card.
- Retailer can access the product eco-debits by scanning the barcode attached to the product.
- The printer prints out the eco-receipt showing the eco-debits of the items purchased, eco-account, and the cash payment information.

A video has been made to demonstrate how the retailer tool works, which is uploaded to the project SharePoint:

https://myntuac.sharepoint.com/sites/CIRC4Life/Shared%20Documents/Forms/AllItems.aspx?id=%2Fsites%2FCIRC4Life%2FShared%20Documents%2F04%5FWork%20Packages%2FWP3%5FSustainable%20Consumption%2FTask%203%2E3%20Consumer%20eco%2Daccount%2FVideo%2FRetailer%20tool%20demo%2Emp4&parent=%2Fsites%2FCIRC4Life%2FShared%20Documents%2F04%5FWork%20Packages%2FWP3%5FSustainable%20Consumption%2FTask%203%2E3%20Consumer%20eco%2Daccount%2FVideo

2. Methods applied in the Eco-shopping mobile app development

This section is to present the technologies and methods utilised in the mobile app development.

2.1 Structure of data model for mobile app

Based on the requirement of functions of the mobile app, which is addressed in DoA [1], the data model for the mobile app is developed, and relevant data tables are created with a MySQL server, which are detailed in Tables 1 - 5.

Table 1. *user* Data Table

Items	Data Field	Description	Data Type	Auto-increment	Primary key	Is null
1	user_account	user account	varchar(20)	False	True	False
2	user_name	user name	varchar(50)	False	False	True
3	user_pwd	user password	varchar(20)	False	False	True
4	user_identity_id	user identity number	varchar(50)	False	False	True
5	user_sex	user gender	char(4)	False	False	True
6	user_phone	user moblie phone	varchar(50)	False	False	True
7	user_birthday	user birthday	date	False	False	True
8	user_email	user email	varchar(255)	False	False	True
9	user_img	user head image	varchar(255)	False	False	True
10	user_id_qr_img	user QR_code image	varchar(255)	False	False	True
11	user_incentive_scheme	user incentive scheme	text	False	False	True

Table 2. product Data Table

Items	Data Field	Description	Data Type	Auto-increment	Primary key	Is null
1	pid	record ID	int(4)	True	True	×
2	product_id	product ID	varchar(50)	False	False	×
3	product_name	product name	varchar(100)	False	False	True
4	product_barcode	product Barcode for EAN-13	varchar(50)	False	False	True
5	product_qrcode	product QRCode	varchar(100)	False	False	True
6	product_barcode_gs1_128	product Barcode for GS1-128	varchar(50)	False	False	True
7	product_img	product image url	varchar(255)	False	False	True
8	product_class_name	product category name	varchar(255)	False	False	True
9	product_sustainability	Product sustainability	varchar(500)	False	False	True

Items	Data Field	Description	Data Type	Auto-increment	Primary key	Is null
10	product_description	Descriptions (e.g. food ingredients; or function, material, etc	text	False	False	True
11	product_lifespan	Life span/used time and Warranty	varchar(255)	False	False	True
12	product_cost	product price	float(11,0)	False	False	True
13	product_eco_points	product eco-points	float(11,0)	False	False	True
14	product_eco_debits	product eco-debits	float(11,0)	False	False	True
15	product_recycling_scheme	product recycling scheme	varchar(500)	False	False	True

Table 3. *purchasing_activities* Data Table

Items	Data Field	Description	Data Type	Auto-increment	Primary key	Is null
1	id	record ID	int(11)	True	True	False
2	user_account	user account	varchar(20)	False	False	False
3	product_id	the product id of purchasing	varchar(50)	False	False	True
4	purchasing_date	the datetime of purchasing	date	False	False	True
5	purchasing_number	the number of purchasing products	int(11)	False	False	True
6	purchasing_eco_debits	the purchasing eco-debits	float(11,0)	False	False	True

Table 4. *recycling_activities* Data Table

Items	Data Field	Description	Data Type	Auto-increment	Primary key	Is null
1	id	record ID	int(11)	√	√	×
2	user_account	user account	varchar(20)	False	False	×
3	product_id	the product id of purchasing	varchar(50)	False	False	√
4	recycling_date	the datetime of recycling	date	False	False	√

Items	Data Field	Description	Data Type	Auto-increment	Primary key	Is null
5	recycling_number	the number of recycling products	int(11)	False	False	True
6	recycling_eco_debits	the recycling eco-debits	float(11,0)	False	False	True

Table 5. *information* Data Table

Items	Data Field	Description	Data Type	Auto-increment	Primary key	Is null
1	id	record ID	int(11)	True	True	False
2	inf_title	information title	varchar(255)	False	False	False
3	inf_type	information type	varchar(50)	False	False	True
4	inf_content	information content	text	False	False	True
5	inf_date	information publishing date	date	False	False	True

Figure 3 shows the relationship among the above data tables, where the tables '*purchasing_activities*', '*recycling_activities',* and '*user*' are linked by the data field *user_account*. In addition, the data field *product id* is used to link the tables '*purchasing_activities*', '*recycling_activities',* and '*product*'.

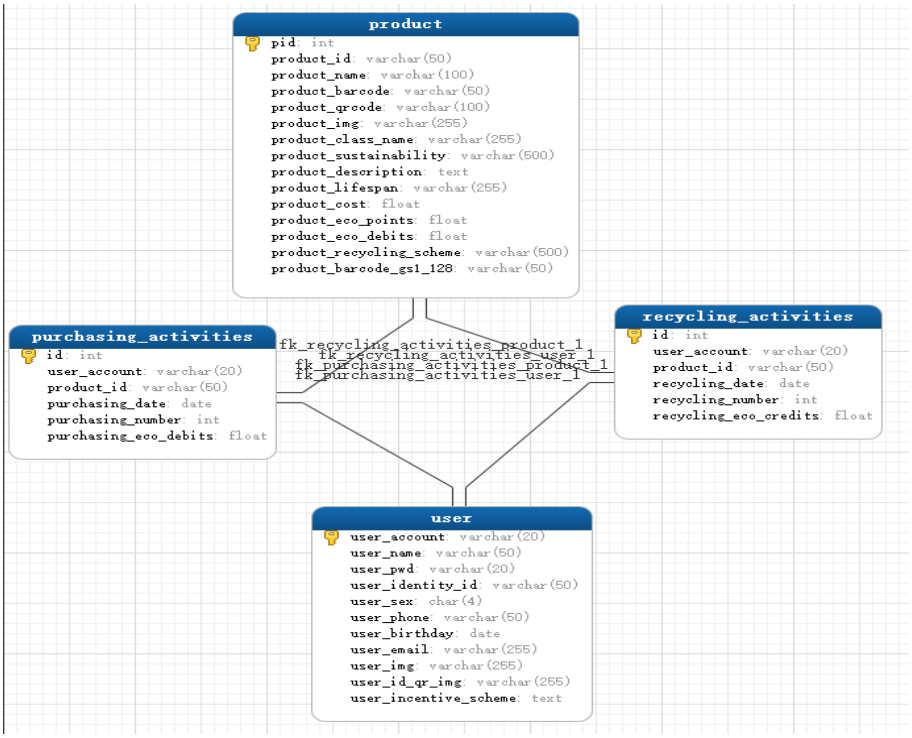


Figure 3. The relation diagram of all data tables

2.2 Barcode standard and scanning method

In the mobile app, we adopt the GS1-128 barcode to identify the CIRC4Life products. Generally, GS1-128 was developed to provide a global standard for exchanging data between different companies. GS1-128 not only encodes the data, but provides a method of defining the meaning of the data by defining a list of "Application Identifiers" (AI's). In 2006, the Uniform Code Council changed their name to GS1 US, and have moved towards creating global naming structures for all their terminology and guidelines [2]. Consequently, UCC/EAN-128 barcodes are now referenced as GS1-128. GS1-128 is by itself not a bar code language (symbology). It is a standard that defines both the kind of data and the data format. In essence, GS1-128 is a derivative language of the Code 128 symbology, utilizing a flagging character (Function Code 1 (FNC1)) and application identifiers. The detail description of the GS1-128 barcode can be found in the web page (https://www.gs1-128.info) [2]. To better understand the GS1-128 barcode, some GS1-128 barcode examples used in the mobile app were shown in Figure 4.

The GS1-128 barcode consists of two parts starting with prefix AIs. The first part includes the Global Trade Idem Number (GTIN), a 14digit Number identifying a Product/Article identified by the AI (01). In Europe the EAN13 is the common Article Identifier and the corresponding GTIN is the EAN13 with a leading zero. The last digit of the EAN or GTIN is a check digit. For example, a product with EAN 3021105049098 (this identifies a Ele lamp) can be represented as (01)03021105049098. The second part is used to identify an individual product or a batch of a product, which utilisesAI(21) as the serial or the AI(10) as the Batch/Lot-Number. These are both variable length identifiers with up to 20 characters terminated by "Function Code 1" (FNC1) as the delimiter for variable length AIs.

For more information about the specification of GS1-128 standard applied in the CIRC4Life project, please see the Appendix 1 at the end of this document.

Figure 4. GS1-128 barcodes developed for CIRC4Life products

There are many methods to implement a barcode scanning APP program, for example, using Java Programming in Android Studio, adopting the API of Baidu AR or EasyAR, or making use

of the Unity's AR SDK. In the mobile app, we apply java programming language within Android Studio to implement the function of barcode scanning.

The implementation of barcode scanning consists of the three steps: Firstly, the image of product barcode (e.g. GS1-128 barcode) is obtained by calling the Camera API of mobile devices. Then, the obtained image is pre-processed to be a grayscale image. Secondly, the grayscale image is decoded through the decode analysis. Finally, the related information contained in the barcode, such as the product ID, the number or the text are retrieved from the network or the remote database server according to the results obtained in the second step. The mobile app interface has been developed for scanning a GS1-128 barcode, which is shown in Figure 5.

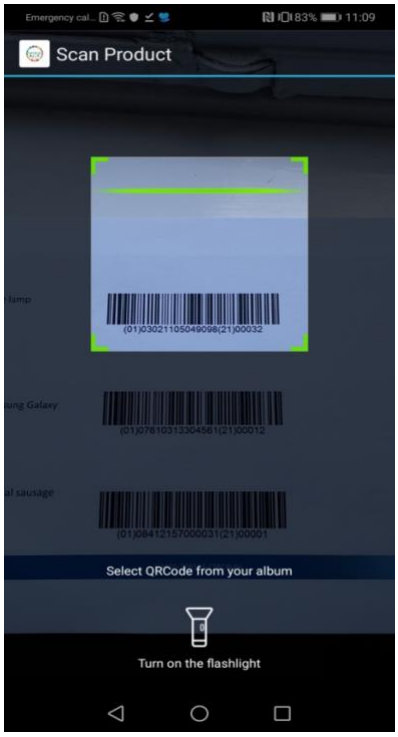


Figure 5. The interface of scanning product barcode

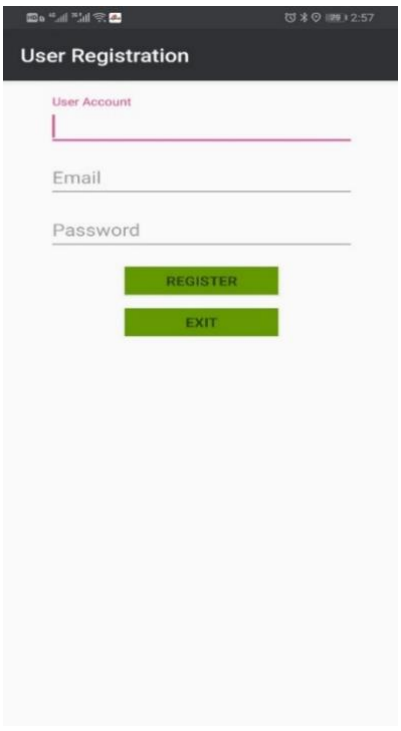
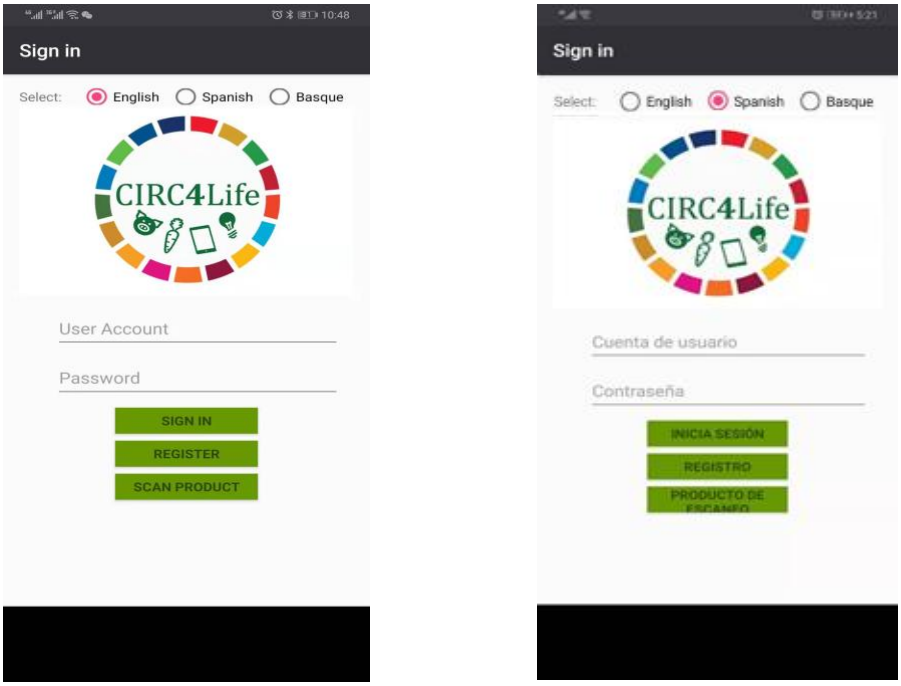


Figure 6. The interface of user register

2.3 User log in and registration

For the first-time users who use the mobile app, they must complete a User Registration form to create an account. To do so, the user needs to provide the personal information, such as email and password, as shown in the registering interface in Figure 6.



(a) English (b) Spanish

Figure 7. The interface of user log-in

After the completion of registration, the user can sign in the mobile app by inputting his/her username and password with the user login-in interface (see Figure 7), and then access the information related to the eco-account and product purchasing/recycling. As shown in Figure 7(a) and (b), multiple language features are included, such as English, Spanish, and Basque.

2.4 Display of product detail information

To display the detail information of a product, the product ID needs to be obtained by scanning the barcode that is attached to the product. As an input parameter, the product ID is passed to the service API, which is used to obtain the product information.

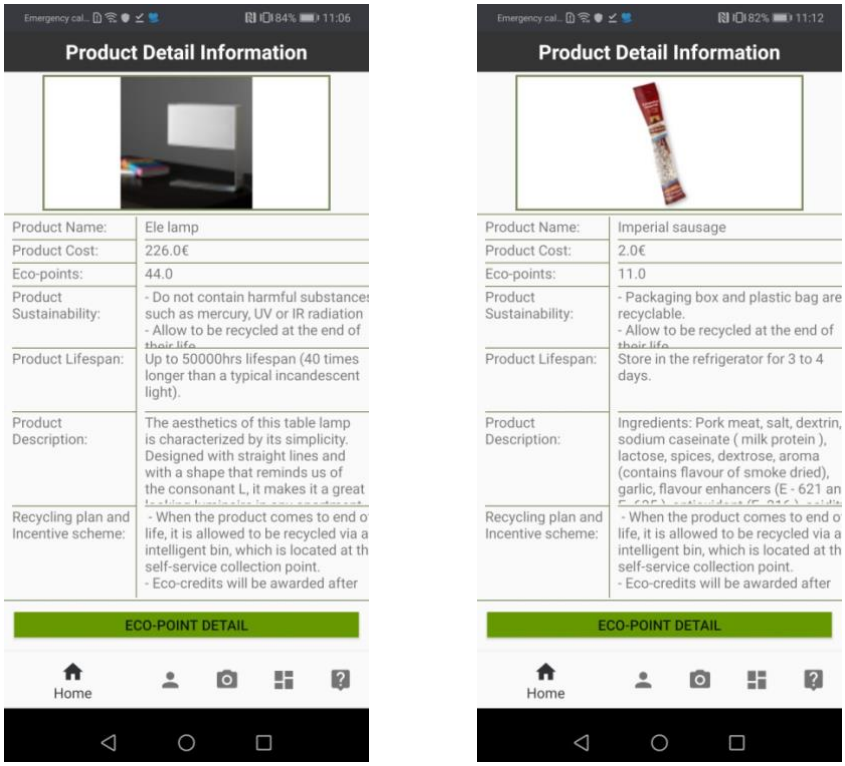


Figure 8. Displaying the information of different products, such as LED light and meat

Figure 8 shows the examples of scanning the barcodes attached to the two products respectively. With retrieving the data from the API, the following information can be obtained: product name, product price, eco-points, product description, product sustainability, and product lifespan.

2.5 Consumer Eco-account

To obtain consumers' eco-account information, consumers need to sign in their mobile apps using user account and password. Within the interface of *User Center*, the mobile app retrieves the current user's personal information (e.g. user name, gender, phone, email), and eco-account information (eco-debits total, eco-credits total, eco-balance total) from the remote database (i.e. the MySQL database in the testing server). Subsequently, the monthly eco-balance chart of each user is created based on the history data recorded in the eco-account, such as product purchasing and recycling records every month. Figure 9 shows an example of displaying user eco-account information in the *User Center* interface.

In the home page of the mobile app, consumers can view the detailed information of purchasing and recycling activities, which is shown in Figure 10.

Figure 9. Eco-account information Figure 10. User details in English & Spanish

2.6 Communication interface with the server (RESTful web service)

A number of communication interfaces are developed based on RESTful web services, which are utilised for the communication with the mock-up web server. A PHP testing server is built to test the interfaces developed. In this sub-section, the schema of the communication interface is presented, which is followed by the descriptions of interfaces (APIs) developed.

---Global Description----

Request Rule： API_URL+ Method Name + Parameters
Request Method： Get/Post
Returned Value：Json format

```
{
        code: "String ",
    message: "String",
        data: Array|Object
}
```

API_URL= http://bs.cifuwu.com/api
Returned Value Description:

Items	Returned code	Returned message	Description
1	20000	success	success
2	40001	failed	failed

API 1：Obtaining product information by barcode (GS1-128)

Method name：Product/GetProductByBarcode_Gs218

Request URL：API_URL/Product/GetProductByBarcode_Gs218
Input Parameters：

Items	Parameter name	Data Type	Description	Not null
1	product_barcode_gs1_128	varchar(50)	product Barcode for GS1-128	Yes

Returned value: It can be demonstrated in Section "Global Description" and the latter example.

Request Example：
API_URL/Product/GetProductByBarcode_Gs218?product_barcode_gs1_128=01030211050490982100032

(Namely, http://bs.cifuwu.com/api/Product/GetProductByBarcode_Gs218?product_barcode_gs1_128=0103021105049098210003 2)

API 2：Obtaining the user information and his/her all eco-balance information by user account

Method name：Purchase/GetAllEcoBalanceByUserID

Request URL：API_URL/Purchase/GetAllEcoBalanceByUserID
Input Parameters：

Items	Parameter name	Data Type	Description	Not null
1	user_account	varchar(20)	user account	Yes

Returned value: It can be demonstrated in Section "Global Description" and the latter example.
Request Example：API_URL/Purchase/GetAllEcoBalanceByUserID?user_account=circ4life

(Namely, http://bs.cifuwu.com/api/Purchase/GetAllEcoBalanceByUserID?user_account=circ4life)

API 3：Obtaining the total eco-debits of one user by user account

Method name：Purchase/GetTotalEcoDebitsByUserID

Request URL：API_URL/Product/GetTotalEcoDebitsByUserID
Input Parameters：

Items	Parameter name	Data Type	Description	Not null
1	user_account	varchar(20)	user account	Yes

Returned value: It can be demonstrated in Section "Global Description" and the latter example.

Request Example：
API_URL/Purchase/GetTotalEcoDebitsByUserID?user_account=circ4life

(Namely,
http://bs.cifuwu.com/api/Purchase/GetTotalEcoDebitsByUserID?user_account=circ4life)

API 4：Obtaining all eco-debits information of one user by user account

Method name：Purchase/GetAllEcoDebitsByUserID

Request URL：API_URL/Purchase/GetAllEcoDebitsByUserID
Input Parameters：

Items	Parameter name	Data Type	Description	Not null
1	user_account	varchar(20)	user account	Yes

Returned value: It can be demonstrated in Section "Global Description" and the latter example.

Request Example：
API_URL/Purchase/GetAllEcoDebitsByUserID?user_account=circ4life

(Namely,
http://bs.cifuwu.com/api/Purchase/GetAllEcoDebitsByUserID?user_account=circ4life)

API 5：Obtaining all purchasing information of one user by user account

Method name：Purchase/GetPurchaseByUserID

Request URL：API_URL/Purchase/GetPurchaseByUserID
Input Parameters：

Items	Parameter name	Data Type	Description	Not null
1	user_account	varchar(20)	user account	Yes

Returned value: It can be demonstrated in Section "Global Description" and the latter example.

Request Example：
API_URL/Purchase/GetPurchaseByUserID?user_account=circ4life

(Namely, http://bs.cifuwu.com/api/Purchase/GetPurchaseByUserID?user_account=circ4life)

API 6：Obtaining the total eco-credits of one user by user account

Method name：Recycle/GetTotalEcoCreditsByUserID

Request URL：API_URL/Recycle/GetTotalEcoCreditsByUserID
Input Parameters：

Items	Parameter name	Data Type	Description	Not null
1	user_account	varchar(20)	user account	Yes

Returned value: It can be demonstrated in Section "Global Description" and the latter example.

Request Example：
API_URL/Recycle/GetTotalEcoCreditsByUserID?user_account=circ4life

(Namely,
http://bs.cifuwu.com/api/Recycle/GetTotalEcoCreditsByUserID?user_account=circ4life)

API 7：Obtaining all eco-credits information of one user by user account

Method name：Recycle/GetAllEcoCreditsByUserID

Request URL：API_URL/Recycle/GetAllEcoCreditsByUserID
Input Parameters：

Items	Parameter name	Data Type	Description	Not null
1	user_account	varchar(20)	user account	Yes

Returned value: It can be demonstrated in Section "Global Description" and the latter example.

Request Example：
API_URL/Recycle/GetAllEcoCreditsByUserID?user_account=circ4life

(Namely,
http://bs.cifuwu.com/api/Recycle/GetAllEcoCreditsByUserID?user_account=circ4life)

API 8：Obtaining all purchasing information of one user by user account and purchasing date

Method name：Purchase/GetPurchaseByDate

Request URL：API_URL/Purchase/GetPurchaseByDate
Required Parameters：

Items	Parameter name	Data Type	Description	Not null
1	user_account	varchar(20)	user account	Yes
2	purchasing_date	date	the datetime of purchasing	Yes

Returned value: can be demonstrated in Section "Document Global Description" and the latter example.

Request Example：
API_URL/Purchase/GetPurchaseByDate?user_account=circ4life&purchasing_date=2019-06-14

(Namely,
http://bs.cifuwu.com/api/Purchase/GetPurchaseByDate?user_account=circ4life&purchasing_date=2019-06-14)

API 9：Obtaining all purchasing information of one product by product ID

Method name：Purchase/GetPurchaseByProductID

Request URL：API_URL/Purchase/GetPurchaseByProductID
Required Parameters：

Items	Parameter name	Data Type	Description	Not null
1	product_id	varchar(50)	the product id of purchasing	Yes

Returned value: can be demonstrated in Section "Document Global Description" and the latter example.

Request Example：

API_URL/Purchase/GetPurchaseByProductID?product_id=p0001
(Namely, http://bs.cifuwu.com/api/Purchase/GetPurchaseByProductID?product_id=p0001)

API 10：User login authentication

Method name：User/Checklogin
Request URL：API_URL/User/Checklogin
Required Parameters：

Items	Parameter name	Data Type	Description	Not null
1	user_account	varchar(20)	user account	Yes
2	user_pwd	varchar(20)	user password	Yes

Returned value: can be demonstrated in Section "Document Global Description" and the latter example.
Request Example：API_URL/User/Checklogin?user_account=circ4life&user_pwd=circ4life
(Namely,
http://bs.cifuwu.com/api/User/Checklogin?user_account=circ4life&user_pwd=circ4life)

API 11：Obtaining User Information

Method name：User/Userinf
Request URL：API_URL/User/Userinf
Required Parameters：

Items	Parameter name	Data Type	Description	Not null
1	user_account	varchar(20)	user account	Yes

Returned value: can be demonstrated in Section "Document Global Description" and the latter example.
Request Example：API_URL/User/Userinf?user_account=circ4life
(Namely, http://bs.cifuwu.com/api/User/Userinf?user_account=circ4life)

The above APIs are the major interfaces for app programming for the communication with the web server. For more information about the other auxiliary programming interfaces, please see the Appendix 2.

2.7 Recycling

This module is to inform the consumer of the location/schemes of recycling EoL products, allowing the consumer to obtain eco-credits through recycling/reuse activities.

A QR code is acquired from the user database in the ICT platform, which is shown on a card or a mobile phone, as shown in Figure 11. The consumer scans the QR code using the reader on the intelligent bin, in order to proceed with recycling. With the eco-account, the consumer can track eco-credits of the products recycled. The above function has been achieved in the current test version of mobile app.

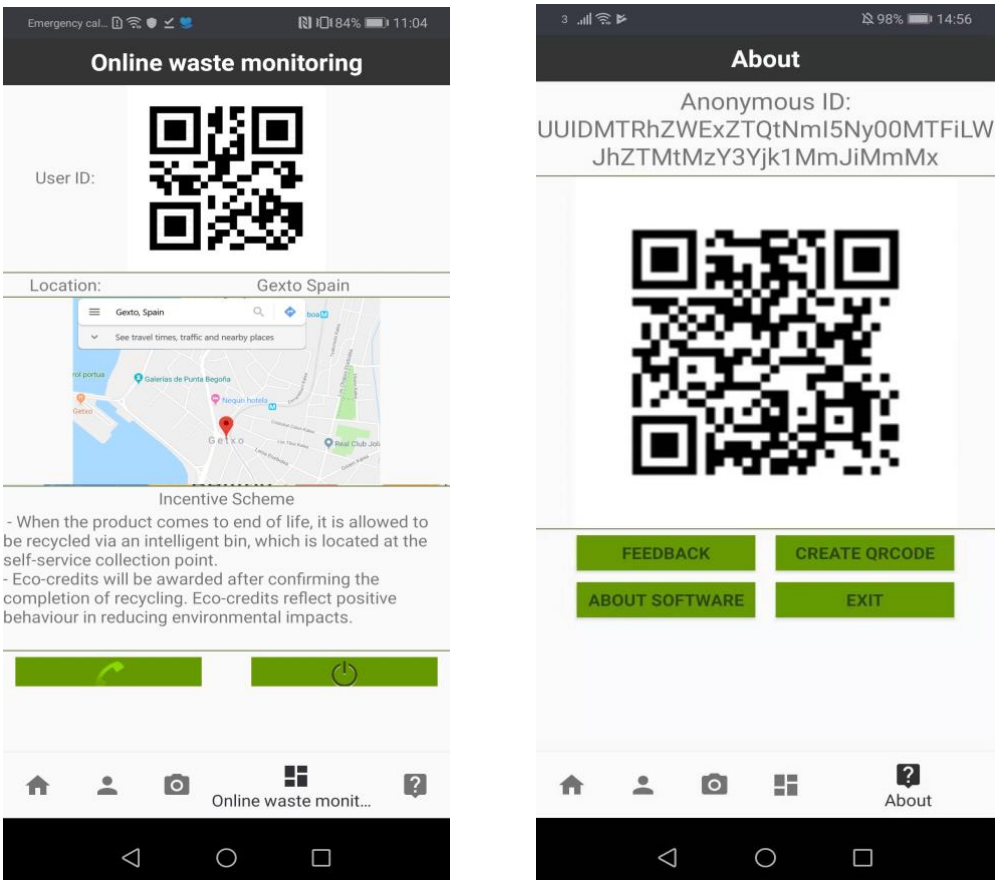


Figure 11. recycling scheme and QR code shown in mobile app

3. Example: Product scanning with Android mobile phone and mock-up server

Figure 12 presents the implantation flow of scanning product barcode, based on Android mobile phone and the RESTful web service, which illustrate the interaction between the mobile app and a mock-up web server (local).

To test and evaluate the real process within the workflow, an Android phone and a mock-up server computer were utilised. The test started with clicking the button “scan product” in the first interface to trigger the phone camera. The camera on the mobile phone is enabled to scan the barcode (i.e. GS1-128 barcode) attached to a product (i.e. sausage) in order to get its *product ID,* as shown in Figure 13. Then the *product ID* obtained, as an input parameter, is used to retrieve the product's detail information from the remote database based on the API for reading product data. When the corresponding product information was obtained successfully, the mobile app can display the information on the phone screen properly.

The product data and eco-account information arise from the testing data used in the case study, which are utilised to test the functions of the app, check if the app works and to be tested by other partners, so comments and suggestions can be collected. Real data will be

able to be acquired via the connection to the central database of the ICT platform during the on-site demonstration.

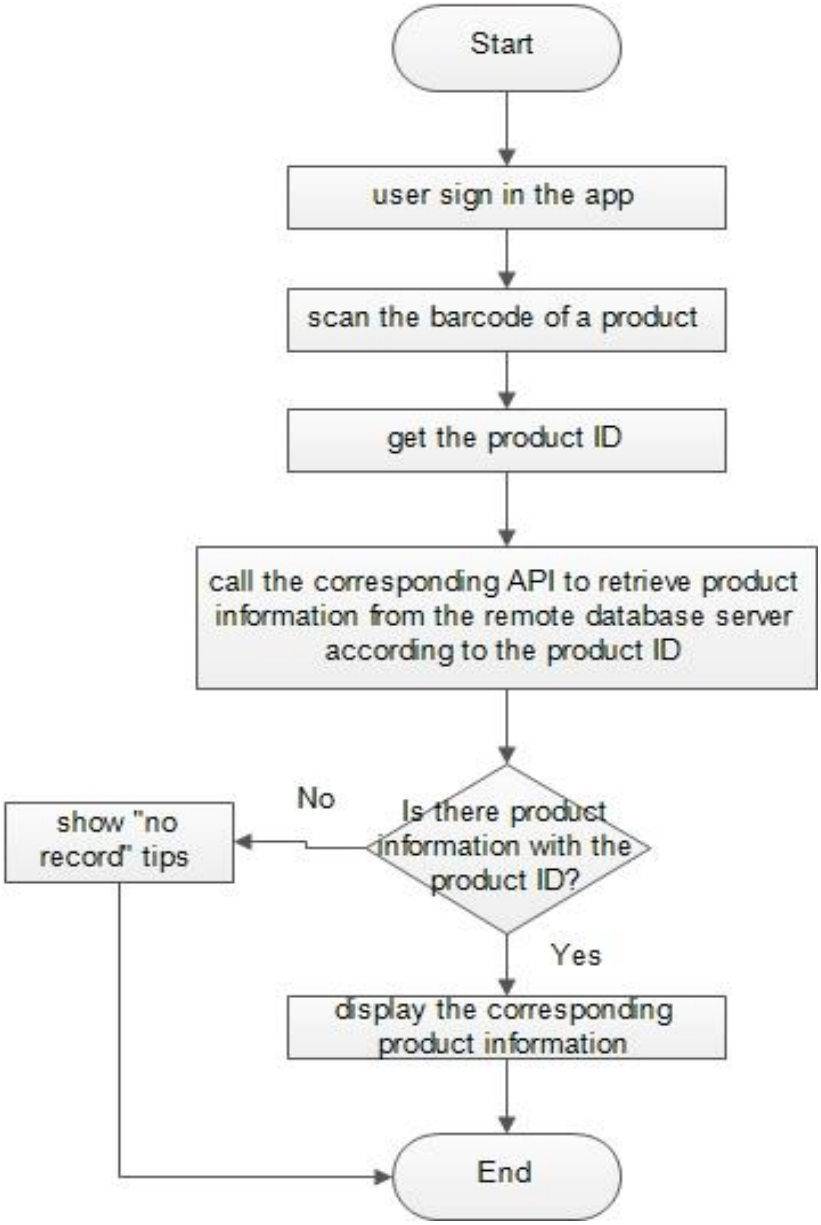
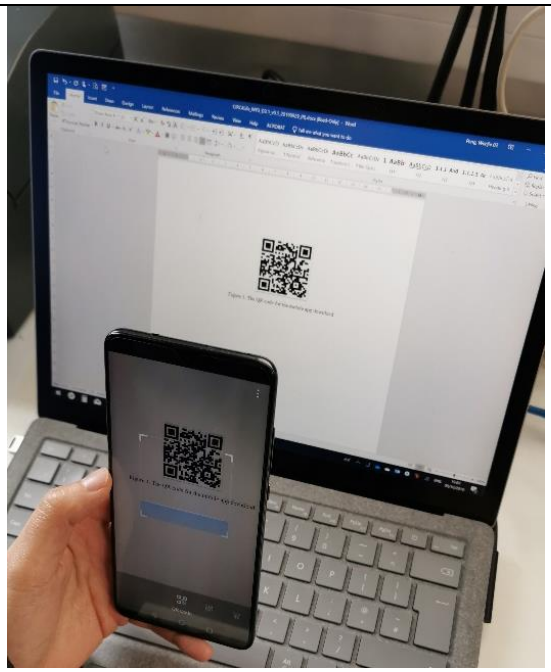
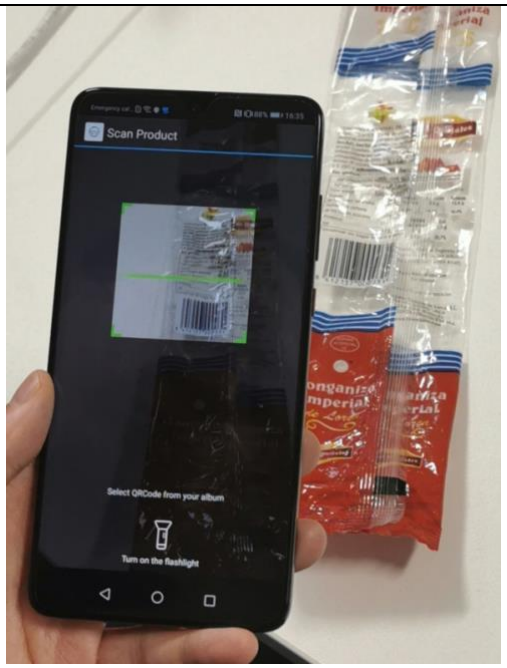


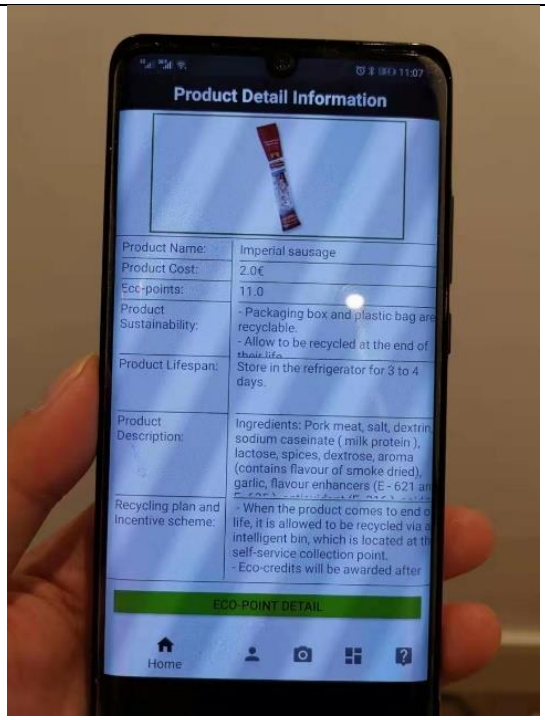
Figure 12. The workflow diagram of product scanning with Android mobile phone and mock-up server



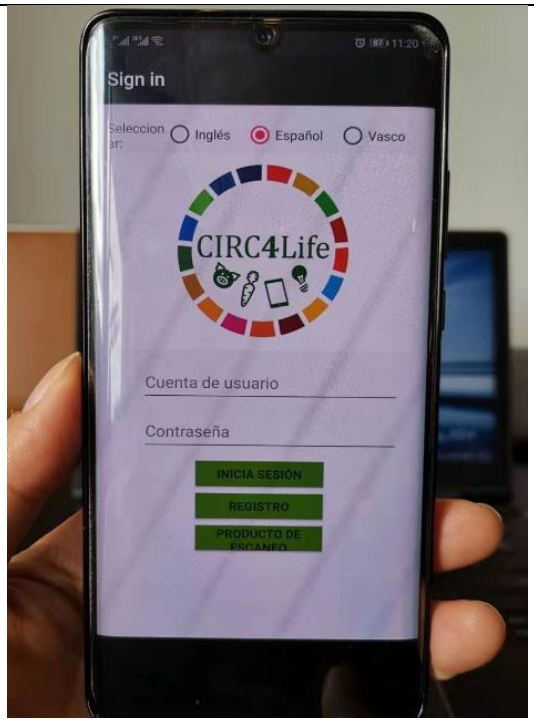
(a) Download the mobile app via QR code



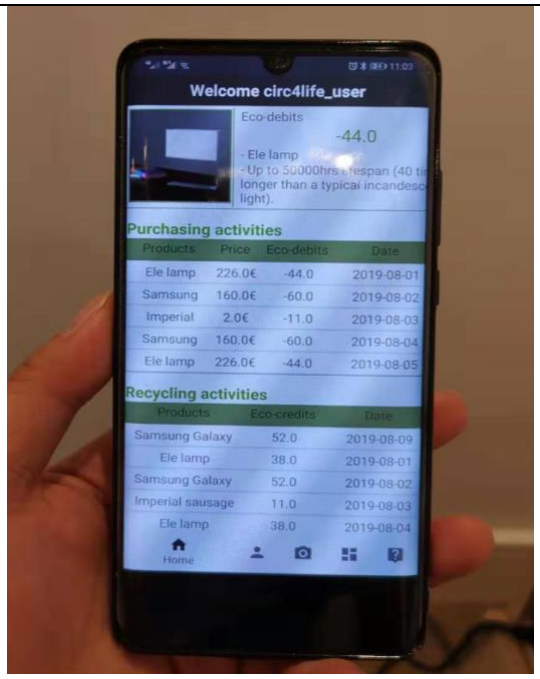
(b) Scan the barcode of a product



(c) Get eco-points via the barcode



(d) user sign-in



(e) Get purchasing and recycling details

(f) Eco-balance

Figure 13. Retrieving the information of eco-account and product eco-information

To support multi-language application, the mobile app is provided with the options of the three languages: English, Spanish, and Basque, as shown in Figure 13 (d).

4. Retailer tool for accounting of consumer purchasing

This section presents the development of the retailer tool for consumer purchasing.

4.1 Overview

In the implementation of eco-shopping, there will be the two systems in the shop (see Figure 14): CIRC4Life eco-shopping system and shop's existing accounting system, which are separate and will not affect each other. The shop assistant is to work on the two systems.

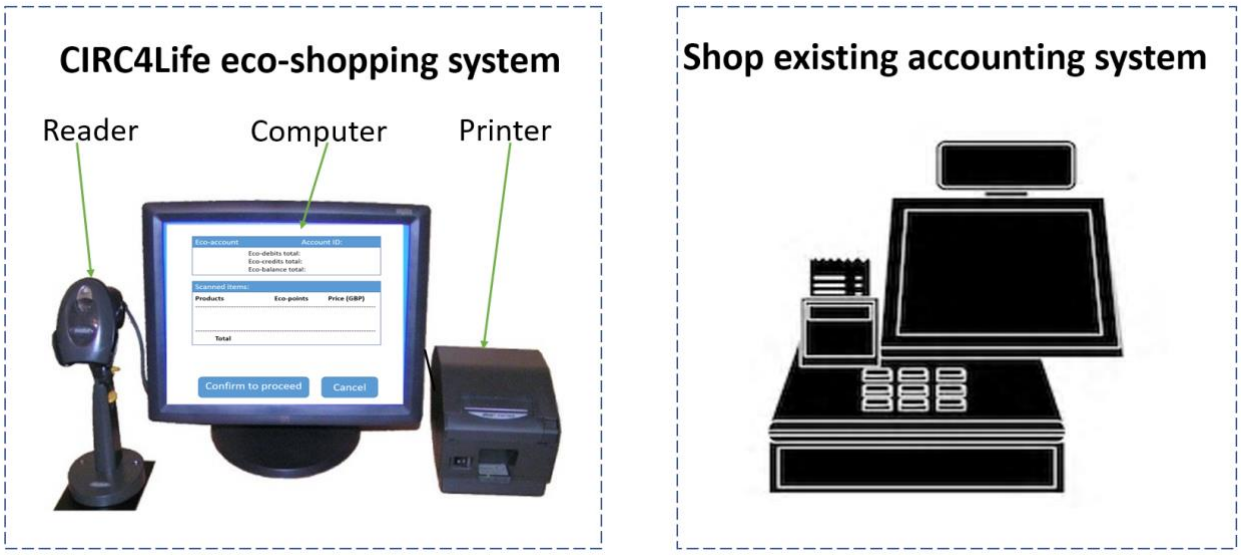


Figure 14: CIRC4Life eco-shopping system and the existing accounting system

The operation procedure of the eco-shopping system includes:

- At the check-out point, consumer scans the QR code shown on the ID card or mobile phone though the reader, which allows the consumer to gain access to the eco-account.
- The shop assistant scans the barcode attached to the product with the reader, to get the product eco-points.
- The printer prints out the customer receipts showing both cash payment information and the eco-debits related to each item purchased.
- The system will record the eco-debits of products into the consumer's eco-account located at the ICT platform. The eco-balance will be updated in real time, in order to reflect the purchasing activity in real life.
- Cash payment will be made by the shop's existing cashing system.

The computer programming languages used in the software development include: (1) PHP (Hypertext Preprocessor) for software code development; (2) Javascript for barcode scanning interface development; (3) MySQL for database development; (4) CSS (Cascading Style Sheets) for web style definition.

4.2 Example: printing a receipt showing eco-debits of products purchased

The system test is conducted with an example of printing a receipt, which shows the cash payment information, eco-debits of each item purchased, and eco-account information.

Figure 15 shows the user interface of the software shown in the computer where the retail assistant will operate.

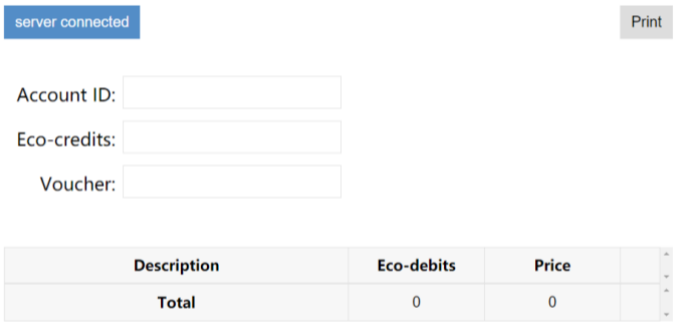


Figure 15. User interface of the software in the retailer's computer

When scanning the QR code shown in the consumer's ID card, the computer shows the consumer's ID and eco-account information (see Figure 16).

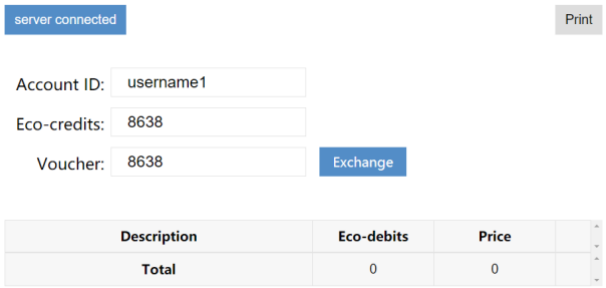


Figure 16. Eco-account information shown after scanning the consumer's ID card

After scanning the barcode of the product, the computer shows the eco-debit information, and description and price of the product (see Figure 17).

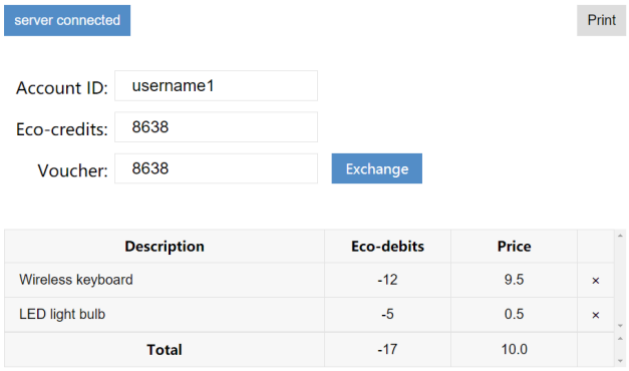


Figure 17. Eco-debit and product information shown after scanning the product barcode

With selecting "print" button, the system will calculate the total amount of eco-debits and then print out the receipt, as shown in Figures 18 and 19.

The receipt contains the following parts: (1) Eco-account information (eco-credits total, eco-debits total, and eco-balance total); (2) Eco-debit and cash payment information of each item purchased.

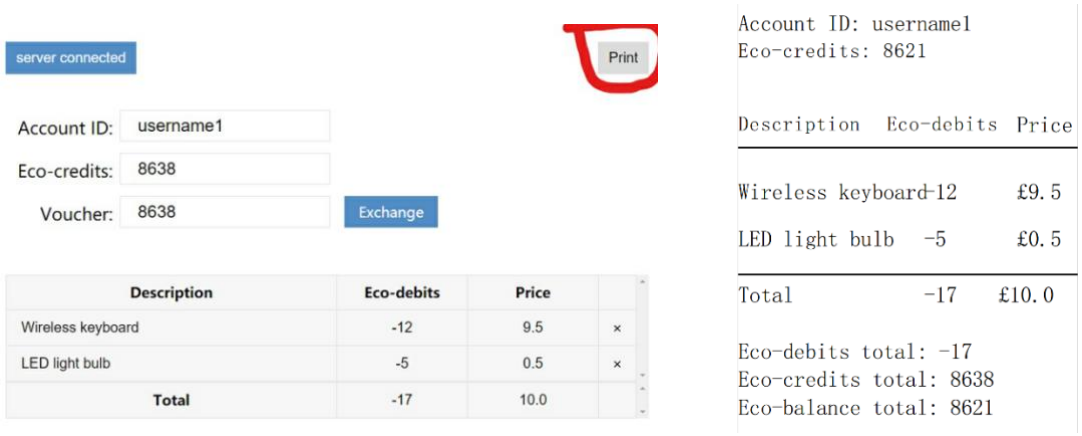


Figure 18. Calculating the total amount of eco-debits and printing the receipt

Figure 19. receipt showing both the eco-points and cash payment information

5 Concluding remarks

The development of eco-shopping and consumer eco-account tools has been reported in this document. Based on the requirements of functionality of mobile app, which is stated in DoA of GA [1], the first test version of consumer mobile phone app is developed, which is now available in the project sharepoint and can be downloaded via QR code. The mobile app developed has been demonstrated with an example of scanning product attached by the traceability barcode, showing that the software works and provides the necessary information for consumers to select sustainable products. The mobile app will be further developed/improved through the integration with the ICT platform. At the demonstration stage, the mobile app will be applied to be demonstrated with real product information data, via the connection with the central database.

The retail tool for accounting of consumer purchasing is to be developed, which will be separate with the shop's existing cashing system. At the demonstration, the two system will

be applied, and a retail assistant is needed to operate the two systems during the purchase process. The retailer tool will be developed with barcode scanning and receipt printing methods, via the interaction with the ICT platform.

Consumers are to check the eco-points on their computers through the product website. This function will be achieved in the implementation stage when all product eco-points are acquired. The relevant contents are to be included in the report on the on-site demonstration.

References

[1] EU H2020 CIRC4Life Grant Agreement (number: 776503)

[2] Resources and Education, URL:https://www.gs1-128.info,2019.9.20

Appendix 1

Specification of GS1 barcode

GS1 provides a so called “Global Company Prefix” to identify a Supplier. The supplier can define “Item References” to create a EAN13 (or GTIN). EAN13 is the GCP & the Item Reference resulting in a 13-digit EAN13, the last digit being a check digit. Example: 4002372209810 The more important part from my experience is the concept of Application Identifiers (AIs) in the GS1 Barcode data.

The AIs are a prefix to the encoded Data. As an Example, the Global Trade Idem Number (GTIN) is a 14digit Number identifying a Product/Article identified by the AI (01). In Europe the EAN13 is the common Article Identifier. The corresponding GTIN is the EAN13 with a leading zero. Please be aware that the last digit of the EAN or GTIN is a check digit. If you, for example are having a product with EAN 4002372209810 (this identifies a Notebook Size DIN A5) the representation as a GS1-128 or Databar barcode would be 0104002372209810 or for better readability on the label usually printed as (01)4002372209810. The brackets are NOT encoded to the Barcode itself.

In our case, as we want to identify an individual product or a Batch of a product, there should be AI(21) as the serial or the AI(10) as the Batch/Lot-Number. These are both variable length identifiers with up to 20 characters terminated by “Function Code 1” (FNC1) as the delimiter for variable length AIs.

Our example could be 0104002372209810211234567890ABCDE[FNC1] resulting in a GS1-128 Barcode like this:

You can create own examples e.g. here:
GS1 128 https://barcode.tec-it.com/en/EANUCC128?data=0104002372209810211234567890ABCDEF\F (use “\F” to create FNC1)
GS1 Databar (Expanded) : https://barcode.tec-it.com/en/RSSExpanded?data=0104002372209810211234567890ABCDEF\F

For Example, Software has to decode like this:

- I found "01", the following is the 14digit GTIN and read out these 14 digit number as the GTIN (
- If there is more: check the next (up to four) digits and check for known AIs.
- Depending on the AI identified proceed to read the next Number.
- I found (21) read the following as the Serial until FNC1 appears.
- Proceed to the next AI …

For a quick introduction, Wikipedia is a start: https://en.wikipedia.org/wiki/GS1-128

Appendix 2

The secondary APIs for app development for the communication with the application server are detailed as follows:

API 12 ： Checking User Account

Method name： User/Checkuseraccount

Request URL： API_URL/User/Checkuseraccount
Required Parameters：

Items	Parameter name	Data Type	Description	Not null
1	user_account	varchar(20)	user account	Yes

Returned value: can be demonstrated in Section “Document Global Description” and the latter example.
Request Example： API_URL/User/Checkuseraccount?user_account=circ4life
(Namely, http://bs.cifuwu.com/api/User/Checkuseraccount?user_account=circ4life)

API 13 ： Checking User Email

Method name： User/Checkuseremail

Request URL： API_URL/User/Checkuseremail
Required Parameters：

Items	Parameter name	Data Type	Description	Not null
1	user_email	varchar(255)	user account	Yes

Returned value: can be demonstrated in Section “Document Global Description” and the latter example.
Request Example： API_URL/User/Checkuseremail?user_email=circ4life@qq.com
(Namely, http://bs.cifuwu.com/api/User/Checkuseremail?user_email=circ4life@qq.com)

API 14 ： Adding User Information (User Registration)

Method name： User/AddUser
Request URL： API_URL/User/AddUser
Required Parameters：

Items	Parameter name	Data Type	Description	Not null
1	user_account	varchar(20)	user account	Yes

Items	Parameter name	Data Type	Description	Not null
2	user_pwd	varchar(20)	user password	Yes
3	user_email	varchar(255)	user email	No

Returned value: can be demonstrated in Section "Document Global Description" and the latter example.

Request Example：

API_URL/User/AddUser?user_account=zz&user_pwd=123456&user_email=dd@qq.com (Namely, http://bs.cifuwu.com/api/User/AddUser?user_account=zz&user_pwd=123456&user_email=dd@qq.com)

API 15：Obtaining the detail of one information by id

Method name： Information/GetInformationByID

Request URL： API_URL/Information/GetInformationByID

Required Parameters：

Items	Parameter name	Data Type	Description	Not null
1	id	int(11)	information id	Yes

Returned value: can be demonstrated in Section "Document Global Description" and the latter example.

Request Example：

API_URL/Information/GetInformationByID?id=1

(Namely, http://bs.cifuwu.com/api/Information/GetInformationByID?id=1)