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THE PROVISION OF SUSTAINABILITY INFORMATION FOR ELECTRONIC PRODUCT CONSUMERS THROUGH MOBILE PHONE TECHNOLOGY

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ABSTRACT

Life Cycle Assessment (LCA) studies are designed to be used by designers, manufacturers, engineers and companies, howeverthere are very few that would be readily understood by consumers. This article explores a new perspective of sustainability assessment methods from the retailers' perspective on LCA information and the consumers' viewpoint in order to provide consumers with easy-to-understand and meaningful sustainability information, influence shopping behavior and therefore stimulate industry to manufacture product with less negative environmental impacts. The research presented in this paper explores the potential for providing environmental information to consumers, through the use of a mobile phone application in Near Field Communication (NFC)-enabled phones and NFC tags, and proposes a new eco-label to enable consumers to compare the environmental performance of electronic products and a recycling incentive scheme.

KEYWORDS: Life Cycle Assessment (LCA), Near Field Communication (NFC), Sustainability, Product Category Rules (PCR)

INTRODUCTION

Since 1999 to present, there have been many policies and acts to regulate industry's activities for environmental protection and sustainability such as ISO 14040(2006), which defined that a Life Cycle Assessment (LCA) assesses the environment impacts of a product and the resources used throughout a product's life cycle; from raw material acquisition, via production and use phases, to waste management.

The development of modern products is being decisively influenced by the application of technologies contributing towards increased efficiency; thus the need for tools/methods to monitor and assess the impact of our industrial activities has become crucial.

Paolo Frankl of IstitutoAmbiente Italia states that environmental performance display should not be based on a full LCA (Jensen et al, 1997). However, preserving the confidentiality of commercially sensitive raw data without reducing the credibility of LCAs is also a major problem. Therefore, improving the quality of LCA is crucial in order to make information less complicated for the consumers(Schmidt et al., 2007 and Jensen et al, 1997).

This research proposes to address the research questions by focusing on the following aim: To enhance the understanding of Life Cycle Assessment (LCA) information to the consumers by creating a presentation method for enabling consumers to judge the relative environmental merits of products by using Near Field Communication (NFC) and mobile phone technologies. Through providing products information about the environment, consumers will be better informed and more aware of environmental issues, therefore they may be more likely to purchase products that are making less negative impact environmentally and socially. The first part of the paper explores consumer attitudes to sustainable

products and current environmental indicators assessment and communication. It introduces a Consumer Life Cycle Assessment (CLCA) approach, a method to bridge the gap between technical environmental data and information that consumers need and can understand. CLCA approach will be applied to a case study base on “Computer mice”.

It then proposes a new format of presentation to be used in mobile applications, which gives detailed environmental impact information, product information, Eco-Points, and Energy Consumption; it will allow consumers to compare with other similar products internally.

CURRENT ISSUE OF ENVIRONMENTAL INDICATORS ASSESSMENT AND COMMUNICATION

The World Business Council for Sustainable Development defined eco-efficiency as”the delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity, throughout the life cycle, to a level at least in line with the earth's estimated carrying capacity” (International Institute for Sustainable Development, 2012). Moreover, the earth Summit Conference at Rio (UNCED) informs that all those who are affected by environmental decision-taking should be able to participate and that they should have effective remedies and redress for the wrongs they suffer as a result of environmental degradation (Hughes et al, 2002).

Consumers Attitude to Sustainable Products

WRAP (2010) mentions consumer behaviour is clearly a key element in the phase of selling consumerelectronic products, however, customer had a very low level of understanding about eco- products, and most of the customers think that "Green products "would have lower specifications and a higher price. Therefore, the best way to help consumer's behaviour to change towards sustainability will be developing a method to educate them (Dobson, 2007; Ottman et al., 2006and Young et al., 2010).

Recent evidence suggests that consumers generally wanted more information on eco features before purchase. They were mainly interested in how they could make savings on their energy bills (WRAP, 2010 and Platt et al., 2009). Information provided to customers should include product performance, pricing, packaging and supply chain from sourcing, production and distribution through to the consumption and disposal (Deloittea, 2009). Green shoppers will be a great customer target, representing a high value segment that buys more products on each trip, visits the store more regularly, and demonstrates more brands and retailer loyalty in their purchasing behaviour (Deloitteb, 2009).

The Environmental Labels

Eco-labels is method to provide environmental information to public decision-making introduced by the European Union, which is a symbol designed to encourage businesses to designand create products that meet environmental standards.(Wimmer et al., 2010).The most recent ISO-proposal for a definition of environmental label or declaration is that "communication of a product environmental claim that may take the form of statements, symbols, or graphics on product or package labels, product literature, technical bulletins, advertising, publicity, etc." (Competition Bureau Canada, 2008)

The Gap between LCA Information, Eco-Labels to Consumers

The World Business Council for Sustainable Development (2008) pointed out that many consumers remain confused about which products are better for the environment according to the consumers International and the UK's National Consumer Council report (The World Business Council for Sustainable Development, 2008). There are numerous motivating factors behind the decision to take part environmental issues, many of which are interrelated such as consumer demands, Compliance with legislation, community needs for environmental improvement, security of supply, and product

and market opportunities (Jensen et al, 1997).

The natural tendency with LCAs tried to distil complexity down into single numbers or “scores”, however, LCA is as much an art as it is a science and the LCA reports are extremely technical and very complicatedfor consumers(Esty et al, 2011 and Heiskanen, 2005), so it is very hard to be interpreted by the consumers. Consumers may not take action easily, but they couldbe very powerful in influencing the way businesses and supply chains are running, in terms of how products are designed.

Upham et al. (2009) suggests that to make customer to take more actions, or even make better decision during their purchases of green products,we should make customers to understand the meaning of LCA information quickly and in an easy way.

The existing Eco-labels may be one of thesolutions to increase consumer awareness, however, the most of the consumers are confused by the existing sustainable information. Climate Action (2011) agrees that consumers may be confused or misled by it.

This research will bridge the gap between the technical environmental information and what information consumers actually understand and need to increase transparency and communications with consumers.

CONSUMER LIFE CYCLE ASSESSMENT (CLCA) METHOD

In this research paper, we have developed a new holistic approach ‘Consumer Life-Cycle Assessment’ (CLCA, also called ‘consumer life-cycle analysis’), which is a technique to assess environmental impacts associated with all the stages of a product's life from-cradle-to-grave (i.e., from raw material extraction through materials processing, manufacture, distribution, use, and disposal or recycling). It assesses the environmental impacts associated with identified inputs and releases, interprets the results to help consumers make a more informed decision. It also combines product information (such as brand name, price, etc.), environmental information (such as global warming, acidification, etc.), and other environmental information such as energy consumption and Eco-Points, presenting it in a simple way for the consumers.

Method of LCA Data Collection and Analysis

Product Category Rules (PCR) will be used as a basis of Data Collection; PCRs describe the scope and methodology for performing the LCA. It is a form of guidance and rules for the collection of data and other information, how the calculations should be done to transfer the data to the climate impact and how this information should be presented. This will ensure the data is gathered and functional units are the same, achieving a fair and meaningful comparison between similar products.

The next step is to conduct a product LCA following the PCR and ISO 14040. A range of factors are used to assess a product’s environmental performance, such as materials acquisition and manufacturing phase, packaging and transportation of main components to product manufacturing site, energy product use, and End-of-Life.

The method we will use analyses the data collected by using SimaPro. SimaPro is the most widely used LCA software, used by major industries and consultants, through to research institutes and universities. It allows complex life cycles to be modelled and analysed in a systematic and transparent way. Process LCA will account the energy and material flows, converting those flows into ‘impact categories’ (emissions and wastes to the environment), such as global warming, acidification, etc.

The results can then be used to create our Consumer Environmental Product Declaration (CEPD), which is a comprehensive report detailing the results of the LCA and must contain criteria defined in the PCR, plus additional Eco-Points and product information. CEPD provides credibility, consistency, comparability and transparency.

Although SimaPro is a very sophisticated tool, and it is designed to be used and understood by environmental consultants or specialists; it is not designed for the consumers. Consumers don't typically have the context to understand whether 50 pounds of carbon for a pair of shoes is good or bad (Deloitte, 2009), these raw figures can be difficult for consumers or customers to comprehend. Therefore in our Consumer Life Cycle Assessment approach, we will also re-analyse these figures and convert them into units, which can be easily compared and understood by the consumers.

Format of Presentation

Format of Presentation is a way of presenting all the important information for the consumers, creating a form or type of Eco-label. Information displayed in the Eco-label include Product Information, Environmental information, Energy Efficiency and Eco-Points.

The format of which the information is presented is also crucial. It is important to present sufficient environmental information, which can be easily understood and compared by the consumers during their purchase.

Method for 'Product Information' (PI)

In October 2011 we conducted 50 questionnaires for which we chose 25 males and 25 females aged between 17 to over 60 in Nottingham, UK. This survey is based on gaining insight into consumers' shopping behaviour in the electronic shop. In the questionnaire the questions include customers' considerations when purchasing an electronic product. The survey's result shows that environmental attributes is only one factor considered by consumers in their purchasing decisions, and is usually only factored in one comparable quality and performance has been established.

In practice, when consumers purchase electronic products, they do not only consider the environmental impact, they also take into account the design, price, quality, brand, functions, durability, etc. If an Eco-Display only provides environmental impact information but without product information, it will not be user-friendly and widely used, therefore it will not be the most appropriate method of Format of Presentation for the consumers. We need to have simple and not over-complicated Product Information in the label. We have included product category, brand name, model number, price and expected lifetime in the Product Information. In addition we recommend having a product picture within the Product Information (As it can be seen in the Figure 1).

Figure 1: Interface Design for Product Information

Environmental Indicators (EI)

As PCR already provided guideline to what criteria to include, we can utilise the readily available information as our main Environmental Indicators. By using data from PCR, it is possible to gather comparable information between

similar products and to compile a database. The five main indicators, which we will include in our Eco-Display, will be, global warming, acidification, eutrophication, ozone layer depletion, and summer smog (as shown in Figure 4).

The reason for choosing those indicators is because we need to recognise that the climate change is only one of the dimensions. In the case of some product groups, greenhouse gas emissions are not the most significant environmental aspect, therefore other environmental impacts need to be taken into account as well in order to provide balanced information for consumers on the environmental performance of products. Consequently, we have decided to include at least four of the most important Environmental Indicators in the Environmental Information section of the Eco-Display.

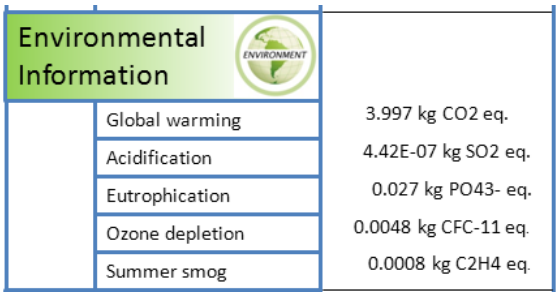


Figure 2: Interface Design for Environmental Information

Environmental Score and 'Smiley Faces' Assessment Method

We have developed the smiley face assessment method to assist consumers with the comparison between products. This method allows consumers to compare the overall environmental impact of the products against each other easily without having to go into the detail of each Environmental Indicator. There are three faces, happy face coloured in green, normal face coloured in orange, and the last one is sad face which is coloured in red.

Colour is an essential part of the world around us. It provides us with important information about our surroundings; it affects the way we feel about, and react to, everyday things (Beaird, J, 2006). Therefore choosing a suitable colour for the assessment will be very important. Green is the colour of nature and safety and used to indicate 'environmental friendly' products. Red is the colour that is associated with danger. Orange can be used to imply warning. The colours are used to emphasise and highlight each emotion, to aid the consumers in interpreting the message instantly.

Figure 3: Smiley Faces Designs

In addition, global warming is one of the most important indicators, CO2 is a big contributor to environmental damage, and therefore this indicator should be weighted more to the total score. For the comparison of products' environmental information it is decided that whichever product has a lower global warming figure, it will receive 2 points. Subsequently each product's score will be added up to give a total; the product with the higher total will receive the happy face, and the product with the lower total score will receive the sad face. The consumers do not see this background calculation. Consumers will only see the results (happy face or normal face or sad face) of this assessment.

For example, when computer mouse 1's acidification indicator figure is lower when compared to computer mouse2 and computer mouse 3, it means it is more friendly to the environment, therefore it receives 1 point, computer mouse 2 receives 0.5 point and computer mouse 3 receives 0 point (Figure 4).

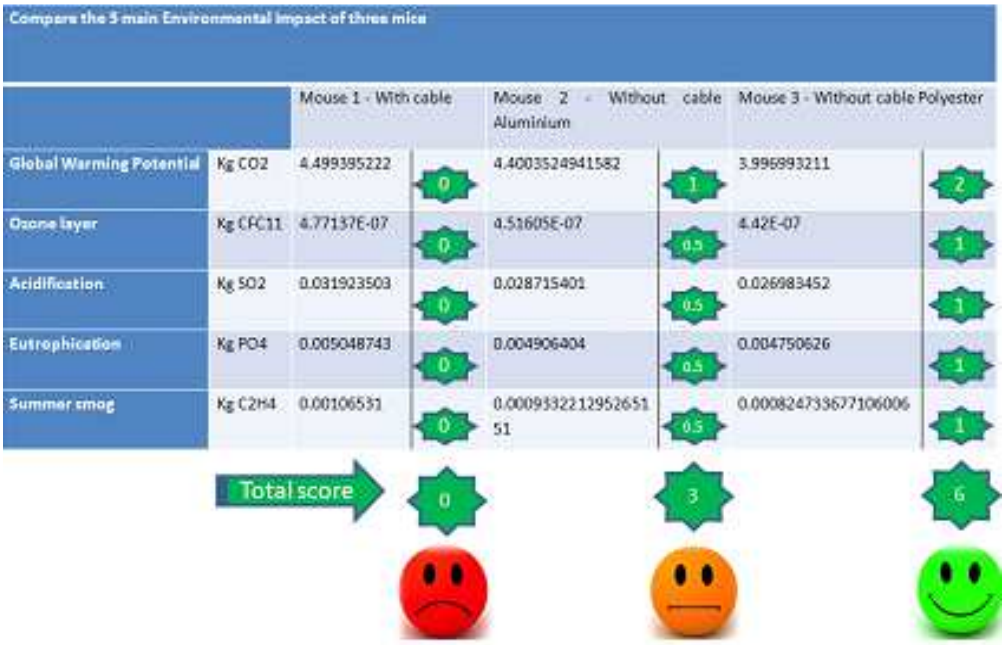


Figure 4: Comparison of Five Main Enviromental Impact

Energy Consumption with Thumbs up/down Assessment Method

The energy consumption of a product in the use phase is determined by three factors: its power demand, usage patterns and estimated functional lifespan. Calculation for Energy Consumption associated with the use phase will vary from one product category to another.

For a desktop computer mouse its time of use is directly proportional to the desktop computer use, thus the guideline in the Energy Star Program Requirements for computer equipment willbe followed (Primax electronics, 2011). In accordance with the Energy Star Program Requirements for Computers, the Typical Energy Consumption (TEC) is calculated as:

$$\mathbf{E_{TEC} = (8760/1000) \times (P_{Off} \times T_{Off} + P_{Sleep} \times T_{Sleep} + P_{Idle} \times T_{Idle}) \times 3.6}$$

P_{off} = Measured power consumption in Off Mode (W)

P_{sleep} = Measured power consumption in Sleep Mode (W)

P_{idle} = Measured power consumption in Idle Mode (W)

T_{off} = Values are percentage (%) of time within a year in Off Mode

T_{sleep} = Values are percentage (%) of time within a year in Sleep Mode

T_{idle} = Values are percentage (%) of time within a year in IdleMode

E_{TEC} = Expressed Typical Energy Consumption

E_{LTY} = Expected Life Time Years

The unit for E_{TEC} is MJ (1.0 kilowatt-hour (kWh) = 3.6 MJ), the Px are measured values for the computer mice corresponding with usage of desktop computers in units of W. The Tx values are percentage (%) of time within a year the product is in the specific state.

The annual energy consumption in kWh per Life Time Year for desktop computer mice can be calculated as:

$EC = E_{TEC} / E_{LTY}$

EC= Energy Consumption

*With regard to Px (Poff, Psleep and Pidle), they are measured and provided by the manufacturer, in units of W.

For example, In the average of time within a year for computer mouse use in Off Mode is about 55%, for mouse use in Sleep Mode is about 5%, for mouse use in Idle Mode is about 40% (Primax electronics, 2011).

Mouse 1's Measured Consumption is

Poff=0.05W, Psleep=0.2W, Pidle=0.5W

E_{TEC} = (8760/1000) × (0.05W × 55% + 0.2W × 5% + 0.5W × 40%) =0.2375

EC=0.2375/3= 0.6935 kWh/LTY

Mouse 2's Measured Consumption is

Poff=0W, Psleep= 0.0018W, Pidle= 0.06W

E_{TEC}= = (8760/1000) × (0W × 55% + 0.0018W × 5% + 0.06W × 40%) =0.21031884

EC=0.21031884/4= 0.05257971 kWh/LTY

Mouse 3's Measured Consumption is

Poff=0W, Psleep= 0.0018W, Pidle= 0.03W

E_{TEC} = (8760/1000) × (0W × 55% + 0.0018W × 5% + 0.03W × 40%) =0.10519884

EC= 0.10519884/3= 0.03506628 kWh/LTY

From the results of the calculation we can see that mouse 3 has smaller energy consumption in expected lifetime, thus, the consumer can save more energy during the product's use stage. However, some consumers might find the numeral figures slightly confusing, therefore we decided to create graphic figures, which could be easily understood by anyone who uses this method to compare the products' energy consumption.

We decided to use the design of coloured 'thumbs up' and 'thumbs down' since we believe it is an almost universally used gesture for expressing the approval or disapproval (Siljerud, 2008). We also believe these graphic figures may also have the ability to fulfil the needs of elderly or people with problematic eye vision.

Method of measuring the products: When two products are compared, the lower the "Energy Consumption per year per Life Time Year" is, the better the product may be seen; therefore the lower figure will be given a Thumbs Up, the higher figure will be given a 'Thumbs Down'. If more than two products are compared, the middle high figure of products will be given a sign 'Thumbs in the middle'. The purpose is to take products' Expected Life Time into account when dealing with electronic products in use stage, to educate the consumers as well as increasing the awareness for the makers of these products as shown in Figure 5.

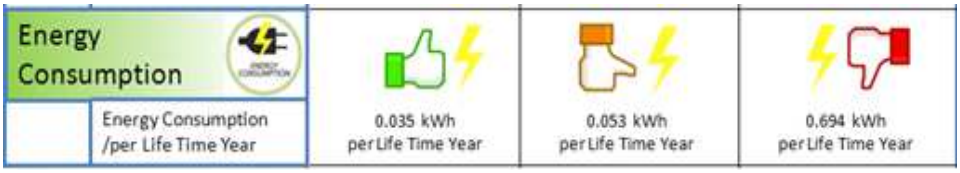


Figure 5: Thumbs up/down Assessment Designs

Eco-Points (EP) Calculation Method

The Eco-Points is a loyalty and reward schemedesigned to motivate consumers to recycle their EoL (End of Life)electronic products.

The Equation

MRV (Maximum Reward Value) = Product's price × 10%

Eco-Points = (MRV) × Recyclable Content (RC) %

* We set one pence is equal to one Eco-Point

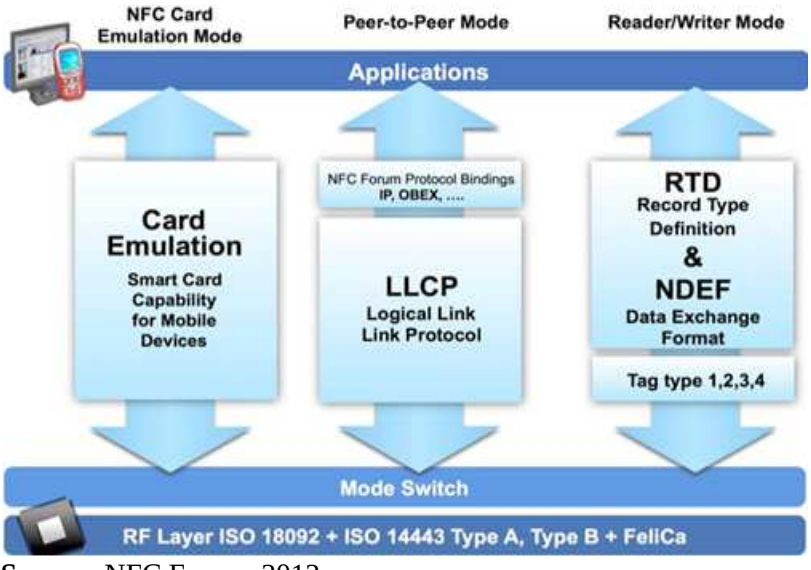
The price of mouse 1 is £12.99, the price of mouse 2 is £59.00, and the price of mouse 3 is £14.99.

- Eco-Points for Mouse 1: 96 Points = (1299 × 10%) × 74%
- Eco-Points for Mouse 2: 437 points = (5900 × 10%) × 74%
- Eco-Points for Mouse 3: 120 points = (1499 × 10%) × 80%

NFC Mobile Technology Communication Method

Mobile phones have become ubiquitous, and handheld computers such as smart phone have become commonplace technology. Using mobile devices it is now possible to perform most tasks normallyon a stationary computer, such as browsing the web, reading and sending email, retrieving information, royalty programme and communicating in real-time with other people. Near Field Communication (NFC) allows for simplified transactions, data exchange, and connection between two devicesby touching them together. A smartphone with an NFC chip could make a credit card payment or serve as key card or ID card. NFC device can read NFC tags on a museum or retail display to get more information or an audio or video presentation (Roebuck, 2011). NFC is working in the frequency band of 13.56 MHz and is compatible with ISO/IEC standards 14443 (proximity cards), 15693 (vicinity cards) and Sony's FeliCa contactless smart card system. Enhanced Near Field Communication (eNFC) can support the standards ISO/IEC 14443B (e.g. Philips MIFARE) and ISO/IEC 15936 (RFID tags) (Falke et al, 2007).

NFC forum (2012) defined that NFC technology have currently three usages of NFC mobile devices (Figure 6):



Source: NFC Forum, 2012

Figure 6: NFC Phone Usage Modes

Emerging NFC standards allow customers to quickly purchase products and transfer secure information by touch devices. In May 2011, Google announced Google Wallet, an Android application that will make use of NFC to make payments at stores. The card information will be stored in the application and will be used to make the transactions (Roebuck, 2011).Android is a Linux-based mobile phone operating system developed by the Open Handset Alliance led by Google (Karch, 2011). Merchant 360 CEO Steve McRae said "we decided to release this as a solution allowing any Android developer to get engaged with NFC technology and increase adoption"(Clark, 2011).

NFC already deployed in some Android mobile devices and currently international handset makers such as Samsung, HTC, Motorola, LG, Acer and Sony Ericsson all have announced Android NFC mobile phone (NFC world, 2012). Therefore Android platform has been chosen for the implementation of the prototypes.

Proposed System for NFC Eco-Display

Providing a mobile phone application"Eco-Display Mobile App" supports the comparison of environmental merits between similar electronics products. This application allows consumers touseNFC enabled phones by touchingNFC tag, which gives detailed environmental impact information, product information, Eco-Points, and Energy Consumption which will allow consumers to compare with other similar products internally during their purchasing process.

The system will work in the following procedure: (Overall of NFC Eco-Display System shows on Figure 7).

Customer can find the Eco-Display Mobile App from Google Android market then install to their Near Field Communication enabled phones. During the process of installation of this application, there will be running an automatic download of latest inventory database. Customers use their Near Field Communication enabled mobile phones to touch NFC tag in the retail shelf next to the product they wish to see.

Foreground Activity Dispatch System will force "Eco-Display Mobile App"to be automaticallyopened; the system will also check the receiveddata, if it matches, this application will deal with data content. When NFC tag's data matches one of products from inventory database, then the detailed environmental impact information, product information, Eco-Points, and Energy Consumption will be displayed on the mobile phone.

Customers can use this application's comparative function to compare a certain product with other similar products internally, during purchasing process.

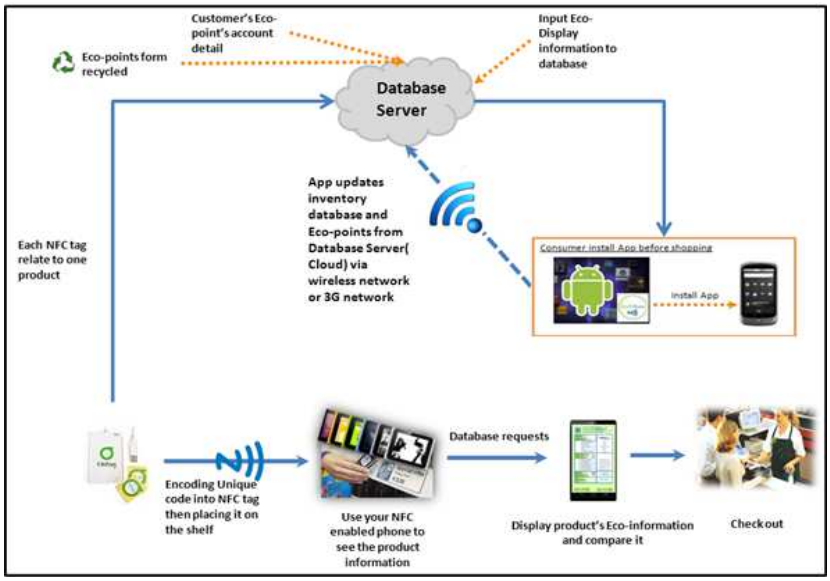


Figure 7: NFC Eco-Display System form Install to Use in the Retail Shop

APPLYING RESULT TO ECO-DISPLAY

Database Design

In order to achieve CLCA database system, we created a CLCA database by Structured Query Language (SQL)which includes designing the structure for the relational database, the logical systemdesign of CLCA database, and physical system design which links the database system to NFC enabled mobile phone.

The figure below is the initial draft of the database design; it shows each ID number relating to a certain device and each device relates to four data types such as product images, manufacturer information, Eco-impact information and product category.

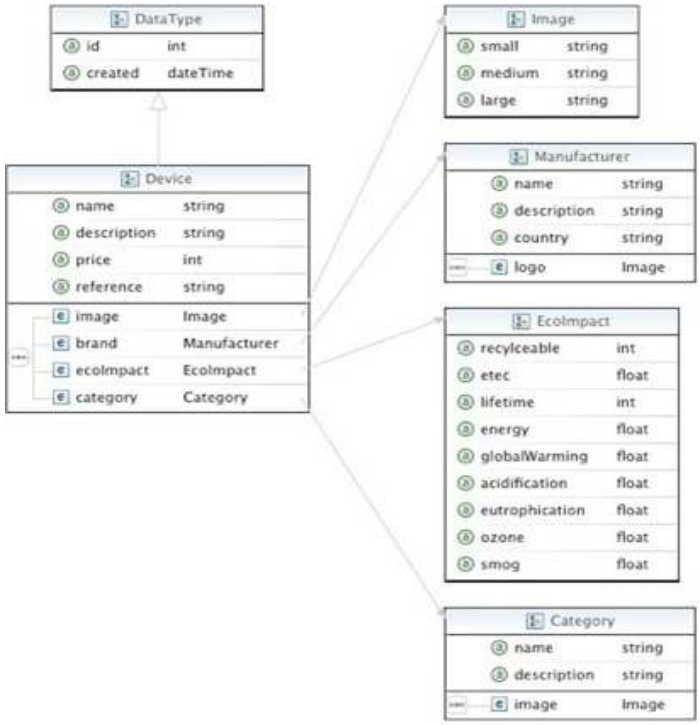


Figure 8: The Initial Draft of the Database Design

The Process of Programming

Information on the NFC tag is encoded in the raw byte; therefore, to make information appear to the user, the data written to the NFC tag should transform byte data to program readable format. In order to ensure that the information can be read by Android NFC-enabled mobile phone, the main format use to read and write data on tags must qualify to NFC Data Exchange Format (NDEF)standard (Android Developers,2012).

When we started to develop Eco-display application for Android NFC mobile phone, in the first step we setup “AndroidManifest.xml file”. As shown below:

- To use the NFC API, applications must request permission from the user by declaring <uses-permission android: name="android.permission.NFC"> in their manifest files.
- We set up the minimum version of Google APIs should be in “10”. <uses-sdkandroid:minSDKVersion=”10”/ >.
- We set up the “users feature” must have NFC faction. <uses-feature android: name = “android minSDKVersion=”10”/ >.
- We set up the “Intent Filter” ask Android system which Application can deal with NFC data.

```
<intent-filter>


<action android: name="android. Nfc. Action.
TAG_DISCOVERED" />

<category android: name="android. Intent. Category.
_DEFAULT" />

</intent-filter>
```

Figure 9: Xml for Intent Filter

In addition, we chose"Foreground Activity Dispatch System", which is a system used to notify about a matching application. We use this system because we want the customer using their NFC-enabled mobile phone to touch NFC tag in the retail shelf next to the product they wish to see.

After touching the NFC tag, "Eco-Display Mobile App" willautomatically open, which could save customer's time to run the application.

Moreover, to make NFC application deal with the content of 'TAG_DISCOVERED', this application must have an AndroidManifest.xml file (with precisely that name) in its root directory.

The manifest presents essential information about the application to the Android system; without this information there cannot be run any of the application's code. The example of source code is shown on the figure below.

```
01 NdefMessage [ ] getNdefMessages (Intent intent) {
02      // analyse intent
03     NdefMessage [ ] msgs = null ;
04     String action = intent . getAction ( ) ;
05     if  (NfcAdapter . ACTION_TAG_DISCOVERED. Equals (
action)) {
06          Parcelable[ ] rawMshs =
07                    intent . GetParcelable.ArrayExtra ( Nfcadapetr .
EXTRA_NDEF_MESSAGES) ;
08          if (rawMsgs != null) {
09               msgs = new NdefMessage[ rawMsgs . length ];
10               for (inti = 0; i<rawMsgs . length; i++) ;
11                    msgs[ i ] = (NdefMessage)  rawMsgs[ i ]
12               }
13          }
14          else {
15          // unknown tag type
16             byte [ ] empty = new byte[ ] {} ;
17           NdefRecord record = new NdefRecord (NdefRecord
.TNF_Unknown , empty, empty,
empty) ;
18                NdefMessagemsg  =  new NdefMessage ( new
NdefRecord [ ]   { record } ) ;
19                msgs = new NdefMessage [ ] {msg } ;
20          }
21     }
22     else {
23          Log . e ( TAG ,  "unknown tag type" + intent ) ;
24          finish ( ) ;
25     }
26    return msgs ;
27 }
```

Figure 10: Xml Code for Tag Discovered

Furthermore, we created"Pending Intent" object used when the mobile phone touches NFC tag; Android system can readthe tag's detail. Then Application will request the database to deal with product ID which is matched to the tag.

```
PendingIntentpendingIntent = PendingIntent.getActivity(
this, 0, new Intent(this,
getClass()).addFlags(Intent.FLAG_ACTIVITY_SINGLE_T
OP), 0);
```

Figure 11: Xml Code for Pending Intent

Then, the “Foreground Activity Dispatch System” will check the intent and received data, if they match, our application will deal with intent. The source code form the figure 14 deals with all MIME types.

```
IntentFilter ndef = new
IntentFilter(NfcAdapter.ACTION_NDEF_DISCOVERED);
try {
ndef.addDataType("*/*");    /* Handles all MIME based
dispatches.
                            You should specify only the ones that
you need. */
   }
catch (MalformedMimeTypeException e) {
throw new RuntimeException("fail", e);
   }
intentFiltersArray = new IntentFilter[] {ndef, };
```

Figure 12: Xml Code for Foreground Activity Dispatch System

User Interface Design for Eco-Display Mobile Application

User interface is everything that the user can see and interact with; therefore, we begin forming the design of the application’s layout with a size of display expressed in a width and a height, and size of texts and images, which will be shown in the application. User experience is another key factor for mobile application development; this application is mainly aimed to provide consumers with easy-to-understand and comparable sustainability information during their purchase. Therefore, this application should be not too complicated for user.

The information shown in the Eco-Display application includes that the product’s information, environmental information, and Eco-Points from the product have been selected. As shown in Figure 13.Figure 14 and Figure 15, user can also use their fingers to swipe down to see energy consumption’s information. This application also allows customer to swipe the view to horizontal paging (Figure 16).

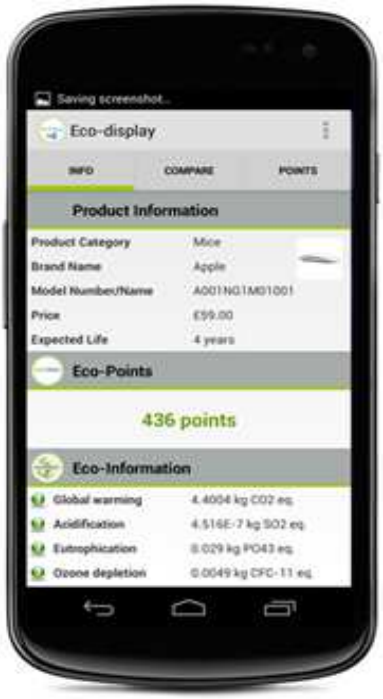


Figure 13: Product Information in Eco-Display App

Figure 14: Moving Finger to See More Information

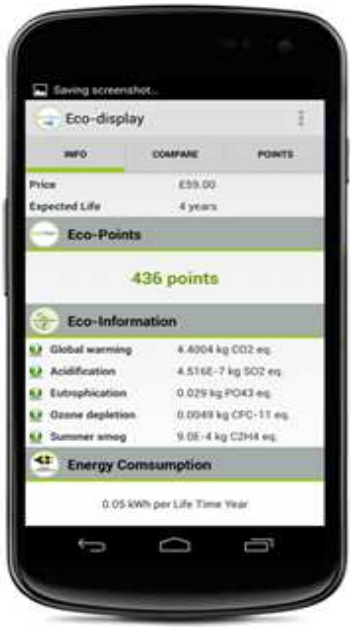


Figure 15: More Product Information in Eco-Display App

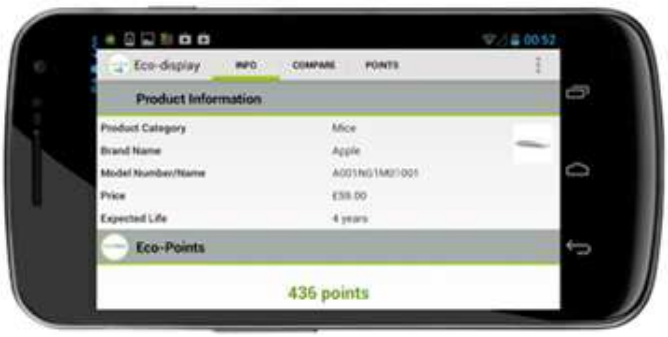


Figure 16: Horizontal Paging

This application also provides the explanation of environmental information such as global warming, acidification, eutrophication, ozone depletion, and summer smog; they can simply touch the question mark button to check the meaning of environmental impact they would like to know more information about (Figure 17).

Figure 17: The Explanation of Global Warming

The main function of this mobile phone application is to allow customer to compare different product in order to make them topurchase an ecofriendly product. When customer touches the button of compare form in the top of application, the application will showthe product category to choose the product type, which is shown in Figure 18. In the next step, customer can select the products they wish to compare, form the list, (Figure 19).

The comparison result from “Eco-Display mobile app” is shown in the example Figure 20. The smiling green face or sad red face show which product is more eco-friendly; customer can also compare which product is more energy saving in using stage by using thumbs up/down method.Moreover, the application displayswhich product has more Eco-Points for recycling.

Besides, if customerwants to know the reason why a certain product has a bad or good rating, theycan simply select the device, which they would like to check (Figure 21).

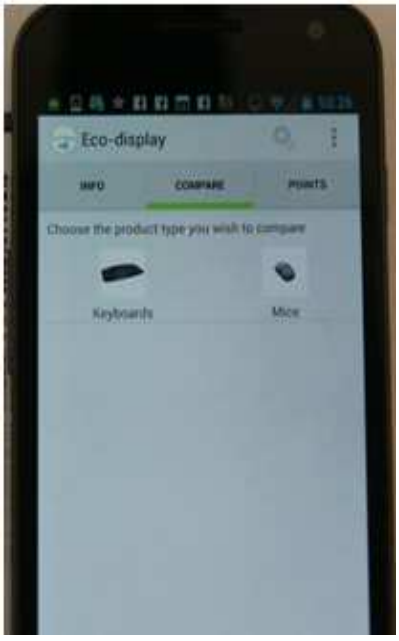


Figure 18: Choose the Product Type

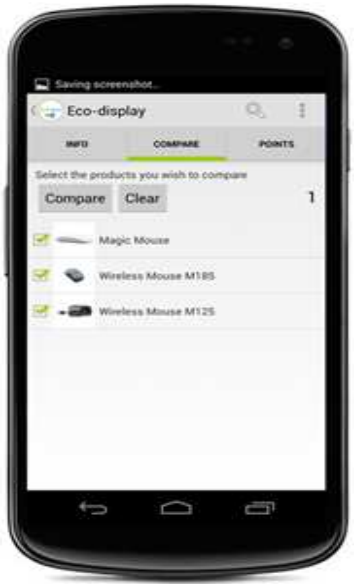


Figure 19: Select the Products to Compare

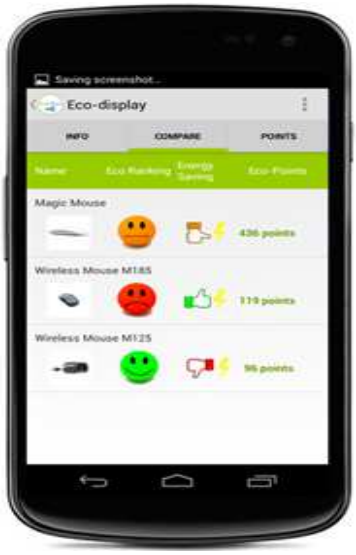


Figure 20: Compare Three Mice

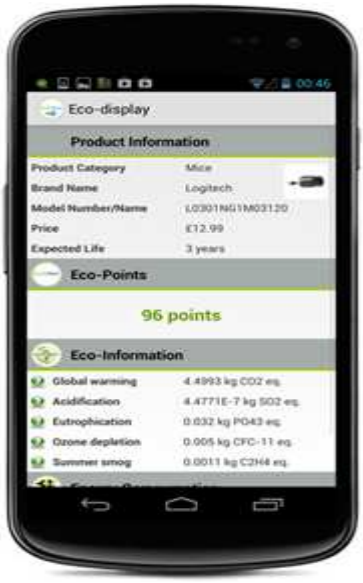


Figure 21: Checking Product Information

CONCLUSIONS AND FURTHER WORK

The LCA reports are extremely technical and very complicated for consumers, they cannot understand it easily, although Eco-label provides an easily identified method, but most of the Eco-label only used a logo or symbol without any detailed information, no linking to company's unique effort.

This paper proposes a possible solution, which is a unique combination of innovative technology and quality sustainability information to fit in with EPD requests, and to present sufficient environmental information, which can be easily understood and compared by the consumers during their purchase. Through providing products information with the environment, consumers will be better informed and more aware of environmental issues, therefore they may be more likely to purchase products that are making less negative impact environmentally and socially.

The environmental communication method with NFC mobile technology can assist consumers to judge the relative environmental merits of products; consumers will be better informed and more aware of environmental issues, and it may alsoencourage them to purchase products that are making less negative impact on the environment. Most of companies will not like to be stacked with a bad label because of their product,or fail to compare with other similar products, therefore, our environmental communication method may influence companies to design or manufacture product withless negative environmental impact,increasing their sales and their social image.

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