Prototyping a Community-Generated, Mobile Device-Enabled Database of Environmental Impact Reviews of Consumer Products

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Abstract

GreenScanner is a system that helps people engage in environmentally preferable purchasing during their everyday consumer transactions. This system has two parts: a dynamic online database of community-generated environmental impact reviews of products, and a mobile phone application that allows consumers to access these reviews at a point of purchase by photographing a product's Universal Product Code (UPC). This paper describes a prototype of the system that was released publicly in April 2006, and analyzes the results of that deployment. Over its first year of existence, the site received approximately 31,000 hits. However, during that time, only 79 subjective comments were uploaded. This paper analyzes the site's usage patterns, and describes a number of improvements to the system that are currently under way.

1. Introduction

As the global population increases and the demands for natural resources approach or exceed their limits, a critical issue is the conservation of resources. A significant problem in U.S. society is the great deal of waste that is produced as a result of the production and consumption of consumer products. According to EPA's Consumer Handbook for Reducing Solid Waste [4], the U.S. produces 179.4 million tons of trash per year, or more than 3.2 pounds per person per day. A sustainable environment mandates the reduction of consumer waste.

Many consumers have at least some degree of environmental goodwill and the desire to engage in environmentally preferable purchasing [5] but do not have access to reliable information in this domain at the time of purchase. In the absence of this information, they may instead choose products based on price, labeling, imperfect memory, or force of habit. To help provide useful information to consumers at the point of purchase, various rating systems have been proposed, for example, relating to the healthiness of products (e.g., [16]). Product labels sometimes include statements regarding the environmental impact of products; however, these labels are not ubiquitous, they may be inconsistent, and often their relevance is not clear. Ultimately, consumers still may not know how environmentally sound different products are. Environmental considerations are clearly a priority for federal purchasing [5]; the goal of the GreenScanner project is to achieve similar ends with large numbers of consumers.

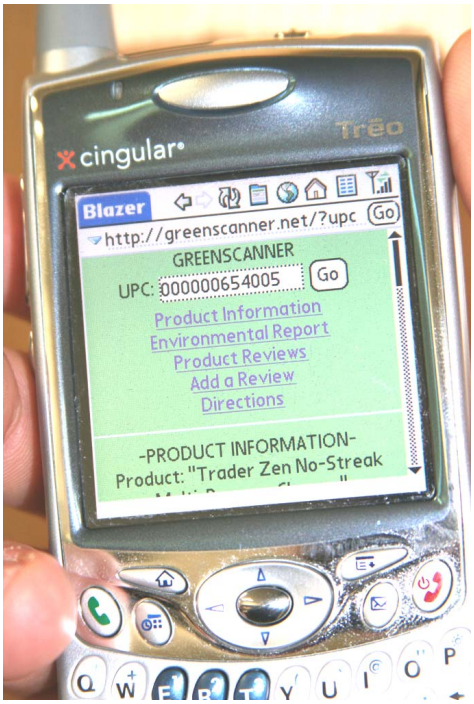

Figure 1: GreenScanner provides environmental impact reviews of consumer products via mobile phones.

Much of the waste produced in the U.S. comes from products that have UPCs[1] or similar identifying information on them. Of the solid waste mentioned above, 63 million tons come from the "glass," "plastics," "metals" and "other" categories, which frequently have UPCs [4], or 1.1 pounds of UPC coded waste per person per day. Corporations and stores use

[1] The term UPC has been renamed UCC-12, and its functionality subsumed by the broader EAN/UCC-13 standard. For ease of understanding, all of these machine-readable tags are called "UPC codes" in this document.

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these markings to identify and track their stocks of goods and enhance their efficiency and productivity. However, individual consumers have not traditionally had the ability to use these markings effectively themselves. The GreenScanner project (see Figure 1) lets shoppers use the UPC system for their own purposes – in this case, to access information about environmental impacts.

To summarize, consumer waste is a major problem, and shoppers frequently do not have sufficiently useful information to make environmentally sounds purchasing choices. UPCs help companies to access relevant information about products, but these tags are rarely used by shoppers to access information that is of relevance to them. GreenScanner helps to solve these problems, coupling mobile phone software for reading UPCs with a database of information about the products' environmental impact (see Figure 1). The component technologies are readily available; constructing the system, populating the database and expanding the community of users have been the goals of this project.

1.1. Vision

The following scenario presents an example of the potential use of GreenScanner. A father and daughter go to the food store to shop together. They walk down the canned vegetable aisle, looking at the different brands. "Do you want peas or corn tonight, Sara?" the father asks. "Corn!" the daughter replies. They move their cart to the corn section. "Hmm, this can is 99 cents, and this other one is $1.09. I wonder what GreenScanner has to say about them." The father gives his daughter his cell phone. They've made a tradition out of shopping like this – Dad picks two choices, and she gets to pick between them based on the results from GreenScanner. She aims the camera on the phone at the each can of corn in turn, and clicks "Scan." The results rapidly appear: for the $1.09 can, GreenScanner displays a score of "6.3," with text that reveals that the corn had been sustainably farmed and packaged in a recyclable can. For the $0.99 can, a score of "5.9" appears, with less favorable reviews. Sara picks the $1.09 can. The father is glad to spend a dime for his daughter to learn respect for environmental conservation and to share this time together.

2. Related Work

The idea of connecting information to products through unique ID tags has a significant history in corporate contexts. UPC, ISBN, VIN, RFID and many other protocols have been developed to allow various industries to track their production and inventories. These unique IDs help facilitate a wide variety of business processes and make them more efficient. Certain companies primarily use their own barcode system for tracking, which makes the integration of their content into comprehensive databases more challenging. However, many manufacturers and distributors use standard tagging technologies; it is with these companies' products that GreenScanner is designed to work.

The existence of these standardized identification mechanisms also allows other individuals and groups to exchange other kinds of information about those products. Coopting these identification processes enables stakeholders whose interests may not be directly aligned with a given corporate entity to construct their own bodies of information about various products. For example, sites such as upcdatabase.com [10] allow people to access a variety of product information online, in particular discovering what company makes a given product, and what other products that company makes.

Accessing these identification systems via mobile devices has been done for several years in grocery and department stores, where handheld UPC scanning "guns" allow employees to identify many different products. Using consumer-owned mobile devices to scan these identifiers was pioneered by the AURA project from Microsoft Research [1], which used Pocket PCs to scan UPCs and allow users to view, store and share metadata and annotations about different products.

GreenScanner is the first project to have focused on using this kind of process specifically for environmental ends. As such, it has a unique set of requirements and opportunities beyond those found in a standard e-commerce application. A student project called iBuyRight [14], completed shortly after the public release of GreenScanner, also looked at the environmental domain for this type of application. However, despite some interesting work in terms of interface design, this site does not appear to have been made publicly available.

In terms of the connection between consumerism and environmental concerns, the US EPA has offered its guidelines for Environmentally Preferable Purchasing [5], which provide information for consumers on the environmental impact of a range of different products. While this site provides a large amount of useful information, the site is not designed to allow consumers to access the information with the necessary speed and convenience to enable it to influence individual purchasing decisions. More recently, commercial efforts such as PriceGrabber.com's ShopGreen system [9] have also sought to address the needs of environmentally

concerned shoppers. Here again, though, the system is not designed for mobile phones. Mankoff et al. [15] provide an excellent summary of ways in which social networking sites may be used to foster environmental concern, and describes a proposed project to use these sites to encourage behavioral change.

Many different web sites allow different communities to exchange content in rapid and efficient ways. UrbanDictionary [11] is a community-generated database of definitions of slang terms. It allows users to upload definitions of terms, and uses a thumbs-up and thumbs-down mechanism to allow other users to evaluate the quality of those definitions. Ratemyprofessors [8] provides an opportunity for students to write candid anonymous reviews of their university professors and rank them by "clarity," "easiness," "helpfulness" and "hottness." Epinions allows consumers to evaluate products on a five star [7] scale, and write reviews of those products. Wikipedia [12] lets people contribute to community-generated encyclopedia articles. Each of these sites has characteristics that are helping to inspire the current and future versions of GreenScanner, as discussed later in this paper.

3. Prototype

A prototype of GreenScanner (see Figure 2) has been in active public use since April 2006. The prototype runs on all web-enabled mobile phones by accessing a SQL database of consumer products through a PHP web site. The system is available at: http://GreenScanner.net

The database of environmental impact information underlying the GreenScanner system stores several main tables of data. First, it stores product information about all of the consumer items about which information is being collected – product name, size and company – in an "Items" table. There is also a "Companies" table that includes names for each of the companies that users have input. These tables are populated with information about over 600,000 products, downloaded initially from http://www.upcdatabase.com and expanded by GreenScanner's user community. Environmental impact reports are stored in two tables – one for "Product Reports" and one for Company Reports". Finally, there is a table for "Visits," which keeps track of all of the actions taken by users of the site.

These tables are manipulated by several web pages. First, there is an index page, which contains directions for using the site and a text box into which people can type a UPC. When a number is entered, the site confirms that it is a valid UPC and then takes the user to an Item View page (see Figure 2), where he/she can see the product name, its size and the company that produced it; he/she can read reviews written by other users; he/she may enter a review of that product and score it on a scale from 1 to 5; or he/she may link to several other pages. In addition, there is a Company View page, which provides a list of all the products by that company, a list of all the comments written by users about that company, and a secthat company. Finally, there is an update page where users make changes to the name of the product, its size, and the name of the company that produced it.

Figure 2: GreenScanner Product page.

An element of the design of the initial GreenScanner site was the ability to add product and company reviews that were both environmentally-related and non-environmentally related. Below the text box into which the review can be entered is a radio button to select between these two choices. These two different groups of reviews are displayed separately on the page, along with the average of the scores users had given that product.

GreenScanner was designed to be accessed primarily from mobile devices. This focus has led to several design decisions. First, it is formatted to fit on a very small screen; all critical information is either visible (e.g., UPC) or linked to (e.g., directions) in the top two inches of the screen. Second, the site does not include images, video, sound or any other bandwidth-heavy media, so that it loads as rapidly as possible. Finally, the site was designed using to use a standard web browser, so that compatibility issues could be minimized.

To simplify the process of entering the UPC into the mobile device, the system was designed to use the camera on a given phone to analyze the UPC and input its numerical equivalent into the browser automatically. The initial version of this system was implemented for use on a Palm Treo 650; a freeware application called EAN13Barcode, which uses the Treo's camera, was integrated into the system. In addition, the system could work with a Socket SDIO In-Hand Scan Card, which greatly enhanced the reliability of the UPC scanning. All other systems initially needed to type in the UPC by hand.

A few months after the public release, a collaboration with Microsoft Research's AURA project allowed Windows Mobile devices to use their cameras to enter UPCs with the GreenScanner system as well. The AURA system requires a custom-made macro lens attachment to perform the scanning, available for free from Microsoft Research.

4. Evaluation

The GreenScanner prototype had a number of successes and shortcomings, described here. The methodologies used in assessing the system included analyses of the server logs, of the scanning process itself, of the community-generated content, and of the external reviews of the GreenScanner system.

4.1. Public Reception

A search on google.com for the term "GreenScanner" produced only thee hits on April 3, 2006, the day before the site's public release. Within several weeks, the same google search revealed more than 15,000 hits. As of June 4, 2007, that search produces 702 hits. Note that, due to the structure of sites such as de.licio.us, these numbers are significantly larger than the number of distinct human-usages of the relevant term. For example, the June 4, 2007 search located only 57 distinct references to GreenScanner after accounting for the multiplicity of de.licio.us hits.

The rapid rise and then fall-off of GreenScanner's web presence probably has to do with the fact that GreenScanner was blogged on a number of prominent sites, including worldchanging.com, grist.org, globeandmail.com, researchbuzz.org, smartmobs.com, ecogeek.org, and supervegan.com. These blogs included comments such as "gloriously simple" (supervegan.com), and "It's cool technology, it's empowering individuals, and it's allowing us to more environmentally informed decisions. This... GreenScanner... is the essence of EcoGeek." (ecogeek.org). GreenScanner was also a finalist in the Toshiba Green Innovation Awards, an award for environmental technologies in Orange County, CA. All of these elements point to a public perception that GreenScanner could be useful in addressing some of the world's environmental issues.

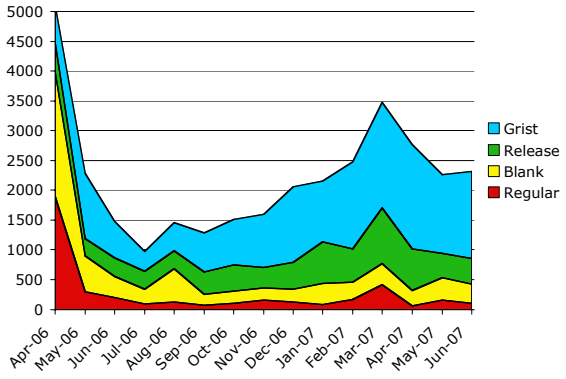

Figure 3: Total hits on the GreenScanner site by month, showing hits for product UPCs related to a 4/19/06 grist.org article, for UPCs related to a 4/04/06 university press release, for blank UPC fields, and for all other UPCs (i.e., "regular users"). (Jun-07 predicted based on first 14 days.)

4.2. Usage

The GreenScanner site received 31061 hits from April 4, 2006 through June 5, 2007, or approximately 73 hits per day. This usage started with several weeks of high usage immediately after the university's press release and the ensuing news articles, then dropped off over the next few weeks, and then has climbed steadily, albeit slowly, over the past year. (See Figure 3.)

Of the total hits, 19.6% were accessing the site's main page without a UPC, meaning that they were probably visiting for the first time of a given session, and had arrived there via a web link. Approximately 43.7% of the total visits were through the product page and included content in the UPC field, meaning that the user had typed something into that field or were accessing the site via a mobile device with an automatic scanning system. The remainder of the hits was split fairly evenly between views of Company pages (18.1%) and visits to the Update page (18.6%). These visits came from 4492 distinct IP addresses, or 6.9 page views per IP address.

A total of 2364 distinct text entries were input by users into the UPC field. Of these, 934 UPCs were found in the product database; the remainder was composed of either products that were never added to the database, or of malformed UPCs (words, alphabetical characters, mistyped UPCs, etc.). Terms such as "Powerbook", "levis", "green", and "Tide", which people entered in the UPC text field point to an

issue in which people expected certain behavior from the system beyond what it was designed to do.

Four UPCs were publicized broadly in the media: "Horizon Organic 1% Low Fat Milk" (742365264108) and "Poland Spring Water" (075720008513) via a university press release [6], and "Clorox Disinfecting Wipes/Lemon" (044600015941), and "ZBar - Chocolate Brownie" (722252194138) via a Grist.org article [17]. Both of these articles were cited by other news articles, blog posts, etc., thereby multiplying their effect. These four products alone had a total of 2203 hits during the study period. In addition, probably due to the ease of navigation within GreenScanner from one product to the company that produced it, and then to a different product by that same company, a large number of other products by these four companies also received a relatively high number of hits. Items by these companies received a total of 20737 hits, or more than 2/3 of the overall hits for the site. Removing all products by these four companies from this analysis reveals a more accurate picture of long-term usage of the site, since the goal is to cultivate a user population that utilizes the system in most or all of their purchasing decisions, rather than just visiting once from a news article link. In addition we removed four products that were used regularly in our research demonstrations, and any hits that did had a blank UPC (i.e., first visits to the site). What remained could be termed usage by "regular users".

Regular users accounted for 3973 hits over the study period. There was an average of 9.3 hits per day. A total of 683 valid UPCs were entered at least once. These UPCs ranged from "Oh Naturel Meatless Chick'n Strips" (062000597812) to "Energizer AAA Battery" (039800045638) to "Ez Wider Papers" (074460000016). None of these UPCs had more than 14 hits, and 640 of them had 5 or fewer hits. Multiple hits were usually caused by a single user visiting various pages on the GreenScanner site with the same UPC. The fact that these hits were spread evenly over so many products suggests that there is a wide abundance of different products in common use within GreenScanner's community.

Ultimately, these data confirm that GreenScanner's users were at least partially using the site as it was intended – to access information about a wide range of different consumer products. In the next version of the site, we plan to continue collecting these and other data (discussed below) so that we can understand the usage more fully.

4.3. Usability

The GreenScanner prototype had a significant shortcoming in how long it took to access information from the database. Based on an average of five trials, typical use of the system by an experienced user with a Windows Mobile device and the AURA UPC scanning system takes a total of approximately 35-40 seconds, including 5-8 seconds to open the application, 9-16 seconds to photograph and digitize the UPC, 10-16 seconds to retrieve information from the web server, and 5-9 seconds to view that information. The time to open the application is eliminated on sequential scans, but the other three time chunks are significant impediments to wide-scale usage.

Using GreenScanner with a Treo 650, which utilized the freeware UPC recognition software, also had a significant limitation regarding the robustness of the scanning process. While it worked reasonably well under optimal conditions, the system required a well lit environment, a steady hand and a flat, non-shiny UPC to perform the recognition reliably. GreenScanner performed significantly better when used with a Windows Mobile device running the AURA system with an attached macro lens.

Nevertheless, even with the fastest of these systems, the GreenScanner prototype took too long to retrieve information. There are two main issues that contributed to this slowness – one technological, and one design-based. Technologically, simply accessing the web via a mobile phone takes several seconds. Given the number of decisions that a typical shopper needs to make during a single trip to a grocery store, waiting 30 seconds or more for each one is prohibitively time-consuming. Even the lead member of the GreenScanner team found the time to be much too long for it to be usable. In terms of the design of the system, to compare two products required several clicks and several queries to the online database (each with an accompanying wait time). Therefore, even were the technology instantaneous, the time required to compare two products was prohibitively great. While the amount of time might have been measured in tens of seconds, it would still have been perhaps an order of magnitude too great. The next version of GreenScanner, described later in this paper, seeks to reduce the overall usage time significantly, since most consumers are not likely to use a system that adds half a minute to each of their purchasing decisions.

4.4. Reviews

A total of 79 product or company reviews were entered, including 38 "environmental" product reviews, 31 "other" product reviews, 5 "environmental" company reviews and 5 "other" company reviews. Of these, 31 of the environmental product reviews, 30 of the other product reviews, 4 of the environmental company reviews and all 5 of the

other company reviews were for products or companies not excluded earlier, and thus appear to have been uploaded by regular users. Comparing this total of 70 reviews to the total number of valid UPCs uploaded by regular users, we see that over 10% of products (70/683) scanned by people were also reviewed by them. While the numbers are fairly low, this result suggests that regular users are relatively willing to provide content to the site.

A number of the environmental reviews contained relevant and reasonably high-quality content. For example:

> "Twleve ounce aluminum can packaging is not as environmentally sensitive as 2-liter plastic (PET) bottles. (See http://www.ilea.org/lcas/Tellus.html). Coca-Cola admits they use high fructose corn syrup that was produced with the use of pesticides (see http://www2.coca-cola.com/citizenship/environmental_report2004.pdf). The Coca-Cola company exposes the public to toxins and depletes local public water sources in India (see http://www.ipsnews.net/news.asp?idnews=29971)."

Other reviews made environmental claims without providing significant documentation of the validity of those claims.

> "Nabisco was accused of releasing hazardous chemicals into the environment."

Still other environmental reviews sought to encourage behavioral change, rather than providing factual information:

> "Paper towels are an uneccesary waste of paper. Don't buy these, just keep a sponge in your kitchen. You don't need paper towels! They are the lazy persons way, and bad for the environment to boot."

There was also at least one case of likely self-promotion, in which a product review and a company review (below) were submitted in quick succession.

> "Today there is a growing public concern for reducing damage to our environment and dependence on fossil fuels. GreenFiber's Cocoon insulation responds to this concern by contributing to environmental responsibility. Cocoon has the advantage of locally available raw materials which consists of 85% recycled content. Cocoon requires less embodied energy- the sum of energy required to obtain materials, manufacture and transport a product. Cocoon's responsibility doesn't end with delivery of the product. When installed, Cocoon improves air, thermal and acoustic environment of a home. From raw material through installation, Cocoon builds environmental responsibility."

While self-promotion is not inherently harmful, since individuals and corporations often have a great deal of information about their own operations, it does demonstrate the potential for exploitation of a system of this kind.

Another potential issue lies in the fact that a number of the reviews labeled as "environmental" did not relate obviously to environmental issues, for example:

> "the best!"

or

> "Made in France."

This issue may have related to a lack of clarity in the interface design of the radio button for choosing to flag one's review as "environmental" or "other". Nevertheless, the fact that almost half the reviews (36/79) were labeled as "other", which required action on the users' part because the radio button defaults to "environmental", suggests that most people were aware of that button.

The reviews in the "other" category for products and companies also had a range of content quality. For example:

> "Frustrated for two years by an intermittent hissing whenever the handset was charging. Returns only yielded the same problem. It appears, after all that, that the problem lay in the Motorola battery. Once it had died and was replaced, the hissing has stopped. Poor sound quality, sporadic failure to connect to phone lines -- a completely unhappy experience with this company."

or:

> "pretty tasty".

Users occasionally added spam reviews and other non-helpful content, such as:

> "Freakin' hippies"

or

> "Seriously, this is good milk. Buy valium and make your lady happy."

Despite the broad assortment of types of reviews uploaded, there did seem to be a facet of the community willing to contribute meaningful content to the GreenScanner database. Nevertheless, the system lacks

sufficient environmental impact information for it to be broadly useful as a tool for shopping at this point. Because the system is simply an infrastructure for the exchange of this information, it did not initially have any information beyond the few reviews supplied by its creators. In order for this system to be of wide use, it must have an abundance of environmental information, at least within certain commercial sectors. This is a similar problem to one faced by Wikipedia, Ratemyprofessors and many other community-generated content sites. In order to address it, it's critical that the act of contributing be inherently satisfying. Wikipedia makes people feel like experts, Ratemyprofessors lets people vent or commend their teachers, and UrbanDictionary lets people feel like part of the "in" crowd; GreenScanner could be improved by making the process of contributing environmental information satisfying in itself. One way in which it could do this is to draw on the example of American Red Cross Blood Drives, which make people feel good because of their contribution to society. Similarly, GreenScanner should be designed to help users feel that they are making a real difference for the environment when they contribute reviews or when they change their shopping habits after using the system.

5. Proposed System

Currently under development is a second version of GreenScanner, which seeks to retain the effective elements of the prototype, revise the problematic sections and add several additional features. In particular, we are planning to separate the contribution and evaluation of environmental information, to include a reputation management system, to present an ordered list of similar products when one item is scanned, to enable local caching to speed up the interaction process, to disseminate the project more broadly, and to archive more salient information about users' interactions so that we can analyze GreenScanner's usage more effectively in the future.

5.1. Environmental Impact Reviews

The product page of the GreenScanner system will continue to be the central focus for the project. This page will contain three main parts, each of which is described in more detail in the paragraphs below. The first part is product information – item name, company and size. The second part is collection of environmental impact statements, each with an accompanying score. The third part is an overall environmental score based on the scores for those statements. These three parts will be described in the above order, but they will be displayed on the page with the overall environmental score above the individual reviews, since the limited screen size of a mobile device constrains how much content can be displayed, and the overall score is likely to be more important to consumers than the reviews that contribute to it.

With regard to the product information, each item will have a UPC, a product name, the name of the company that produces it, and the product's size. As with the initial prototype, contributors will be able to add and edit this information for any product, thereby helping the database grow to incorporate more of the 4.6 million UPC coded items that have ever existed.

The second element on the page will be a collection of environmental impact reviews, each contributed by a user of the system (see Figure 4). Each of these statements will be accompanied by three small icons that other contributors can use to evaluate the impact of the review's content. The first icon is a green leaf, representing a positive environmental impact. The second is a red fire, representing a negative environmental impact. The third is a black 'x', denoting that the comment is not environmentally relevant. These icons will be designed to be recognizable even on grayscale telephone screens. Contributors can click on any one of these icons to offer their opinion of that review. Each logged-in contributor will be limited to one click per review,

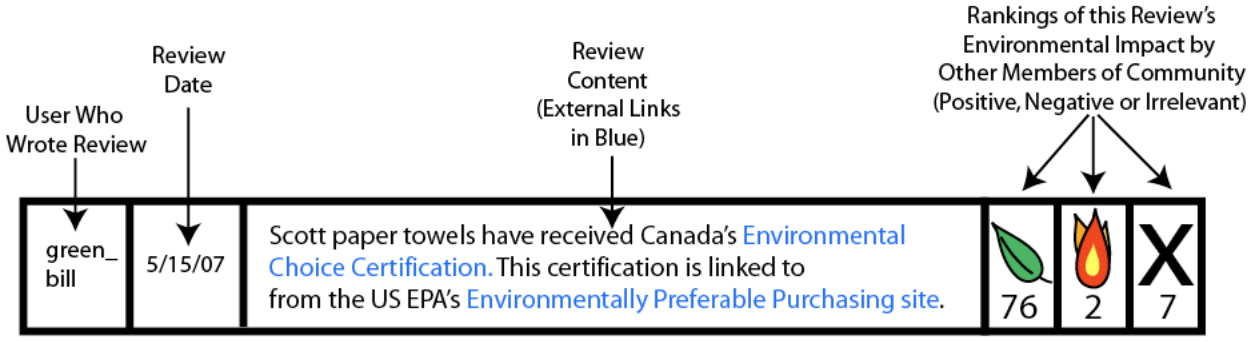

Figure 4: The environmental impact review structure in the proposed system.

although they may change which of the three icons they've clicked on at any time. Anonymous users will also be able to click on the icons to evaluate the reviews; Javascript code and/or cookies will be used to prevent each user from clicking more than once from the same browser window and IP address.

Each of the three icons will be accompanied by a score representing the number of times someone has clicked on that icon to provide his/her assessment of that statement. The environmental impact statements will be listed in order based on each statement's review quality score, defined by the difference between the leaf icon's number and the fire icon's number, minus the x icon's number. This value will determine the community's opinion of that particular review, and will allow higher quality statements (whether positive or negative) to rise to the top of the list.

The third part of the page will be a numerical summary environmental score for that product. This score will be an average of all of the scores given in the individual statements above, weighted by the average score across all items in the GreenScanner database. By providing this summary score, GreenScanner will provide support for decisions across a range of specificity. At the most specific level, the choice between two cans of corn described in the vision statement offers an opportunity to provide information about two versions of a very similar product. Many consumer decisions fall into this category – a decision has been made about what to buy, now the question is which brand of that item. While the relative impact of one can of corn versus another may not be great, the collective impact of millions of specific purchasing acts being nudged toward a consideration for environmental impacts could be substantial. At a more general level, consider the difference between an entrée of beef and an entrée of tofu. It might not be obvious to a consumer that beef production requires 35 calories of fossil fuel to produce a calorie of protein while tofu production requires only 2 calories of fossil fuel per calorie of protein. This disparity is likely to be reflected in their respective summary scores, which would help make clear the vast difference in impact between these two products.

5.2. Ordered List

Since one of the significant shortcomings of the current version of GreenScanner is how long it takes to scan a UPC and retrieve information about it, we plan to add a front page to the site that facilitates comparisons across different products. Rather than having to scan each of the products being compared, and remember the score of the first product while accessing the second, users will be able to scan just one product and be shown a list of related products, ordered by their overall environmental score. Products with no reviews will be given a score based on the reviews of other products by the same company. If the company has no reviews, the product will be given an average score for all products in the database.

The grouping of products will be done by means of keyword searches of the rest of the database. For example, if someone scans Cream of Mushroom soup, it would be compared to other soups, other mushroom products and other cream-based products. Also, data will be collected on temporal proximity in product scanning by users, based on the assumption that similar products are likely to be located near each other in space, and therefore also likely to be scanned near each other in time. Based on these two factors, a list will be generated, which will then be arranged according to the environmental quality of each item. Users may then click on any of the listed items to go to that item's product page, where they can access more information via the individual reviews.

There will also be a search function to allow people to find specific items either from their mobile device or from their home computer. This search function will also enable users to find UPCs for products that they would like to review.

5.3. Reputation Management System

There will also be a reputation management system (RMS) to allow providers of high-quality content to have a greater impact on the system. Anyone may use this system to contribute statements and click icons to evaluate those statements. In addition, users will be given the opportunity to create an account that they can log into. Each logged-in contributor will have a reputation score based on the evaluations that other people have given to the environmental impact statements that he/she has posted. This score will be based on the sum of the review quality scores for all reviews contributed by that user. If the user's reputation score is high, he/she will have a greater impact when they click on one of the icons to evaluate someone else's statements, increasing the number next to that icon by two or more points instead of just one.

5.4. Caching

Since web access speed is one of the major sources of lag in using GreenScanner, we also intend to enable the system to perform partial database caching on mobile devices. While it is probably not feasible to cache all product information and reviews for each of the 30,000-40,000 items found in a typical food store,

it may be possible to cache a subset of the most popular items, or a subset based on what this user has scanned previously.

Another possibility is that users would be able to do most of their searching and evaluation of products using their desktop computers, and then create shopping lists based on that research. If users still wanted to scan other items while shopping, they would be able to do so at the point of purchase.

5.5. Dissemination

A critical factor in the success of the next version of GreenScanner will be much broader adoption. Since the value of the system increases significantly as more reviews are added, we plan to undertake several efforts to increase usage of the system. First, we plan to engage local and regional environmental groups, such as campus clubs, branches of the Sierra Club and similar organizations, in efforts to scan and research products in local grocery stores. Second, we plan to launch a Google Adwords campaign targeted at terms such as "environmental impact", "recycling information", "UPC code" and similar phrases. Finally, we hope that the relatively high-profile act of scanning products in retail stores will help increase usage via word-of-mouth.

5.6. Data Collection

The next steps for data collection and archiving regarding user's interactions involve several elements. First, we would like to track usage episodes more effectively. We are experimenting with cookies for this task, but they do not appear to work consistently with all mobile devices. We also plan to collect details of any changes that people make to the database, so we can determine how many updates to the factual data people tend to make. Finally, we would like to collect what browser and OS people are using to access the site, so that we can develop a better understanding of how GreenScanner is used.

6. Potential Impact

The primary objective of GreenScanner is to help consumers engage in environmentally preferable purchasing. A pivotal moment in a consumer's decision making process is at the point of purchase, where a choice between two or more products may hinge on small differences among them. By letting people scan the UPCs of products using the camera on their mobile phone, and retrieve information from an online database of environmental reviews, GreenScanner helps shoppers figure out what to buy.

In 2004, the Bureau of Labor Statistics (BLS) reported that there were more than 116 million "consumer units" in the U.S., each consisting of an average of 2.5 individuals [2]. It may be estimated that the percentage of these consumer units that carry mobile phones while shopping is very high, since there were 219 million mobile phone subscribers in the U.S. in 2005 [3] or approximately one subscription for each of the 217 million adults in the U.S. [18]. While not all phones have cameras and data service, if 5% of these consumer units were to access GreenScanner while making their consumption decisions, this would result in (116 million consumer units x 5% =) 5.8 million consumer units being influenced by this process.

Each of these consumer units enjoyed an average income before taxes of $54,453, with $43,395 in average annual expenditures [2]. Approximately 13.2% of each consumer unit's annual expenditures is spent on items that are likely to have UPCs. These items include "Food at home" (7.7%), "Alcoholic beverages" (1.1%), "Personal Care products and services" (1.3%), "Reading" (.3%), "Tobacco products" (.7%), and 50% of "Apparel and services" (2.1%). While some items in each of these groups may not have UPCs, items in several other categories may have UPCs as well. This percentage amounts to $5,730 of UPC coded items per consumer unit per year.

If 5.8 million consumer units consulted GreenScanner in these expenditures, a total of $33 billion in purchases would be impacted. Altering the decision process even slightly for this volume of purchases could have a profound impact on the 63 million tons of solid waste described above.

For example, if GreenScanner affects 10% of a consumer unit's purchasing decisions, and the difference in impact is a 10% reduction in waste from the old product to the new product, then GreenScanner will have reduced that consumer unit's total consumer waste by 1%. If each consumer unit includes 2.5 people, and 5.8 million consumer units use GreenScanner, and each person produces 1.1 pounds of UPC coded waste per day, then GreenScanner would reduce consumer waste by 30,000 tons per year. It may take several years for use of GreenScanner impact scales smoothly as the database improves and more people use the service, the project will be able to have smaller impacts immediately and grow as the community and database develop.

7. Conclusions

Many consumers could be willing to change their purchasing habits to take environmental issues into account. However, these individuals often do not have sufficient information to allow environmental concerns

to factor into their decisions at the point of purchase. GreenScanner can help these consumers engage in environmentally preferable purchasing in some or all of their everyday purchasing decisions. By enabling consumers to have environmental impact information at their fingertips while shopping, GreenScanner contributes to a number of environmental goals, such as the reduction of consumer waste.

This paper has presented the design a prototype that has been in active use for over a year, and analyzed the results of that deployment. The system has gathered a small but stable user community, but shortcomings in the design and development have prevented that community from growing and making the necessary subjective contributions that could enable GreenScanner to have a broad environmental impact at this point. This paper has described the design of the next version of the GreenScanner system, which includes a number of significant modifications that seek to remedy these issues.

Looking beyond the current design efforts, there are several interesting directions in which we might see this kind of system developing. First, we have noted that people often defer to other people or organizations in their communities for environmental information. Similarly, if we were to expose the algorithms by which GreenScanner calculates the scores for various products, certain individuals or organizations might be able to construct other ways to evaluate the merits of various products, and other individuals or organizations could choose to use their algorithms. For example, I might choose to follow whatever system my friend Andrew (a PhD biologist) adheres to, or use the algorithms recommended by the Surfrider Foundation. Also, just as Slashdot allows people to modify whose comments to see based on posters' reputations [13], GreenScanner could allow different individuals' comments to be included or excluded based on their reputation scores.

Ultimately, GreenScanner could reach beyond the limits of only UPC coded products to include any systematically-identifiable content. For example, RFID chips, car VIN numbers, and other systems could also be used. While there are numerous questions involved with this expansion, from technical concerns to privacy issues, there may be significant environmental benefits to be gained by collecting environmental information about objects.

The vision for this system is to provide a forum for exchange of environmental information in a format that is reliable and easy to access. By doing so, people around the world may be enabled to make more informed decisions in their everyday lives, and potentially work together to address the environmental issues that surround each of our lives.

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