Discovery of Usability Patterns in Support of Green Purchasing

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Abstract

Market analysis indicates that consumers are increasingly becoming more aware of the impacts of the current choices and are showing interest in understanding how to choose more healthy, ethical, and environmentally friendly items. Given the abundance of information available for this task, it has increasingly become more difficult for consumers to decipher quality among the quantity. Design and development of highly usable support tools that enable consumers to compare product selections in relation to their own individual values could greatly assist consumers in this task. There exist several usability metrics that could be utilized to determine the usability of such tools. By utilizing these metrics, system designers could obtain the necessary information to design and develop more usable support tools of this kind, thus providing consumers with the most satisfying shopping experience possible. This paper will provide an overview of work being done towards this goal. Specifically, the authors will discuss common issues relevant to the domain of environmental preferable purchasing. The authors will also discuss several metrics that could be used to determine the usability of such tools, with specific emphasis on decision accuracy. The authors hypothesize that support tools that enable consumers to obtain higher decision accuracies could provide consumers with a more satisfying shopping experience and possibly increase the selection of eco-friendly alternatives. A discussion outlining future work is also provided.

1. Introduction

In the current marketplace, there are several indications that consumers are increasingly becoming more aware of, and more interested in understanding the impacts of their current product choices (Harris, 2007). The concept of *green purchasing* has been gaining momentum in the European Union, the United States, and Canada (as well as other nations) for quite some time (Krystallis and Chryssohoidis, 2005; Canadian Environmental Assessment Agency, 2006). Education for sustainable development has also become the premier concern of the United Nations (UN), with the UN providing many initiatives into formalizing research and development into education for sustainable designs, developments, and innovations (Harris, 2007).

1.1 Local Examples

Canada is a nation among many of the OECD (Organization for Economic Cooperation and Development) nations who are leading the initiative towards education for sustainable development. In particular, the province of Saskatchewan has become at the forefront of provinces in Canada who are showing initiative in developing sustainable designs, practices, and innovations. Examples of these could include:

- The development of the Sustainable Living Project (Eco-Centre and Eco-Village) in Craik, Saskatchewan.[1] The Sustainable Living Project aims at design and development of eco-efficient housing solutions
- The development and implementation of the Saskatchewan Local Food (LoFo) social network website.[2] The LoFo website aims at linking local producers with local consumers
- The development and implementation of the Regional Centre of Expertise (RCE) on Education for Sustainable Development (ESD)[3], which received official recognition from the UN in 2007 (only three such Regional Centres exist in Canada; Saskatchewan, Toronto, and Sudbury). The Saskatchewan RCE on ESD aims at promoting sustainable education in Saskatchewan

These examples indicate the strong interest among Canadians to promote sustainable practices, designs, and innovations. Interestingly, two of the three examples provided above include web-based systems designed to offer support for education and consumer decision-making for green purchasing. Given the accessibility and widespread usage of the World Wide Web, it provides a unique and highly adequate medium to educate citizens (local and global) and equip consumers with the necessary knowledge in order to make the most informed decisions with respect to their item selections.

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[1] http://www.craikecovillage.ca/ (accessed March 2007)
[2] http://lofo.uregina.ca (accessed March 2007)
[3] http://www.saskrce.ca (accessed March 2007)

1.2 Consumer Attitudes

Although the 1990's were heralded as "the decade of the environment" (Krystallis and Chryssohoidis, 2005; Hartmann and Apaolaza Ibanez, 2006), there is still much to be accomplished if sustainability is to be achieved (Peattie and Crane, 2005). Although current research does indicate that consumers are aware that their choices do impact their health and environment and consumer attitudes have shifted towards making more healthy, ethical, and environmentally friendly choices (Schlegelmilch et al., 1996; Vlosky et al., 1999; Hartmann and Apaolaza Ibanez, 2006; Bhaskaran et al., 2006; Harris, 2007), consumers often lack the necessary support to make the most informed choices possible.

1.3. Support Tools for Environmentally-Preferable Item Selections

Development of support tools to aid consumers in the task of researching their product choices would be highly beneficial to both consumers who wish to "green" their item selections and manufacturers who develop and manufacture "green" items. Key to the success of such tools is providing system users with a highly usable user interface that enables users to explore and find products matching their individual values while enabling them to compare current selections with potential alternatives. This paper will discuss preliminary research with the goal of defining a metric that could be used to rate a user's experience while using such tools. The described metric emphasizes the relationship between consumer values and product selections as a means to determine the usability of a support tool.

The rest of this paper is organized as follows. Section 2 will discuss issues relevant to consumer decision-making for environmental product selections. Section 3 will provide an overview of commonly used usability metrics with an emphasis on the metric of decision accuracy. Section 4 will provide a discussion on the results obtained from an experiment conducted by the authors and Section 5 will provide concluding remarks and opportunities for future work.

2. Consumer Issues Stemming from Environmental Decision-Making

A number of issues surround consumer decision-making for green purchasing tasks. Many of these issues stem directly from consumer attitudes towards green products and manufacturing.

2.1 Environmental Labeling and Certification

Environmental certifications have become a popular marketing strategy to indicate green, or eco-efficient/effective products (McDonough and Braungart, 2002; Grankvist and Lekedal, 2007). Eco-Labeling is also a popular marketing strategy used to distinguish products that pass given thresholds and can be considered environmentally friendly. Many companies who develop eco-efficient and eco-effective products attempt to utilize these certifications and labels to make their product(s) more visible to consumers (Harris, 2007).

When consumers are making product selections, many consumers will attempt to seek out products that are labeled or certified as eco-friendly (Fotopoulus and Krystallis, 2002). An issue

that arises from this process in consumer decision-making is that there exist a myriad of certification and eco-labeling bodies, all of which utilize varying criteria to determine a product's eco-efficiency. For example, with organic food manufacturing in Canada, each province has many certification bodies all of who use varying criteria to determine if a given product can be labeled organic or otherwise.[4] The myriad of certifications and eco-labeling programs only adds to the confusion of consumers when attempting to formulate purchasing decisions and increases consumer skepticism towards green products (Harris, 2007).

2.2 Willingness to Pay

A recent study that elicited consumer attitudes towards organic food production and consumption among Greek consumers indicated a clear distinction between three types of consumer groups: *the unaware*, *the aware buyers*, and *the aware non-buyers* (Fotopoulus and Krystallis, 2002). Although the authors' study was limited to Greek consumers, it is the assertion of the authors of this paper that these groups could also indicate consumers in other geographic areas. Of interest is the percentage of *aware non-buyers*, which was significantly larger than the other two consumer groups found. One of the reasons given by the *aware non-buyers* group in the authors' research was directly linked to the high price of organic foods (Fotopoulus and Krystallis, 2002). Many consumers indicated that although they were/are aware and understand what organic food is, the high price of such food is a deterring factor in purchasing organic-based products (Fotopoulus and Krystallis, 2002).

It is hypothesized that although consumers may indicate their awareness of the benefits of eco-friendly alternatives (health, ethical, and environmental benefits), many consumers may not fully understand the true *cost* (or life cycle) of their item selections. For example, there may exist products considered to be environmentally friendly that *cost* the same or less than current item selections. Since many consumers may overlook these items due to the assumption that they generally *cost* higher in terms of price, the need to develop more adequate support for these decision-making tasks is realized.

2.3 Consumer Trust

The issue of consumer trust is one of the most critical issues of environmental decision-making. False marketing has plagued much of the green purchasing initiative and has had a tremendous impact on consumer attitudes towards green purchasing (Peattie and Crane, 2005). Peattie and Crane (Peattie and Crane, 2005) and Harris (Harris, 2007) provided the following rationale(s) for consumer mistrust:

- Some manufacturers guise their products as environmentally friendly without any true analysis of their products' true impacts

[4] http://www.innvista.com/health/foods/organics/certcan.htm provides a province-to-province listing of organic certification bodies in Canada (accessed March 2007).

- Some manufacturers use inventive packaging schemes, e.g. “green imaging”, such as nature illustrations/logos, even though their products are not environmentally friendly
- Many manufactures only consider the environment if it benefits their company financially
- Many manufacturers only focus on reducing the impact of their products marginally, without changing their current practices or make an attempt to design more innovative, eco-effective, cradle-to-cradle (McDonough and Braungart, 2002) alternatives
- Many manufacturers who have been publicized as being non-environmentally friendly, e.g. oil companies, attempt to place “spin” on the criticisms by claiming their “environmental credentials”
- Many manufacturers who are forced to clean up their act by government law use their new found environmentalism to indicate their concern and compassion for the environment

These factors of consumer mistrust aid in visualizing the need to develop support tools that enable consumers to connect these linkages and truly be enabled to evaluate their current selections with alternatives.

2.4 Consumer Values

There is an abundance of information available both *offline* and *online* that can aid consumers in making informed product choices. In order for consumers to make the most informed product choices, consumers must filter through all relevant information to make the best possible decisions. Consumers often use the information they collect in conjunction with their set of values to formulate their purchasing decisions. Given the complexity of this task, due to the amount of information that consumers must filter through, this can be quite daunting. Currently consumers lack the necessary support to conduct this analysis for green purchasing.

Another issue relevant to consumer values is whether or not consumers understand environmental attributes and if they can use their understanding to conduct a true comparison with their set of values. Given the scientific nature of many environmental attributes, some consumers may not have the necessary skills or knowledge to satisfactorily compare their values with these attributes.

Given the issues described above in the previous sub-sections (2.1 - 2.4), development of support tools to aid consumers in formulating more eco-effective selections may reduce/limit their skepticism and adequately equip them to be empowered to make more informed product selections. Such tools would also benefit consumers as they may enable them to conduct item comparisons and view *focused* product information based on their values. The usability of these tools is a key factor to whether or not consumers will have a satisfactory shopping experience while using these tools. The following section will discuss environmental decision support tools as well as an experiment conducted by the authors here to evaluate the metric of decision accuracy.

3. Usability of Environmental Decision Support Tools

The topic of environmental decision support tools, the unique characteristics of the environmental decision support tool architecture, and the unique nature of their system users has received significant research interest (Swayne et al., 2000, Frysinger, 2005; Hepting and Maciag, 2006). For the past several years, the authors of this paper have been conducting research in understanding how to design and develop more effective and usable consumer-oriented environmental decision support tools for green purchasing tasks (Maciag, 2005, Maciag and Hepting, 2005; Maciag et al., 2005; Maciag et al, 2006; Maciag et al., 2007).

Specific to the scope of this paper, the authors conducted an analysis of a metric to rate the usability of such tools. The metric enables discovery of user patterns, leading design and development of more usable support tools. This section will provide a discussion of the metric evaluated and describe the experiment conducted by the authors.

3.1 Usability Metrics

There exist several metrics that could be used to determine the usability of a system. For example, user response times could be used to indicate whether or not system users are performing tasks efficiently and with ease. As well, system users could be given prescribed tasks where their responses are evaluated and graded accordingly. This information could be used to indicate whether system users are using the tools effectively to find products matching given criteria. Although these metrics provide some indication on how well system users are conducting analyses using the system, they give no indication whether or not these users could use the system effectively for personal tasks that are based on their own individual values. This metric is arguably of greater interest. For this purpose, the metric of *decision accuracy* could be used.

3.2. Decision Accuracy

Decision accuracy is a metric that can be used to determine how well consumers are finding items matching their individual value set (Pu and Chen, 2005). To evaluate decision accuracy for consumer-oriented environmental decision support tools for green purchasing, consumer preferences could be elicited and analytically compared with product selections.

3.3 Experiment Design

Using data previously obtained from a usability evaluation conducted by (Maciag, 2005) of two environmental decision support tools, one based on a suite of tools designed by the United States Environmental Protection Agency (US-EPA) and the other designed by the authors called *cogito*, an analysis of decision accuracy was conducted. Each support tool enabled comparisons of 29 environmentally preferable cleaning products using eight environmental attributes (i.e. *skin irritation, product is a concentrate, product reduces exposure to concentrate, product contains fragrance, air pollution potential, food chain exposure, product uses recyclable packaging, product contains dye*).

For the usability evaluation in (Maciag, 2005), 56 participants were recruited and asked to conduct a number of tasks on the two support tools. One of these tasks was to rank the eight environmental attributes using the following four-point scale:

- *Unimportant*
- *Somewhat important*
- *Important*
- *Very important*

As well, participants were asked to select a product while using one of the support tools that they would consider purchasing for their own personal use. Some participants did not respond with a product selection and thus were excluded from the evaluation (ten and four participants did not provide product selections while using the US-EPA and *cogito* tools respectively). The information collected was used to derive an equation to calculate the participants' decision accuracies.

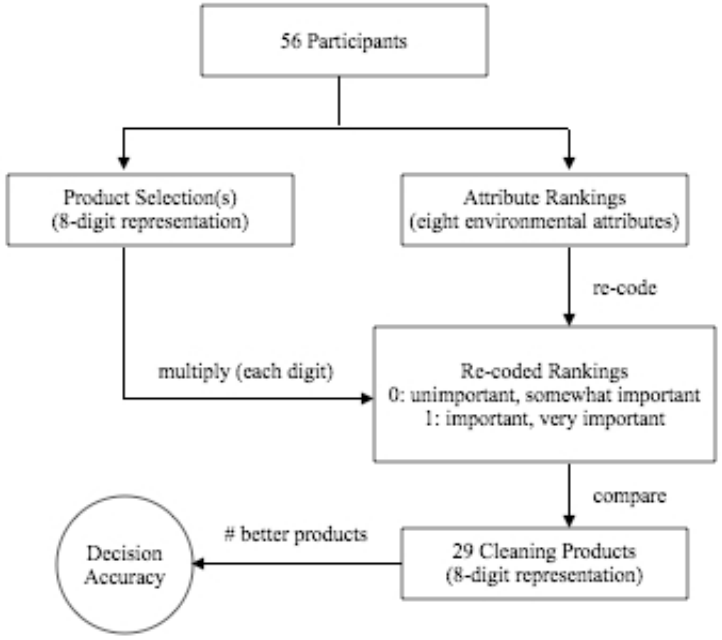
3.4 The Evaluation

Decision accuracy was calculated in terms of a participant's *selected* and *ranked scores.* Figure 1 illustrates this procedure and provides a detailed example. The participant's selected score was calculated by analyzing all of the products with respect to each of the participant's product selection(s). The participant's ranked score was calculated by analyzing the participants' pre-stated attribute preferences with respect to the eight environmental attributes found in the each of the cleaning products (for each product, the eight environmental attribute assignments were re-coded into a numeric value thus forming an 8-digit value assigned to each product, refer to the example in Figure 1). The rankings were re-coded into those attributes ranked as important or higher (value = 1) versus all others (value = 0). For each product, their attribute values were multiplied with the participant's re-coded attribute rankings. This procedure determined the number of products that were "better" then the ones selected by each participant and thus formed the participant's decision accuracy.

4. Discussion

Based on the results obtained from the experiment described in the previous section, for participants using the US-EPA tools 9 of 18 (50%) were able to find products with 100% decision accuracy. For participants using the *cogito* tool designed by the authors, 13 of 24 (54%) were able to find products with 100% decision accuracy. These results prove interesting since preliminary results from (Maciag, 2005) indicated that participant response times and task scores were significantly improved when participants were answering prescribed tasks on the *cogito* tool designed by the authors. Although it appeared that participants performed more effectively using the *cogito* tools in terms of these metrics, given the results of the analysis of decision accuracy described here, there would seem that there is still room for improvements in the design of the user interface.

Some work by the authors has already been done towards this goal with respect to personalization of user interfaces for these tools. Specifically, in (Maciag et al., 2007), a procedure is described to design and develop customizable and personalized user interfaces for online shopping support tools of this kind. The authors of this paper hypothesize that incorporating customizable and personalized aspects in the design of the user interfaces for such support tools could increase the likelihood consumers would achieve higher decision accuracies. Thus, consumers would have more satisfying shopping experiences and an increased likelihood of being more adequately equipped to truly compare current item selections with possible eco-effective alternatives.



Example:

- Product Selection: Product 14
- Recoded ranking: 10010010
- Product 14: 10030012
- Product 14's score:
  10010010*10030012 = 10030010
- Product 12: 10020000
- Product 21: 10041102
- Product 12 score:
  10010010*10020000 = 10020000
- Product 21's score: =
  10010010*10041102 = 10040000
- Product 12 < Product 14
- Product 21 > Product 14
- Only **1** product is better than selected

Figure 1. Illustration and detailed example of the functionality of the authors' calculation of decision accuracy.

5. Conclusion

This paper provided an overview of metrics that could be used to discover usability patterns in consumer-oriented environmental decision support tools for green purchasing. The authors discussed numerous issues specific to environmental decision-making and provided an overview of research being conducted by the authors towards the goal of designing and developing more usable support tools of this kind. A review of commonly used usability metrics was provided with emphasis on the metric of decision accuracy. The authors hypothesize that decision

accuracy could give a clearer depiction of the usability of a support tool, rather than the commonly used metrics of user response times and task scores, as decision accuracy directly evaluates whether system users can find products matching their individual values.

The work described in this paper has led to plans to incorporate decision accuracy functionality in the design of user interfaces for online shopping support tools for green purchasing. As such, the authors are currently planning an extension of the research described in this paper by further evaluating new calculations for decision accuracy, specifically utilizing techniques in classical data mining and rough sets. The underlying goal of this research is to formalize a procedure to incorporate decision accuracy functionality in the design of the support tool user interface. This functionality would provide system users with dynamic feedback concerning their item selections, thus enabling them to automatically evaluate their selections. Future work will include implementation of the decision accuracy functionality and its evaluation.

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