Encouraging Sustainable Consumption through Product Lifetime Extension: The Case of Mobile Phones

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Abstract

Mobile phones are more frequently replaced than any other electronic good, withover 140 million unitsdiscarded annually in the U.S; only 10% of them are recycled. The objective of this research was to identify marketing strategies such as designing for durability and customization that might encourage individuals to extend the lifetime of their mobile phones and thereby decrease replacement frequency and negative environmental impacts. A conjoint experiment was designed to examine the relative importance of durability/functional life, cost, performance, style, customization and upgrade procedure on preference for mobile phones among U.S. college students. Durability and phone customization were found to have a significant impact on phone preference, and mobile phones designed to last five years or more and that included many options for personalization were most preferred. The paper concludes with a discussion of how lifetime extension strategies for mobile phones and other products might be successfully integrated into new product development processes and encouraged by public policy initiatives.

Keywords: mobile phones, sustainable consumption, conjoint analysis, product des

1. INTRODUCTION

Americans are often characterized as the "disposable society" or a "throwaway culture," buying, consuming and disposing of products at ever increasing rates. For example, 90% of all products are thrown away within 6 weeks of purchase (Mont, 2008), and many products that used to be repairable are no longer capable of being fixed. This is a particular problem with consumer electronics (including mobile phones), a product category with complex components, short technology cyclesand low recycling rates. In fact, it is estimated that globally, 20-50 tons of e-waste are generated annually, making up over 5% of municipal solid waste worldwide (Greenpeace, 2011). Members of the "net generation" who have grown up with electronic goods, expecting and even demanding frequent technological improvements, have the potential to generate an even greater amount of e-waste during their lifetimes. For example, a recent empirical study with those 18-21 reported that the product lifetime for mobile phones is one year or less, and that 33% of the respondents had owned 4-8 mobile phones in their lifetimes; wealthier respondents had owned even more (Hanks, Odom, Roedl&Blevis, 2008).

One reason for this preference for new electronics is based on consumers' conditioned response to manufacturers' strategies of frequent technological upgrades and style "facelifts"as a means of increasing sales and profits. While significant improvements in eco-efficiencyhave been made over the last decade, this type of technological fix leaves a fundamental problem unaddressed: the short lifetime of our electronic products. Increases in eco-efficiency do little to reduce the overall environmental impact of electronic products because the *absolute levels* of consumption (and thus disposal) continue to rise as the innovation cycle shortens(Cooper, 2005; Mont, 2008). If we cannot rely on ever-increasing resource productivity and technological solutions to the problems of overconsumption and e-waste, we must then consider how to encourage individuals and society to consume in a more sustainable manner. One means of accomplishing this goal is to persuade individuals to hold on to their current electronic products for a longer period of time; extension of a product's lifetime is frequently cited as a means of reducing environmental impact, although little has been done by manufacturers to encourage individuals to do so (Charter &Tischner, 2001; Cooper, 2004; Nieuwenhuis, 2008; Strandbakken, 2009). Product lifetime extension or optimization can be achieved via design for environment (DfE) strategies (e.g., designing for increased durability and repairability).

Design innovations are particularly important since 90% of environmental impacts are determined at the design stage (Lewus, Gertsakis, Grant, Morelli, &Sweatman, 2001). To be most effective, DfEstrategies need to be paired with marketing strategies that encourage attitudinal and behavioral shifts consistent with sustainable consumption (e.g, establishment of an emotional attachment to a product) and with incentives for manufacturers to design more durable phones (e.g., Extended Producer Responsibility; EPRrefers to legislation or voluntary policies in which manufacturers are responsible for discarded goods).

1.1 Research Objectives

The research presented here aims to explore the product design route to increasing product lifetimes for one particular product,mobile (cell/smart) phone. Mobile phones were chosen for several reasons: (1) over 80% of Americans own a mobile phone, 90% of 18-29 year olds (PewResearchCenter, 2010), (2) mobile phones are more frequently replaced than other electronic goods; over140 million units are discarded annually in the U.S, while only 10% of them are recycled (EPA, 2008), (3) mobile phone waste is toxic, including such persistent, bio-accumulative toxins (PBTs) as antimony, arsenic, beryllium and lead (Mineral Information Institute, 2010), and (4) globally, mobile phone penetration is increasing rapidly – there are over 5 billion mobile phonescurrently in use(CBS news, 2010).Clearly,"mobile devices have become part of consumers' lifestyles, an extension of who they are and what they do for work and recreation" (J.D. Power, 2010a; p. 1). This is particularly true of college-aged individuals, the focus of the present study (Katz & Sugiyama, 2006; Wilska, 2003).

There are few empirical studies that have explored which attributes drive mobile phone choice and satisfaction or how individuals might be persuaded to keep their mobile phones for a longer period of time. Several authorshave called for more research on how individuals would respond to new products that are more durable and resistant to technological obsolescence (Guiltinan, 2009; Sheth, Sethia&Srinivas, 2010).The primary research questions addressed by the present researchare:

> **Research Question #1:**What is the relative importance of current and potential product design attributes – including attributes like durability that can increase product lifetime - on preference for a particular mobile phone, as determined by a conjoint experiment?
> **Research Question #2**: Are there effective marketing, design and/or public policy strategies that will encourage individuals to extend the lifetime of their mobile phones?

The next section of the paper begins witha discussion of sustainable consumption/production and the slow consumption movement. Next is a summary of research on the product attributes important in mobile phone choice.The third section of the paper describes the empirical research conducted and how the findings address the research questions above. The paper concludes with a discussion of how lifetime extension strategies for mobile phones might be successfully integrated into new product development processes and encouraged by public policy initiatives.

2. BACKGROUND

2.1 Sustainable Consumption and Production (SCP)

"Current global consumption patterns are unsustainable…. changes will be required to consumer lifestyles, including the ways in which consumers choose and use products and services" (World Business Council for Sustainable Development, 2008). Note that nothing is said about limiting consumption; this has not been part of the strategy agenda for either marketing practitioners or most academics, with the exception of researchers in the macromarketing discipline (Huang &Rust, 2011; Kilbourne&Carlson, 2008;Kjellberg, 2008). This is not surprising, given that the dominant social paradigm of developed (and now developing) countries equates increased consumption with "progress" and a better quality of life (Kilbourne&Carlson, 2008; Sheth, Sethia&Srinivas, 2010). Marketers, with their focus on purchases and how to achieve them, encourage consumption with the continuous introduction of "new and improved" products/services; the relationships between consumption and resource depletion (environmental degradation) or consumption and community/individual well-being are rarely addressed.

The SCP branch of the United Nations Environment Programme (UNEP), on the other hand, considers production and consumption policies to be two sides of the same sustainability coin that need to be considered using an integrated life-cycle approach.

They define sustainable consumption as the individual's responsibility to "use services and related products which respond to basic needs and bring a better quality of life while minimizing the use of natural resources and toxic materials as well as the emissions of waste and pollutants over the life-cycle so as not to jeopardize the needs of future generations" (http://www.unep.fr/scp/).On the production side, the UNEP has developed policies and initiatives on sustainable product design (Design for Environment or DfE), and sustainable procurement (greening the supply chain), cleaner and safer production (a broad term that encompasses eco-efficiency, waste minimization and pollution prevention), and sustainable resource management (achievement of circular material flows). While the UNEP places more emphasis on reducing the use of toxic materials and increasing resource productivity, the successful implementation of SCP policies will require overall reductions in the throughput of resources, including a decrease in virgin inputs and waste outputs. One means of achieving this is to increase product lifetimes by developing product-service systems that encourage individuals to hold on to a product for a longer period of time (Cooper, 2010; Kang &Wimmer, 2007).

Will this work in a culture that defines citizens as "consumers" and in which individuals spend an average of 20-30 minutes a day purchasing goods and services (Bureau of Labor Statistics, 2009)? While marketing theory and practice have traditionally assumed a positive relationship between consumption, need satisfaction and personal happiness, there is a significant body of empirical research that indicates that once basic needs are met, there is a negative relationship between consumption levels and perceived well-being(Kaiser, 2002; Roberts &Clement, 2007; Seligman, 2006). One hopeful sign that members of industrialized societies are beginning to rebel against a cultural value system that emphasizes economic growth, individual wealth, conspicuous consumption, 24/7 convenience and speed is the "slow activism" movement.

2.2 "Slow Activism"Movement

The slow movement is a philosophy that advocates a slower pace of life, originating with the Slow Food movement in Italy in 1986 (www.slowfood.com). Consistent with the sustainable consumption definition offered by the UNEP, but with no ambivalence about the destructive environmental and social roles currently being played by overconsumption, "slow consumption" calls for slowing the rate at which raw materials are transformed into products and eventually discarded (Ax, 2001; Fuad-Luke, 2010). This is a broad movement that is finding expression through such avenues as slow design (SlowLab), slow localism (Slow Cities) and anti-consumerism(Buy Nothing Day). Thus, slow movement advocates are more likely to invest in a well-made, long-lasting, aesthetically pleasing, repairable product then to buy one that performs the same function but does not possess these qualities. They are more likely to make a product than to buy it, to reuse products as much as possible, and to customize or personalize products (Andrews&Urbanska, 2009; Honore, 2004). To meet these desires, slow designers are creating durable, high quality products that age with dignity, encourage emotional attachment, allow customization and co-production, and stimulate social contact through shared use (*Eternally Yours Foundation*, Cooper, 2005).

2.3 Relative Importance of Product Attributes in Mobile Phone Preference

How important such attributes are in consumers' mobile phone choice remains an empirical question. Several studies with adults report that product durability is not a particularly important attribute in choice, even for so-called durable products like washing machines or refrigerators (Cooper &Christer, 2010; Guiltinan, 2009).Turning to studies on mobile phone design specifically, most focus on usability testing using observational methods (see Ling, Hwang&Salvendy (2007) for a review).In usability research based on interviews with adults and college studentsthe following attributes have been found to be important in mobile phone choice: price (phone and plan), physical appearance/visual aesthetics, performance (e.g., speed, sound quality), ease of operation, features,[1] ability to personalize the phone, and durability (including battery life). Table 1 summarizes the findings related to each of these attributes. No clear ordering of relative importance emerges from a review of this research stream, except for the findings that (1) satisfaction with many phone characteristics is low, even as the number of features increases, (2) young adults express a desire for a more durable/robust phone, and (3) younger individuals place more weight on the physical appearance of a phone and the ability to customize or personalize it than older individuals.

[1]Features most often used: SMS, alarm clock, calendar, calculator, ringtones (Yankee Group, 2010).

Table 1: Product Attribute Importance in Mobile Phone Choice

Product Attribute	Findings	Source
Durability; robustness	• Unsatisfactory: design life only 1-2 years • Conflict between light as possible and some weight that will convey robustness • Teenagers want more robust design for everyday use; feel physical quality of devices has dropped	Geven et al., 2008; Ling et al., 2007; Mazzoni et al., 2005;Totten et al., 2005; Wilhelm, 2012
Personalization	• Unsatisfactory: little customization possible • Very important to teenagers • Increased concerns about security and privacy w/increases in customization (e.g., apps downloads)	Geven et al., 2008; Ling al., 2007; Puligadda et al., 2010; Wilhelm, 2012
Style/Design	• Unsatisfactory: limited number of design options • Teens: final look more important than specific form ("has to look cool"); seen as lifestyle object	Geven et al., 2008; J.D. Power, 2011; Katz & Sugiyama, 2006; Ling et al., 2007; Puligaddaet al., 2010; Totten et al., 2005; Wilska, 2003
Performance	• Unsatisfactory: battery lifetoo short, hasn't kept up with other innovations • Satisfactory: speed, sound quality	Geven et al., 2008; Ling et al., 2007; J.D. Power, 2011; Mazzoni et al., 2005 ; Puligadda et al., 2010; Totten et al., 2005
Price of Service Plan and Phone	• Unsatisfactory: service plan; prices are increasing &lower prices are main reason for switching providers • Phone prices are decreasing; average price paid in 2010 was $80	J.D. Power, 2010a, 2011; Manzzoni et al., 2005; Yankee Group, 2010
Ease of Operation	• Unsatisfactory: increasing number of features=greater complexity=steeper learning curve	J.D. Power, 2011; Mazzoni et al., 2005
Key Features	• Unsatisfactory: picture quality, storage • Camera/camcorder,SMS & ring tone options most important • Other desirablefeatures: internet access, MP3 playback, ability to download apps, storage (pictures, MP3, video), USB memory capability	Geven et al., 2008; J.D. Power, 2011; Mazzoni et al., 2005; Puligadda et al., 2010; Yankee Group, 2010

Mobile phones as "fashion statements" among young adults has been demonstrated in several studies (Katz & Sugiyama, 2006; Wilska, 2003). This "fashion attentiveness" is consistent with the findings that young people place more emphasis on physical appearance in mobile phone choice. Further, satisfaction levels increase with a greater variety of attribute options, because this allows for personalization and customization of the device (Puligadda,Grewal, Rangaswamy&Kardes, 2010). The ability to customize a product has been found to increase satisfaction levels and reduce replacement frequency; it is a form of co-creation (Ho & Lee, 2011). Ease of operation is also important to young people because it is vital to their self-presentation that they demonstrate expertise when using their mobile phone (Ling &Yttri, 2005). Hypotheses about which mobile phone attributes would be the most important in choice were not developed for this study due to a lack of theoretical and empirical evidence. For purposes of the current research, it is important to determine the relative importance of durability and other attributes that would allow individuals to keep their phones for a longer period of time (e.g., phone personalization options, upgrades delivered via software instead of hardware).

2.3.1 Individual Differences in Attribute Importance. Men rate themselves as higher on "technology enthusiasm" andlower on environmental values than women (Wilska, 2003). The same study found that teen men believe that advanced technology can solve environmental problems while teen women believe that technological innovations make environmental problems worse. This suggests that young men, relative to women, may place more emphasis on mobile phone technological performance/features in choice and be less concerned about design elements that improve sustainability. On the other hand, self-proclaimed environmentalists are more likely to choose a phone that possesses features that enhance product sustainability (durable design, upgrades delivered via software, phones made from recycled components) (Makower, 2010; Ottman, 2011).

2.4 Strategies to Encourage Lifetime Extension

Can we identify marketing that would serve to increase individuals' attachment to their mobile phone and thus extend the lifetime of these products? Table 2 matches particular strategies (e.g., upgradable by user) with specific product attributes or marketing tactics (e.g. stand-alone modules that can be added/subtracted) and provides examples of each. While these strategies may work for some products, their effectiveness with mobile phones is unknown. One of the objectives of the present study is to assess individuals' reactions to several of the design approaches listed in Table 2: durable design, personalization options, availability of remanufactured phones, and upgrades delivered via software rather than hardware.

Table 2: Marketing Strategies to Encourage Mobile Phone Lifetime Extension

Strategies	Tactics	Examples (existing & possible)
Design for Emotional Attachment: Emotionally Durable Design	• Design for co-creation (similar to open-source movement & collaborative consumption) • Design for durability, variability, personalization, customization • Design for "unmasking" the object: working parts revealed, construction explicit, familiar materials • Product reassignment: design for sequential "use careers"	• Buy "skins" for electronics w/designs created by an online community (e.g., threadless.com); design submissions win $ if chosen • During use: product captures contact list and pictures, add personal elements; improves over time • Mobile phone changed to be used for keeping track of your dog or for use by your child
Design for repair and maintenance by user	• Make it easy & fun to maintain/repair • Note: harried lifestyles negatively affect priority assigned to repair • Target specific segments that defy obsolescence (e.g., collectors)	• Parts easily changed • Product lets you know when and what it needs fixed/maintained • Parts easily available (including internet) • Provide spare parts w/original product
Modular/upgradable by user	• Design for software upgrades, not hardware • Design for upward and downward compatibility • Design for ability to add/subtract stand-alone modules • Design for reliability and robustness	• iPhone: software upgrades • Mobile Phone Kit (MMPK); • Asus and Dell planning upgradable laptops
Make life extension "cool"(new = gauche)& discarding expensive	• Design w/variability caused by wear and tear • Marketing tactics; viral campaigns • Internalize current externalities to include cost of discarding in price • Luxury product positioning: users expect long-life and durability	• Swatch watches that reveal a unique pattern with usage • Hard to do with mobile phone because most people don't think of plastic products as luxuries or as ageing gracefully
Sell services rather than product (move to product-service systems)	• Design for modular replacement • Guarantee functionality and durability of product (free maintenance, repair) • Address needs rather than selling physical ownership	• Leasing, renting (e.g., Interface Carpet Inc.; Xerox)
Educate individuals about the problem of e-waste; give them access to data on design life of products	▪ Eco-labels ▪ Associate durability associated environmental sustainability	• Not currently being done • Eco-labels in other product categories
Increase value through information networks & secondary markets	• Manufacturer trade-in programs	▪ ebay: 333 used mobile phones and 1013 new phones for sale (7/11/2011) ▪ Increasing trade-in values for smart phones

Sources: Cooper, 2004, 2010; Geven et al., 2008; Guiltinan, 2008; Ling et al., 2007; Mazzoni et al., 2005; McCullough, 2009;Totten et al., 2005; Truttmann&Rechberger, 2006; Wilhelm, 2012.

3. METHODOLOGY

3.1 Research Design

Preferences formobile phone attributeswere estimated in a choice-based conjointexperiment where the product attributes subject to choice were (1) performance/features, (2) style/design, (3) functional life or durability,(4) phone cost, (5) policy on obtaining upgrades, (6) personalization options,and (7) ease of operation (see Figure 1 for a definition of each attribute as communicated to respondents).Findings from previous studies (Table 1) and pilot study findings with members of the target population identified these attributes as important in cell phone choice. The service provider attribute was held constant across conjoint tasks by asking respondents to assume that the service provider was the same for all phone options under consideration.

Figure 1: Conjoint Instructions

We will be showing you mobile phone descriptions and asking you to choose the phone you most prefer, the one you would be most likely to buy. **Please assume that the service provider and plan are the same for each phone presented.** Each mobile phone will be described on seven (7) different product characteristics:

1. **Performance/Features** of the phone on such dimensions as battery life, call quality, coverage, speed, and number & kinds of applications
2. **Style/Design** of the phone in terms of its physical appearance and trendiness
3. **Personalization options,** or the ability to customize the phone to suit your personal tastes, including customizing the design, features and look of the phone
4. **Durability** of the phone, as measured by how long it is designed to function properly
5. **Ease of operation**, or how easy/hard it is to learn to use the phone
6. **Upgrade Policy** when you want a new technology, feature or style
7. **Cost** of the particular phone

The design was full-profile in the sense that all seven of the attribute values were presented for each set of two mobile phone alternatives that required a preferred phone choice by each respondent. The experimentobtained respondent choices on each of ten randomly generated screen displays, or *choice tasks*, and a fixed holdout screen, each of which presented two competing phone options. The random displays were generated from 2187possibilities corresponding to three levels of seven different phone attributes as presented in Table 3.

Table 3: Conjoint Attributes and Levels

Phone Attribute*		Attribute	Levels
Performance/ Features	Very Basic	Average/Typical	Cutting Edge
Durability	1-2 years	3-4 years	5 years or more
Style/Design	Really Dislike	Just O.K.	Really Like
Upgrade Policies	Replace current phone with **new phone** to obtain upgrades	Modify **current phone**to obtain upgrades	Replace phone with **recycled/refurbished phone** to obtain upgrades
Personalization Options	Very Few	Some	Many
Ease of Operation	Hard to Learn	Somewhat hard to learn	Easy to Learn
Cost of Phone	$250	$100	$50

*Respondents are told to assume that all phone options have the same service provider, plan and monthly cost

The recorded choices on each of the ten randomly generated choice tasks by each respondent were the inputs to a hierarchical Bayesian analysis that estimated the respondents' utility functions across phone attributes. The responses to the fixed holdout screen were used to test the predictive power of the utility function estimates. The results formed the basis for determining the "ideal" phone and preference shares of the respondents in simulations of competing mobile phones.

3.2 The Respondent Sample

The respondents were solicited from a targeted population of college students at a U.S. west coast university who own a mobile phone and are the decision makers when it comes to making a choice of service provider, service plan and price point. An invitation to participate in the present study was prepared and emailed to a random sample of students with brief background information on the subject of thestudy and how the data would be used. Introductory screening questions on the questionnaire limited respondents to those who metthe above criteria. The data was collected in July 2011. Of 5,050 individuals who received email invitations to participate, 1449 completed the online questionnaire, a response rate of 29%.

3.3 Experimental Design

A fractional factorial,randomized experimental design was used to select the choice tasks for each respondent. A balanced overlap method employed random sampling with replacement for choosing between the phone options and permitted some attribute level overlap in screen displays (e.g., respondents would see two phones that have the samedurability level but differ with respect to performance, style, etc). The overlap increases the power of the test to detect attribute interactions (Chrzan&Orme, 2000; Orme, 2009) In addition to the ten tasks that were randomly generated for each respondent as described above, a fixed choice taskthat did not vary across respondents was presented in the middle of the randomized choice tasks and used as a holdout task(not used in estimating the utility functions). Analysis of the responses to the holdout screen provided an indication of how well the utility values estimated from the ten randomized tasks predicted each respondent's actual holdout choices.

For each of the screen presentations, two different phones were presented side-by-side, and respondents were asked to indicate which they would choose if their mobile phone broke and they needed to purchase another phone that day, assuming these were the only two alternatives available. Respondents were also asked to assume that the service provider and plan were the same for each option, thus removing any confounding effect of provider/plan on their choices. The instructions to the respondents and an example of a screen can be seen in Figure 2. The presentation order of the attributes for the phone remained the same for each respondent in order to make the information processing task easier and to limit the potential impact of fatigue on data quality. For the same reason, the number of tasks was limited to the ten randomly selected screens and the holdout screen described above. Attribute presentation order, except for phone cost which was always displayed last, was randomized across respondents so that it would not have systematic effects such as primacy or recency on the experimental results.

Figure 2: Example of Conjoint Task

Assume your mobile phone broke today and you need to purchase a new one. Which of the two phones described below would you choose to buy?

Assume the service provider and plans are the same for each phone option.

	Mobile Phone:	**Mobile Phone:**
Ease of Operation	Easy to learn	Hard to learn
Personalization Options	Very few	Many
Durability	5 years or more	1-2 years
Style/Design:	Really Dislike	Really Like
Upgrade Procedure	Replace phone with **recycled/refurbished phone** to obtain upgrades	Replace phone with **new phone** to obtain upgrades
Performance & Features	Average/Typical	Very Basic
Cost of phone	$50	$250
	◉	○

Finally, the attribute value ranges included in the experimental design reflect typical industry offerings on these attributes. The validity of the results is enhanced to the extent that respondent choices are reflective of realistic values for important attributes that customers consider in their decision-making processes. The same number of levels was used for all attributes to achieve a balanced design.

3.4 Individual Difference Questions

The conjoint tasks were followed by questions asking respondents about their general cell phone behavior: the number of mobile phones they had owned in their lifetime, motivations for buying a new phone, and how they discard phones they are no longer using. These were followed by three questions on environmental behaviors/beliefs: recycling frequency, organic/free trade purchasing frequency and level of concern regarding climate change. These constructs were selected based on the findings discussed earlier of a positive relationship between pro-environmental behaviors/beliefs and "green" product choice. The expectation is that this relationship will hold for choice of a "green" cell phone so that environmentalists will prefer a more durable, remanufactured phone that can be upgraded without buying a new one. The survey concluded with some basic demographic questions.

3.5 Use of the Internet for Data Collection

Several factors recommended the use of the internet to conduct the study. Computer generated choice tasks are more easily randomized and this form of data collection is much faster and easier for the respondents. Respondents required an average of twenty minutes to complete theonline questionnaire. Several introductory screens were devoted to describing the purpose of the study, to assuring anonymity, and to explaining the choice tasks. The choice tasks were followed by the individual difference questions described above.

4. RESULTS

4.1 Sample Characteristics

Table 4 presents a profile of the respondents. The sample was fairly evenly distributed across year in college and income levels. Women were overrepresented relative to the university student population, at 68%. Most respondents recycle and sometimes or frequently purchase organic or fair trade products; 82% are concerned about global climate change.

These data indicate that the respondents were somewhat more environmentally conscious and more likely to be female than the general population, so care should be taken in generalizing the study results to the U.S. college student population as a whole.

Table 4: Profile of Respondents

Variable	Overall
Level of College	Freshman: 23% Sophomores: 16% Juniors: 25% Seniors: 28% Grad: 8%
Family Income	Under $50M: 37% $50-100M: 35% Over $100M: 28%
Gender	Males: 32% Females: 68%
# of phones (in lifetime, average)	4.4
Expected lifetime of phone (average)	2.9 years
Desired lifetime of phone (average)	5.3 years
Importance of providing phone lifetime info on package (1=not at all important, 7= very important)	4.3 (somewhat important)
Willingness to buy phone made from recycled materials	97% somewhat or very willing
Method of disposing of old phone	64% recycle it 12% keep it as backup 8% give it away 5% throw it away 2% trade in for new Phone
Frequency of recycling at home/work	83% frequently 13% sometimes
Frequency of purchasing organic/fair trade products	52% sometimes 24% frequently
Concerned about global climate change?	82% yes

4.2 Mobile Phone Consumption Behavior Patterns

Respondents had owned an average of 4.4 mobile phones in their lifetime. They expected their current phone to last almost three years, but would prefer a phone with a functional lifetime of more than five years. The provision of durability information on the "package" was desirable and perceived as somewhat important. Over half of the respondents recycle their phones when they are ready for a new one, and very few expressed any reluctance to purchase a phone made from recycled materials. These findings suggest that marketing strategies that extend the product lifetime of mobile phones through design modifications and/or re-manufacturing would be well-received by college students.

4.3 Multinomial Logit and Hierarchical Bayesian Analysis of the Experimental Data

The ten choices by each of the 1449respondents were the input to hierarchical Bayes (HB) estimations.[2]

[2]Sawtooth Software, Inc.'s hierarchical Bayes estimator was used. Simulations described below were also conducted using Sawtooth programs.

The HB technique provided an indication of the heterogeneity in the population in the form of posterior means of the distributions for each individual's part-worths and a more realistic fit for the data than an assumption that all individuals valued the various attributes equally. The individual-level heterogeneity that was captured facilitated analysis conditional on individual difference characteristics of the respondents. Both main and interaction effects models were examined to determine which one best fit the databecause chi-square tests conducted prior to the HB analysis indicated that all main effects and two interaction terms were statistically significant in affecting the respondent choice. Root likelihood (RLH),a measure of goodness of fit, was calculated for each of the HB model distributions.RLH was 93% for the model that included the significant interaction terms compared to 85% for a model limited to main effects, and out-of-sample prediction was better for the model with interactions.

4.4 Relative Attribute and Attribute Level Importance

The relative importance of each product attribute is displayed in Table 5.The most important phone attributeswere the cost of the phone and its style/design, followed by performance/features and durability. An examination of gender differences in attribute importance values revealed that phone style was more important than cost for women, while phone performance and features were more important for men, although cost and style were still the most important attributes in determining phone choice for both men and women. These findings are consistent with the research discussed earlier, indicating that men are more inclined to be technology enthusiasts than women. Finally, the upgrade procedure attribute was of low but significant importance to women, but not to men, consistent with the finding reported above that a recycled or re-manufactured phone does not present much of a barrier to purchase.

Table 5: Relative Attribute Importance's Derived from HB Estimated Utilities

Attribute	**Overall Importance** (n=1449) (chi-square, p value)	**Men** (n=467) (chi-square, p value)	**Women** (n=977) (chi-square, p value)
Cost of Phone	26% (1216, <.01)	26% (403, <.01)	26% (809, <.01)
Style/Design	26% (1179, <.01)	24% (272, <.01)	28%* (913, <.01)
Performance/Features	17% (515, <.01)	20% (237, <.01)	16%* (288, <.01)
Durability	11% (169, <.01)	11% (39, <.01)	11% (129, <.01)
Personalization Options	8% (72, <.01)	9% (28, <.01)	9% (44, <.01)
Ease of Operation	6% (47, <.01)	5% (7, <.05)	5% (43, <.01)
Upgrade Procedure	6% (13, <.01)	5% (1, n.s.)	5% (14, <.01)

NOTE: The relative importance of each attribute was calculated by computing the difference between the largest and smallest part-worth for each attribute, summing the differences, and normalizing to 100. Degrees of freedom=2.

*Significant difference between men and women (p<.01).

A simulation based on the HB-derived part-worth vectors for each respondent was used to estimate market choices (preference shares) for different mobile phones. Preference shares are defined as the percentage of respondents that would prefer (choose) each phone, given a specified set of attribute levels. The randomized first choice method (RFC; Huber, Orme&Miller, 1999) was used. It assumes respondents tend to choose the products that provide them their highest overall utility ("first choice rule"), but it adds unique random error to the utilities in order to recognize the fact that individuals do not invariably choose the product that optimizes their utility. Each respondent is sampled many times to stabilize the share estimates (100,000 times in this study).

The results of these simulations reflect the average utilities of particular attribute levels as displayed in Table 6. The most preferred or "ideal" phone (i.e., the one with the greatest overall utility) across all respondents wasone with a low cost ($50) and cutting edge performance/features, a well-liked and durable design (5 years or more), many personalization options, and an easy to learn layout and operating system. Upgrading through the purchase of new phone was preferred by women, while men did not have a preference for any particular upgrade method (purchase of a new or re-manufactured one, or software modifications to their current phone). Attribute importances did not vary as a function of environmental attitudes or behavior.

Table 6: Ranking of Attribute Level Preferences by Average HB Estimated Utility
Ranking by Attribute Level (utilities)

Attribute	1st	2nd	3rd
Cost of Phone	**$50** (89)	$100 (26)	$250 (-115)
Style/Design	**Really Like** (94)	Just O.K. (17)	Really Dislike (-111)
Performance/ Features	**Cutting Edge** (62)	Average/Typical (4)	Very Basic (-66)
Durability	**5 years or more** (35)	3-4 years (14)	1-2 years (-49)
Personalization Options	**Many** (27)	Some (4)	Very Few (-31)
Ease of Operation	**Easy to Learn** (20)	Somewhat Hard to Learn (-3)	Hard to Learn (-17)
Upgrade Procedure	**Replace Phone w/New Phone*** (8)	Modify Existing Phone (-2)	Replace Phone w/Recycled Phone (-6)

* This attribute and level were only important in mobile phone choice for women.

NOTE: Values are arbitrarily scaled to sum to 0 within each attribute, so some utilities must receive a negative value. This does not mean that this level is unattractive; it does mean that attributes with positive utilities are preferred over those with negative utilities. Utilities are interval data; we can say that the increase in preference from a "Just O.K." phone to a "Really liked" phone is more thanthe increase in preference from a phone that costs $100 to one that costs $50. However we cannot directly compare values between attributes to say that two different attribute levels with similar utility values (e.g., a $50 phone and a "really liked" design) are equally preferred.

4.5 Share of Preference for Different Phone Configurations

A base case simulation was run to examine shares of preference for various phone configurations or products that represent current market conditions. Table 7 displays the results for four different phones that possess different competitive advantages:a low priced, cutting edge performance, very desirable style/design or durable phone. Women have a strong preference for a phone with a very desirable style and average performance (35%) over one with cutting edge performance and only an "O.K." style (19%). Men, on the other hand, are indifferent between a phone with a desirable style/average performance (27%) or one with cutting edge performance/O.K. style (27%). For both men and women, a mobile phone with a long design life (5+ years) does not gain a high share of preference relative to the other competitive offerings.

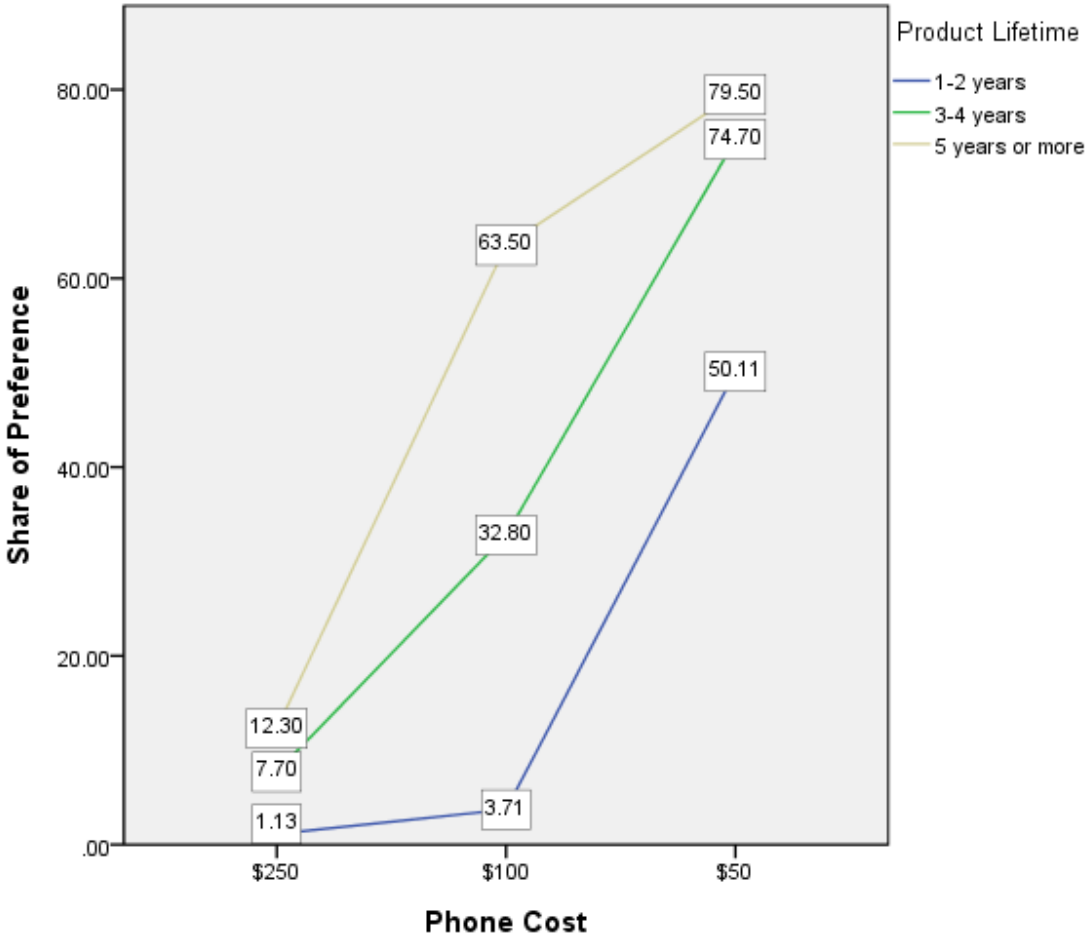
Table 7: The Effect of Gender on Shares of Preferences* for Hypothetical Mobile Phone Products

Product	**Overall**	**Male**	**Female**
Low Price	36%	35%	37%
Cutting Edge Performance	22%	27%	19%
Very Desirable Style/Design	32%	27%	35%
Long Product Lifetime	10%	11%	9%
TOTAL:	100%	100%	100%

***** Share of preference represents an estimate of what percent of the respondents would prefereach product included in the simulation. Shares of preference are ratio data. In this simulation, upgrade procedure, personalization options, and ease of operation were held constant across all four hypothetical products. Except when it was the attribute of focus, price was held constant at $100, performance was held constant at "average/typical," style/design was held constant at "just O.K." and product lifetime was held constant at 1-2 years. These values reflect current market conditions for mobile phones

To examine the impact of durability on preference at different price points, a price sensitivity simulation was conducted in which three products were compared: a phone designed to last for 5+ years, 3-4 years or 1-2 years. The values of the other attributes were held constant at their mid-range, typical levels: average performance, O.K. design, upgrade w/purchase of new phone, $100 price, and easy to learn operation. Figure 3 shows that twice as many respondents would prefer a long-lived phone (5+ years) over a phone designed to last 3-4 years, all else, including price, being equal (64% vs. 33%). At a low price, preferences did not vary significantly between a phone designed to last 5+ years and one designed to last 3-4 years (80% and 75%, respectively).At very high prices, only 12% indicated that they would be willing pay more for a very durable phone. There were no significant individual differences.

Figure 3: The Joint Effects of Phone Cost and Product Lifetime on Shares of Preference*



Share of preference represents an estimate of what percent of the respondents would prefereach product included in the simulation. Shares of preference are ratio data. In this simulation three products were compared: a phone designed to last for 5+ years, 3-4 years or 1-2 years. The values of the other attributes were held constant at: average/typical performance, O.K. design, upgrade w/purchase of new phone,and easy to learn operation.Thus, when phone cost is $100, 64% of respondents prefer a very durable phone over a less durable one.

5. Discussion

5.1 Relative Importance of Product Lifetime on Phone Preference

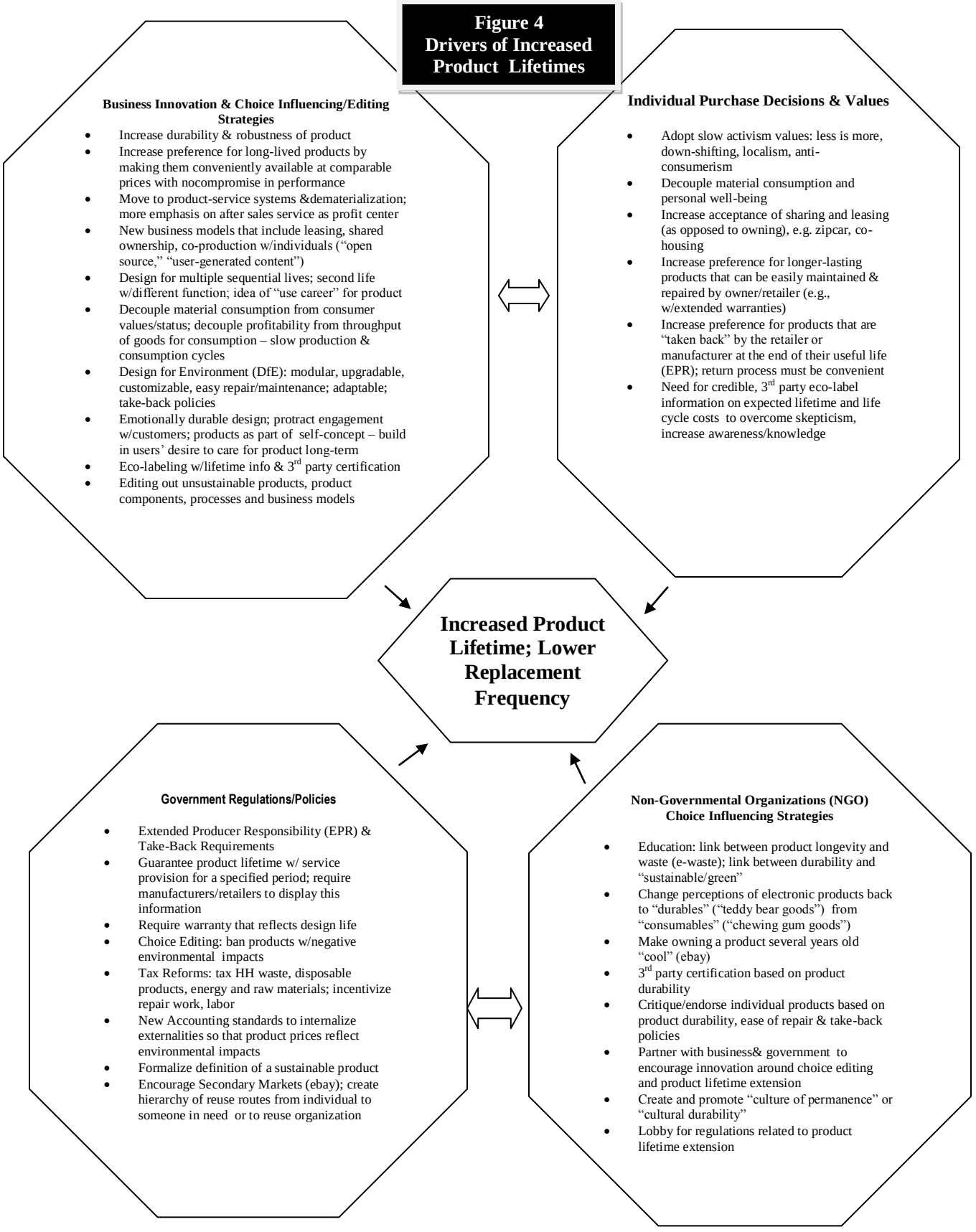
While durability was not one of the most important attributes in determining phone preference, it did have a statistically significant effect on choice and long design life was a componentof respondents' ideal phone product based on the conjoint experiment findings. Further, respondents stated that they would prefer a mobile phone designed to last five years or more, even though they expected their phone to last only 3 years, on average. Respondents also felt it was important to include durability information on mobile phone packaging or at point of purchase. All else being equal (e.g., price, performance, style desirability), a durable phone (5+ years) was twice as preferred as and sixteen times as preferred as a phone with a design life of 3-4 years or 1-2 years, respectively. Thus, a durability strategy to extend the lifetime of mobile phones would be well-received by consumers, if the desired attribute levels on cost, performance and style were achieved. Women in this study were willing to trade some measure of performance for a fashionable phone style/design, while men rated performance and style as roughly equal determinants of phone preference.

This study included two additional phone attributes that might cause individuals to extend the lifetime of their mobile phone, as determined by previous research: the availability of phone personalization options and the ability to upgrade their current phone with software downloads rather than hardware replacement. Customization is one method of increasing emotional attachment to a product, and this attribute had a statistically significant effect on phone choice; respondents' ideal phone would include many options for personalizing their phone. Upgrade procedure, on the other hand, was not important to men, and women preferred replacing their phone with a new phone to obtain technological or feature improvements. This finding is consistent with women's emphasis on style when choosing a particular phone, since it is currently impossible to make major style changes to a phone's via software upgrades alone.

5.2 Product Lifetime Extension Strategies

To motivate manufacturers to re-design mobile phones to extend their functional life, government regulators and non-government organizations (NGOs) need to develop public policies targeting the mobile phone industry. Combining strategy recommendations from the research discussed in this paper,a generalized schematic of potential drivers of increased product lifetimes that could be applied to mobile phones and other productsis presented in Figure 4. For maximum impact, manufacturers, consumers, government, and NGOs would need to work together. Key drivers include extended product responsibility and take-back requirements similar to those already instituted in the EU, eco-labeling with lifetime information and third party certification, new accounting standards to internalize externalities so that product prices reflect environmental impacts, and new business models that represent a move to product-service systems and dematerialization with more emphasis on after sales service as a profit center. These strategies, along with others described in Figure 4, could together have a significant impact on product lifetimes by encouraging product design-for-environment DfE) strategies, thus lowering replacement frequency and reducing negative environmental impacts.

Figure 4
Drivers of Increased Product Lifetimes



5.3 Conclusion

The research reported here was limited to an exploration among U.S. college students of specificproduct design driven lifetime extension strategies for mobile phones. More research is needed with different demographic/psychographic segments of the population and other product categorieson the effectiveness of the lifetime extension strategies discussed in this paper. Gender appears to be an important factor in determining which strategies can successfully extend a product's life,and there may be other individual difference characteristics that impact relative effectiveness, although environmental attitudes or behavior were not found to influence phone preference in this study. In general, sustainable consumption scholarship is an underdeveloped research field that offers many opportunities for empirical and theoretical research (Peattie, 2009). Such research could make a significant contribution to efforts to encourage sustainable consumption and production by individuals and businesses, respectively. It is hoped that this study will stimulate other marketing and business academics to engage in sustainability scholarship.

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