Web-based Decision Support for Mobile Phone Selection[1]

Brian Whitworth, Chun Chieh Yang and Beatrix Jones

Institute of Information and Mathematical Sciences, Massey University, Auckland, New Zealand
bwhitworth@acm.org

Abstract

The rapid evolution of the mobile phone has produced a proliferation of models and features, so selecting a mobile phone is now a complex multi-criteria problem. Customers may find online decision support useful. 105 mobile phone models with 59 technical features were organized by external features like color, and perceived criteria like reliability. The study simulated three forms of online support: 1. A thumbnail catalog, 2. A catalogue plus key features, and 3. A catalogue plus key features plus criteria selection. Subjects rated their satisfaction with the online support. Significant differences were found between the support types and the features and criteria used, with some gender differences. The results suggest that web-based support systems can increase customer satisfaction with mobile phone selection process.

Keywords: Mobile phone selection

1. INTRODUCTION

Mobile phones are a powerful technology that do more than mobile telephony [1], with features like multi-media messaging, e-mail, web-browsing, TV streaming, fax and navigational maps. These developments match the rapid growth of mobile phone use, e.g. while in 1999 only 34% of young people owned mobile phones by 2002 this percentage was 90% [2]. Today mobile subscribers exceed land line subscribers around the world, and in many countries the number of mobile phones surpasses the number of people, as mobile phones are a key social tool in friendship and business. A side-effect of rapid growth has been a proliferation of phone models as manufacturers worldwide compete, with some features quite technical in nature, like Bluetooth, TFT LCD, WAP and MMS. Choosing a mobile phone has become a complex multi-criteria decision problem [3].

Customers selecting a mobile phone may experience *information overload*, defined as facing more information than can be effectively processed [4]. Faulty responses to information overload include over-simplifying by reducing the information attended to, or conversely attending to all the information and spending more time on the problem than it warrants. In the first case the customer may choose a product they later regret, and in the second may spend more time selecting a phone than they want to. An effective response to information overload is to improve information processing, to both use all relevant information and to do so efficiently.

Web-based product selection support could reduce customers selection time and increase satisfaction. For sellers, providing a useful service can predispose buyers to seller products. This paper considers how to design web-based systems to support complex technology selection, and will interest those setting up such systems.

2. CONCEPTUAL FRAMEWORK

Since selecting a phone is a form of technology acceptance, the Technology Acceptance Model (TAM) was used [5], with traditional TAM criteria expanded by Web of System Performance (WOSP) criteria like security and reliability, as argued in [6].

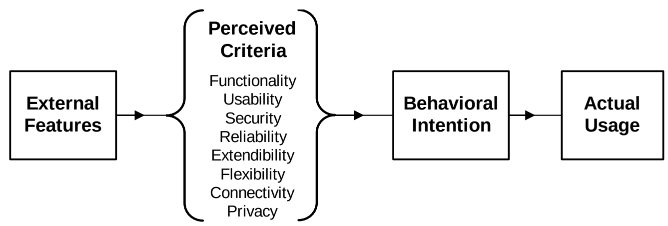

Figure 1. Technology selection framework

Since the scenario envisioned is computer-based support for technology selection, criteria that derive from definable product features are needed. While young people prefer cell phones that are “trendy” [7] or “fashionable” [8], and most U.S. students agree that fashion is important when selecting a mobile phone [9], such it is not easy to relate fashion to product features. Attempts to translate complex cognitive criteria like “elegance” into product design features have struggled [10]. Also criteria like fashion depend not just on the product but also on trends, so what is fashionable in one era may not be so in another. So while social cognitions like “coolness” may affect selection, they are outside the scope of this study. Likewise cognitions that are vary with the individual, like attractiveness were also outside its scope e.g. some people like pink but others do not. This study considers only criteria assumed to derive from external product features like shape, color, size, etc. It assumes a relation between the customer’s intention to buy (product impact) and product features [11], or conversely that various design features affect the model an individual chooses [12].

[1] Published as: Whitworth, B., Yang, C., and Jones, B. (2010). Web-based Decision Support for Mobile Phone Selection. The Ninth Wuhan International Conference on E-Business (WHICEB 2010), May 29 - May 30, 2010, Wuhan, China

The result is the Figure 2 model, where customers form perceptions of criteria like usability from the product's external features [12], which then affect the decision to buy [11]. It distinguishes the *external features* of the phone, and the *perceived criteria* deduced from those features. There is evidence that users are more concerned with user-related criteria like functionality and ease of use than product-related features like size and color, but equally features can affect adoption decisions directly [3]. This suggests these mobile phone selection types:

1. *Selection by catalogue.* A catalogue of all details.
2. *Selection by features*: Users select by features
3. *Selection by criteria:* Users select by criteria.

Most brick and mortar mobile phone shops seem to primarily use the catalogue method, and typically display a board of phones with short summary cards beside each describing presumed key features like WiFi. Normally only a selection of phones the retailer considers representative are displayed. This reduces information overload, as does not showing all the details. However customers have to ask to see the full selection, the same key features are not shown for every phone making comparison difficult, and the features the customer seeks may not be on the summary cards. Customers are expected to ask assistants for more information, which poses problems if assistants are not well informed, are biased or pressure the customer to buy.

Online phone selection support often follows the same method, except now all phones available are listed, with thumbnail pictures, and clicking on the picture gives a full description. When over a hundred phones are listed, this reintroduces the problem of information overload, so some online retailers use pre-selection by features like price, or by criteria, like entertainment. The methods used vary considerably, which leads to the research question:

Does web-based decision support by features or criteria increase satisfaction with mobile phone selection, compared to selection by catalogue?

With sub-questions:

1. Which features/criteria are used more frequently?
2. Are there gender differences?

The question is whether pre-selection, by features or criteria, increases user satisfaction with the process of selection a mobile phone, and if so, which features and/or criteria are relevant, and whether there are gender differences.

3. METHOD

Given the variety of existing online systems, it was necessary to design and build a realistic web-based phone selection support simulation. This was based on 105 phone models available to the New Zealand market in 2008.

3.1 Pilot study

To discover the typical features people used to choose mobile phones 17 participants were asked: "*What are the top three things you will look for when choosing your next mobile phone?*" Subjects were given 20 common phone features, plus an "Other" option if their desired feature was not listed. While price was the most common feature, the next most commonly selected feature was "Other", suggesting there was no clear common "short list". This high degree of variance suggested that over 30 different features were used by users in general. So the common approach, both online and off, of providing a catalogue a few "key" features may not satisfy most users.

3.2 Feature and criterion selection

The first step in developing a cell phone selection decision support system was to prepare a list of features offered, both hardware and software, giving 59 features in all. The following were selected as core features:

1. **Body Design**: Standard, Clam Shell, Slider
2. **Brand**: Imate, LG, Motorola, Nokia, Palm, OKTA, Samsung, Sagem, Sanyo, Sharp, Sony-Ericsson, Other
3. **Network provider**: Vodafone, Telecom
4. **Main Colour**: Black, Blue, Red, Yellow, Pink
5. **Price**: <$300, $300-$599, $600-$899, $900-$1199, $1200+

All features were rated for each of the 105 phones on a 1-5 scale. If a feature was just present or absent, like say USB, absent was rated 1 and present rated as 5. Features with numeric values like weight, talk time, standby time, memory capacity, screen size, phone size and camera pixels were rated by taking 1 as the lowest 20% of values, 2 as the next 20% and so on, with 5 as the top 20%, e.g. the Nokia 6630 with 3.5 hours of talk time was rated as 3 compared to other phones, putting it in the middle 40-60%. Zero variance features were removed from consideration, as they did not discriminate between phones, e.g. the null button was present on all cell phones.

The decision database then allocated features to the criteria functionality, extendibility, flexibility, connectivity, usability and reliability based upon their definitions. There were no features for privacy or security, perhaps as these are properties of the network not the phone itself. An entertainment criterion was added for features like games. All features within a criterion were then correlated, and if any two features had a correlation above 0.8, one of them was removed.

When criteria scores were calculated and correlated across all phones, functionality, entertainment and extendibility were found to be highly correlated ($r > 0.8$), e.g. camera (functionality) correlated with memory (extendibility) and MP3 player (entertainment). So these criteria were combined into a new *capability* criterion, defined as features that increase task and entertainment functions. The resulting criteria then all correlated at r = 0.40 or less, except capability and connectivity correlated at r=0.73, as capable phones tended also to offer more connectivity, but the construct validity seemed sound as it discriminated task and communication roles. The resulting five criteria of capability, flexibility, usability, reliability and connectivity were then considered conceptually independent, i.e. a phone could score high on one criteria but low on another. Table 1 shows the final criteria definitions and the phone features allocated to each.

Table 1. Criteria definitions and details

Feature	Description
FUNCTIONALITY: *Features that support user tasks or games*	
Feature	**Description**
Camera	To take photos.
Video Call	Two-way visual conversations.
Video Camera	Record a video.
Document View	Open and edit Word, Excel, PDF file.
Voice Recorder	Record spoken voice.
HTML	Browse the Internet.
MP3 Player	Listen to music in MP3 format.
FM Radio	Listen to the FM Radio.
Movies	Watch movies on the phone.
Game	Play a game on the phone.
Multi-Media	Send/receive photo & short sound media.
USB	Connect the phone to a computer.
External Memory	Extend the memory of the phone.
Head phone port	Allow users to insert earphones.
PC Synchronize	Synchronise phone with a computer.
CONNECTIVITY*:* *Features that support user communication*	
Feature	**Description**
Infrared	Transfer wireless data to other devices
WAP	Wireless application protocol standard
GPRS	General Packet Radio Service
WiFi	Access Internet by wireless LAN.
Email	Access to Internet email.
HSDP	Download/upload files wirelessly
Push to Talk	Use mobile phone as "Walkie-Talkie".
Bluetooth	Connect Bluetooth devices (earphone)
RELIABILITY: *Features that help a phone to continue to work*	
Feature	**Description**
Talk Time	Maximum talk time for calls.
Standby Time	Maximum standby time phone.
Battery Replace	Users can replace the battery.
Internal Memory	Internal memory size.
Water Proof	Water resistance function.
Operating System	Reliable operating system
USABILITY: *Features that improve ease of use and reduce effort to complete a task*	
Feature	**Description**
Touch Screen	Touch screen enabled function.
Joystick	Scroll and select menus by joystick.
QWERTY	Write emails with a mini keyboard.
Picture Caller ID	See caller photo when receiving call.
One-Touch Calls	Make emergency calls with one button.
Speed Dialing	Make a quick call by pressing a button.
Predict Text Entry	Type messages faster.
Screen Size	Screen size of the mobile phone.
Size	Carrying size
Weight	Weight of the mobile phone.
Button Type	Button type - normal, flat, keyboard
FLEXIBILITY*:* *Features that help users adapt in new cases*	
Feature	**Description**
Speaker Phone	Use speaker phone while driving.
Voice Control	Use voice to make/receive a call.
Multi-language	Switch menu into other languages
SIM Card	Transfer phone contact to other phones
Customize theme	Change wallpaper of the phone.

3.3 Research design

A randomized block experimental design was used, where subjects were randomly allocated to one of three decision support methods:

A. *Catalogue:* A list various phone pictures with short descriptions, which user can click to get full descriptions.

B. *Catalogue plus features:* User can select features to get a shorter catalogue list.

C. *Catalogue plus features plus criteria*: User can select features and/or criteria for a shorter catalogue list.

To ensure all three support methods were equivalent, a software system was written specifically for the task, and then modified to give support types A, B and C. All support types had the same screen design and layout, but differed in decision support type. Figure 2 shows Support Type A, Figure 3 shows Support Type B, and Figure 4 shows Support Type C. In all cases, subjects viewing a catalogue could click on a phone to get a full description.

Figure 2. Catalogue selection (A)

The dependant variable of satisfaction with the phone selection process was measured by post-task questions as follows, with the first four adapted from Davis's Technology Acceptance Model (on a 7 point scale from Strongly Disagree (1) to Strongly Agree (7).):

Figure 3.Features then Catalogue selection (B)

Efficiency: **"**This software would enable me to choose a phone more quickly."

Usefulness: **"**I would find this software is useful in my mobile phone selection."

Easy to use: "I would find this software easy to use."

Easy to select: "Using this software would make my mobile phone selection easier."

Satisfaction: "Overall, I am satisfied with this software."

Subjects were also asked:

Confidence: **"**How confident are you that you have selected a good mobile phone for you?" (from 1 (Not Confident at All) to 5 (Very Confident))

Intention to use again: "I would like to use this method for selecting my mobile phone in the future." (from 1 (Definitely Not) to 5 (Definitely Yes)).

Figure 4. Features and Criteria then Catalogue (C)

3.4 Procedure

Thirty males and thirty females were randomly selected from university students. All currently had a cell phone and 8 had two phones. Over the previous 5 years 37% had bought 1 to 3 mobile phones, 33% had bought 4-5, and 30% had bought over 6. Seven of the group were currently seeking a new mobile phone, 22 were thinking about it, and 31 were not, i.e. almost 50% were considering buying a new phone. The subjects seemed fairly typical mobile phone users. The following procedure was used:

1. **Introduction.** Subjects completed a consent form and simple background questionnaire.

2. **Criterion understanding.** All subjects were shown the criterion explanations and features, and asked to rate their importance. This also ensured they understood the criteria.

3. **Task:** Participants were asked to select their next mobile phone online using a web support system and then rate their satisfaction with the process.

4. **Method evaluation:** Participants answered the post-task questionnaire and made comments.

4. RESULTS

4.1 Decision support type

Table 2 gives mean user scores from the post-task questionnaire for decision support types A, B and C. The Kruskal-Wallis chi-square, a non-parametric test for independent random samples was used in case variance differences between the methods had an effect. There were significant differences between the selection methods for all of the satisfaction measures taken. Support type A, the catalogue method, scored worse than B and C on every measure except for easy to use, where method C was rated the worst. This seems reasonable, as method A involves fewer screens and method C has the most complex screen. Yet surprisingly, method B scored higher than A on every other measure. In conclusion, methods B and C rated better than A except for ease of use, where method C was worse.

Table 2. Satisfaction ratings by support type

Post-task Question	*Mean Score*			*Chi-Square*
	A	B	C	
Time efficiency	3.25	6.25	5.70	p < 0.01
Usefulness	3.75	6.05	6.10	p < 0.01
Easy to use	6.25	6.35	5.65	p < 0.05
Easy to select	3.30	6.10	5.35	p < 0.01
Overall Satisfaction	4.0	6.05	5.95	p < 0.01
Selection confidence	2.3	3.65	4.0	p < 0.01
Intention to use again	2.3	3.9	4.0	p < 0.01

An independent two-tailed t-test between methods B and C showed no significant differences in usefulness, satisfaction, confidence and intention to use again, but method C was seen as significantly less time efficient, less easy to select and less easy to use. So while method C was better than A, it was harder to use than B.

A method C problem was *over-discrimination*, when selecting too many choices gave no result from the mobile phone database. This created the need for a "Results" function, to let subjects know how many phones matched their choices before they clicked on to the catalogue display, e.g. subjects selecting Clam shell, Nokia and Vodafone got five mobile phones matching their requirement but subjects selecting Standard, Motorola, Vodafone and the criteria "4,4,3,4,3" got zero results - no phones matched this specification, so there was nothing in the catalogue. Such "null results" led to frustration, as fewer choices with results were better than more choices with no results. Some comments on the methods were:

Method A: *"It has a very good user interface, but this website is not supportive for me to select the mobile phone."*

Method B: *"It is very easy to go through by selecting the requirement I want. It saves me a lot of time to browse through all of the phones."*

Method C: *"I like the idea that you can find a mobile phone that meets my needs without dealing with a sales person whose advice you might not trust because at the end of the day they only want to make a sale."*

4.2 Feature and criteria usage

The property choices were designed so the default was "Any". Subjects who left a property like body design set to the default were counted as zero frequency for using that property, while subjects who set an option like "Clam Shell" were counted as one use. Table 3 shows the feature use frequencies. Network provider was used by most subjects selecting a mobile phone, followed by body design used by about two thirds of subjects. Surprisingly, price was only used by about a third of subjects, the same usage rate as and colour. Less than a fifth of the subjects specified a brand when selecting a mobile phone, suggesting that brand loyalty is not a critical factor in mobile phone selection. Females were significantly ($p < 0.05$) more concerned with body design and main colour.

Table 3. Usage by feature (N=40)

Feature	*Usage*
Network provider	95%
Body design	65%
Price	35%
Main colour	33%
Brand	18%

In Table 4 subjects rated reliability as the top factor in selecting a mobile phone, then capability, flexibility, and usability with connectivity the least important. Again there were gender differences, with males significantly more concerned with capability, connectivity and usability than females. Both genders saw reliability as the most important criteria.

Table 4 Criteria importance ratings (N = 60)

Criterion	*Mean*		
	All	*Male*	*Female*
Reliability	5.37	5.50	5.23
Capability	4.92	5.27	4.57
Flexibility	4.73	4.77	4.70
Usability	4.40	4.83	3.97
Connectivity	4.13	4.73	3.53

5. DISCUSSION

The results suggest that online decision support for mobile phone selection by pre-selecting features-criteria increases selection satisfaction. Subjects preferred feature-criteria pre-selection to a simple catalogue list, supporting the premise that information overload is currently a problem in mobile phone selection. Pre-selection let users reduce the 105 phones to a short list of perhaps 5-8 phones to browse details, e.g. selecting "Standard", "Nokia" and "Telecom" produced a 6 phone catalogue list that was easy to browse. That everyone has different phone needs means the current retailer strategy of trying to provide a common short list for everyone is not ideal.

However clearly there are trade-offs. A simple catalogue with no options is easy to use but a catalogue of over 100 phones is information overload. In contrast, too many pre-choices can overload both users cognitively and the selection database, as while method B offered five choices method C had ten choices. There may be a need to keep user choices in the range 5-9 lest too many choices give cognitive overload [14]. Another factor is the size of the domain selected from – too few phones and complex pre-selection over-discriminates to produce null results. It was suggestive that despite being more complex, support type C was still rated as high as type B for selection and intention to re-use (Figure 7). Perhaps it added both value and cost, which cancelled out in overall effect. If the number of mobile phones and features continues to increase, complex criteria like reliability may be more used, as they combine many features into one.

It is interesting that our subjects rated reliability above other criteria when choosing a mobile phone, though capability was rated second. This differs from a 2003 study, where users were more concerned about capability and usability than reliability [12], but matches a 2005 study where reliability and capability were the top two priorities for young people choosing phones [3]. Usability and connectivity had the lowest ratings, suggesting that people were less concerned with these criteria. These ratings do not imply a criteria is unimportant, just that it is not salient, i.e. perhaps current mobile phones now largely meet user connectivity and usability requirements, while reliability needs like talk time are still often unmet. So when systems evolve to meet one requirement another springs into prominence [13].

Future research into online technology selection and adoption could consider *social selection*, where partners or families select a mobile phone together online, e.g. a couple wanting matching mobile phones with different colors. Online selection support systems could also use *customer feedback* to indicate the direction of future markets. The features and criteria customers prefer when selecting mobile phones could suggest the models of the future. If the variance of customer requirements increases, Online technology selection may also morph into *on demand* order systems, where if a product combination is not available it can be produced and shipped (for a price) direct from the manufacturer.

This research suggests that the common practice of using common catalogue lists with presumed key features can be improved. Web-based decision support allows customers to select from *all* products, to their own *personal* requirements, in an *easy to use* way. The preference found here for some sort of selection support ran across all the satisfaction measures taken, of time efficiency, usefulness, ease of use, easy to select, overall satisfaction, selection confidence, and intention to use again. If in the future technology features and options for mobile phones continue to grow, then providers with web-based services that help potential purchasers to deal with product information overload are likely to be favored.

REFERENCES

[1] L. Leung and R. Wei, "More than Just Talk on the Move: Uses and Gratification of Cellular Phones," *Journalism and Mass Communication Quarterly,* vol. 77, pp. 308-320, 2000.

[2] K. Aoki and E. J. Downes, "An analysis of young people's use of and attitudes toward cell phones," *Telematics and Informatics 20,* pp. 349-364, 2002.

[3] G. Isiklar and G. Buyukozkan, "Using a multi-criteria decision making approach to evaluate mobile phone alternatives," *Computer Standards & Interfaces 29,* pp. 265-274, 2005.

[4] H. Jinwon and T. Rong, "Towards an optimal resolution to information overload: an infomediary approach," in *Proceedings of the 2001 International ACM SIGGROUP Conference on Supporting Group Work* Boulder, Colorado, USA: ACM, 2001.

[5] F. D. Davis and V. Venkatesh, "A critical assessment of potential measurement biases in the technology acceptance model: three experiments," *Int. Journal of Human-Computer Studies,* vol. 45, pp. 19-45, 1996.

[6] B. Whitworth, V. Bañuls, C. Sylla, and E. Mahinda, "Expanding the Criteria for Evaluating Socio-Technical Software," *IEEE Transaction on Systems Man & Cybernetics, Part A,* 2008.

[7] T. A. Wilska, "Mobile Phone Use as Part of Young People's Consumption Styles," *Journal of Consumer Policy,* vol. 26, pp. 441-463, 2004.

[8] L. Fortunati, "Mobile phones and fashion in post-modernity," *Telektronikk,* vol. 4, pp. 35-48, 2005.

[9] J. E. Katz and S. Sugiyama, "Mobile phones as fashion statements: The co-creation of mobile communication's public meaning," *Mobile Communication,* pp. 63-80, 2005.

[10]M. Nagamachi, "Kansei Engineering in Consumer Product Design," *Ergonomics in Design,* vol. 10, pp. 5-9, 2002.

[11]M. S. Krishnan and R. Subramanyam, "Quality Dimensions in E-Commerce Software Tools: An Empirical Analysis of North American and Japanese Markets," *Organizational Computing and Electronic Commerce,* vol. 14, pp. 223-241, 2004.

[12]S. H. Han and S. W. Hong, "A systematic approach for coupling user satisfaction with product design," *Ergonomics,* vol. 46, pp. 1441-1461, 2003.

[13]B. Whitworth, J. Fjermestad, and E. Mahinda, "The Web of System Performance: A multi-goal model of information system performance," *Communications of the ACM,* vol. 49, May, pp. 93-99, 2006.

[14]G. A. Miller, "The magical number seven, plus or minus two: Some limitations on our capacity for processing information," *Psychology Review,* vol. 63, pp. 81-97, 1956.