Mobile Customer Integration: A Smartphone Application Prototype for Conducting Mobile Conjoint Studies

Dennis Eckjans
Technische Universität München
Chair for Information Systems (I17)
Boltzmannstr. 3, 85748 Garching b. München.
Email: dennis.eckjans@mytum.de

Jens Fähling
Technische Universität München
Chair for Information Systems (I17)
Boltzmannstr. 3, 85748 Garching b. München.
Email: faehling@in.tum.de

Jan Marco Leimeister
Universität Kassel
Chair for Information Systems
Nora-Platiel-Straße 4, 34127 Kassel
Email: leimeister@uni-kassel.de

Helmut Krcmar
Technische Universität München
Chair for Information Systems (I17)
Boltzmannstr. 3, 85748 Garching b. München.
Email: krcmar@in.tum.de

Abstract— **Rapid technological advancements and widespread adoption of smartphones in recent years provide companies with new opportunities for integrating customers in innovation processes. In this paper we present a prototype of a smartphone application that can be used by marketing researchers to conduct mobile conjoint studies. Compared to traditional approaches, our prototype allows conjoint studies to be carried out in a shorter timeframe with a large number of distributed respondents. After a brief introduction to customer integration and smartphones, we describe the conjoint analysis method and its most common form: the full-profile approach. We then propose a system architecture that enables conjoint studies to be carried out in a mobile setting using a smartphone application. Based on the conjoint analysis method and the proposed system architecture, we derive a set of requirements for our smartphone application prototype, describe its architecture and provide a short tour of the user interface. We conclude the article with a discussion of the potentials and limitations of the prototype and highlight further research efforts in the field of mobile customer integration.**

Keywords-conjoint analysis; full-profile approach; mobile customer integration; innovation management; prototype

I. INTRODUCTION

One of the key drivers of long-term corporate success is the ability to constantly innovate and develop new products that meet customer needs. Despite their importance, many companies still face difficulties when it comes to successfully developing and launching new products. Studies have shown that for every seven new product ideas only one is commercially successful in the marketplace [1].

Today, companies increasingly open up their company boundaries and try to integrate customer feedback into different stages of the innovation process, as this has been shown to have a positive impact on new product success [2]. Improvements in information and communication technology have led the internet to become a primary focus in developing so called *virtual customer integration methods*. These methods utilize the multimedia and communication capabilities of the internet to collect, analyze and integrate demand as well as solution information of customers into innovation processes [3, 4, 5].

Recent advancements in mobile technologies now provide companies with a new type of customer integration that we call *mobile customer integration*. Mobile customer integration methods use mobile devices such as mobile phones, smartphones and tablets to integrate customers and their contributions into innovation processes. Smartphones seem to be a particular promising medium for mobile customer integration because they combine many useful technologies and have seen widespread adoption over the past few years.

From a technical perspective, smartphones share many features with ordinary mobile phones but a key differentiating factor is that smartphones feature a high-level operating system that enables them to run third-party applications in addition to voice telephony [6]. They are equipped with fast data connections, sensors capable of measuring motion, orientation and determining geographic location, a camera for taking images and capturing video and internal flash memory for storing data locally. These technical characteristics allow smartphones to be multi-purpose devices which provide a new channel for a rapid and inexpensive integration of customer contributions.

To practically demonstrate the potentials of smartphones for mobile customer integration, we developed a prototype of a smartphone application that can be used by marketing researchers to conduct mobile conjoint studies.

II. CONJOINT ANALYSIS

Conjoint analysis is the most used marketing research method for analyzing customer trade-offs and has been applied for over 30 years in various business and marketing

978-0-7695-4434-2/11 $26.00 © 2011 IEEE
DOI 10.1109/ICMB.2011.53

contexts [7, 8, 9]. In a conjoint study, products are represented by their features where each feature has two or more levels. The goal is to find out which product features and feature levels customers prefer and how much they value individual features. Thus, the results gained from a conjoint study reveal the structure of a customer's preferences for a particular product feature combination. This information is especially useful during product development because it allows the identification and incorporation of those features into the new product that add the most value from a customer's perspective.

A conjoint study can be conducted in a variety of ways but the full-profile approach represents the most common form among practitioners [3]. Using the full-profile approach, respondents are asked to rank order or rate a set of product profile cards according to their preference. Each product profile card represents a particular product configuration with all features present but varying feature levels. Figure 1 shows two sample product profile cards for different tablet configurations.

Tablet No. 1	
Screen Size:	7 inch
Camera:	5 megapixel
Battery Life:	6 hours
Price:	500 €

Tablet No. 2	
Screen Size:	10 inch
Camera:	3 megapixel
Battery Life:	8 hours
Price:	700 €

Figure 1: Sample product profile cards

One of the main advantages of the full-profile approach is that it gives respondents a more complete and realistic description of the product. On the other hand, complex product profile cards with many features can make the ranking task difficult for respondents because they have to read large amounts of information. To reduce the risk of information overload in these cases, researchers can either limit the number of product features or provide pictorial representations that are easier to understand than verbal descriptions.

A conjoint study based on the full-profile approach can be carried out in four steps. The first step comprises the definition of product features and feature levels by the researcher. During the second step, product profile cards are constructed and respondents are asked to rank order or rate them on a scale. For the remainder of this paper, we will assume that product profile cards are rank ordered since it is easier for a respondent to say which product profile card he/she prefers more as compared to expressing the magnitude of his/her preference [8]. During the third step, statistical algorithms such as MONANOVA [10] are used to calculate part-worth estimates and the relative importance of features on basis of the rank ordered product profile cards. The calculated figures reflect the respondent's preferences for individual product features and feature levels. The fourth step deals with the aggregation and analysis of individual study results from respondents in order to identify common preference patterns.

III. System Architecture for Conducting Mobile Conjoint Studies

To technically support the conjoint study steps in a mobile setting using a smartphone application, we propose the system architecture depicted in Figure 2.

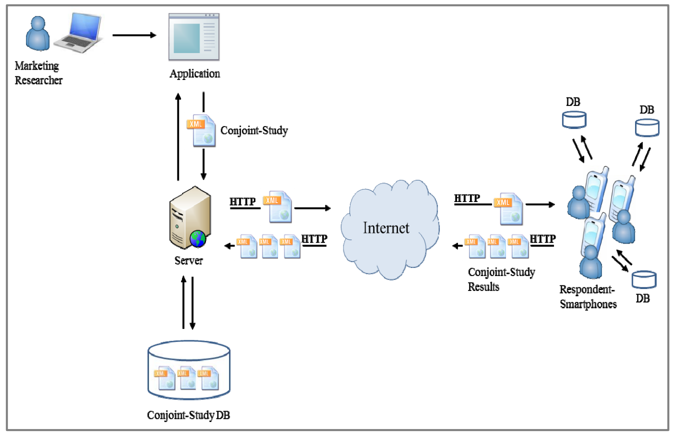

Figure 2: System architecture for conducting mobile conjoint studies

Using this architecture, a marketing researcher first defines a conjoint study through a graphical user interface that is supplied by an arbitrary software application (e.g. a web application). The software application incorporates the conjoint study information into a platform independent XML document that can be processed by any mobile operating system. An XML Schema ensures that only valid XML documents with the structure shown in Figure 3 can be created by the application.

```xml
<?xml version="1.0" encoding="UTF-8"?>
<ConjointStudies>
  <Study id="1">
    <ValidUntil>2011-04-30T17:30:00</ValidUntil>
    <Product>
      <Name>Product Name</Name>
      <Description>Product Description</Description>
      <ImageUri>Product Image Uri</ImageUri>
      <VideoUri>Product Video Uri</VideoUri>
      <Feature id="A">
        <Label>Feature Label</Label>
        <Description>Feature Description</Description>
        <ImageUri>Feature Image Uri</ImageUri>
        <VideoUri>Feature Video Uri</VideoUri>
        <Levels>
          <Level nr="1">Feature Level 1</Level>
          ...
        </Levels>
      </Feature>
      <Feature id="B">
        ...
      </Feature>
      ...
    </Product>
  </Study>
  <Study id="2">
    ...
  </Study>
</ConjointStudies>
```

Figure 3: Structure of a conjoint study XML document

The XML document contains the essential components of a conjoint study: a description of the product including its features and feature levels as well as a validity date for the conjoint study. The validity date allows the marketing researcher to specify a deadline after which the conjoint study can no longer be executed on a respondent's smartphone.

After the XML document with the conjoint study has been created, it is pushed onto the respondents' smartphones by a server that is connected to the internet. The smartphone application that is installed on the respondents' smartphones listens for incoming messages and as soon as it receives the XML document from the server, it extracts and stores the conjoint study information in a local database and notifies the respondent about the new study. Respondents can then participate in the conjoint study at any time using the smartphone application. As soon as a respondent finishes the conjoint study, the smartphone application calculates the study results, stores them in an XML document and sends the XML document back to the server. The server in turn extracts and stores the conjoint study results in a database. The structure of the XML document containing the conjoint study results is defined by an XML Schema and is depicted in Figure 4.

```xml
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<ConjointStudyResult>
  <Study id="1">
    <Product>Product Name</Product>
    <ProductProfiles>
      <ProductProfile rank="1">
        <FeatureCombination id="A1">
          <Feature id="A">Feature A</Feature>
          <Level nr="1">Feature Level 1</Level>
        </FeatureCombination>
        <FeatureCombination>
          ...
        </FeatureCombination>
        ...
      </ProductProfile>
      <ProductProfile>
        ...
      </ProductProfile>
      ...
    <PartWorthResults>
      <FeatureCombination id="A1">0.7500</FeatureCombination>
      <FeatureCombination id="B1">1.5000</FeatureCombination>
      ...
    </PartWorthResults>
    <RelativeImportance>
      <Feature id="A">0.2308</Feature>
      <Feature id="B">0.3077</Feature>
      <Feature id="C">0.4615</Feature>
    </RelativeImportance>
  </Study>
</ConjointStudyResult>
```

Figure 4: Structure of a conjoint study result XML document

The first part of the XML document contains the respondents' rankings of the product profile cards and additional information about the feature combinations (i.e. features and corresponding feature levels) that make up each product profile card. The second part contains the calculated part-worth estimates for each feature combination and the third part the relative importance of each feature. For instance, the results in Figure 4 tell the researcher that the most valued product feature for the respondent is feature C with a relative importance of 46,15%, followed by feature B with 30,77% and feature A with 23,08%.

After the XML document with the conjoint study results has been received and stored by the server, the marketing researcher can retrieve individual study results from the server's database for further analysis.

IV. Prototype of a Smartphone-Application

A. *Requirements*

Based on the process of a full-profile conjoint study and the proposed system architecture in Figure we derived a set of requirements that our smartphone application prototype must fulfill. These requirements are summarized in Table 1.

Table 1: Requirements for the smartphone application prototype

ID	Description
R1	The smartphone application must be able to receive conjoint studies as XML documents and notify the user about their arrival.
R2	The smartphone application must provide the user with a list of all available conjoint studies including their deadline and current status ("Not participated", "Started", "Completed").
R3	After choosing a valid conjoint study from the list, the smartphone application must provide the user with a visual and textual introduction to the product and its features.
R4	After the product and feature introduction, the smartphone application must construct product profile cards and allow the user to rank order them (full-profile approach).
R5	When the user finishes the ranking task, the smartphone application must calculate part-worth estimates and the relative importance of features. These calculated figures together with the product profile rankings must be sent back to the researcher as an XML document.
R6	The smartphone application must ensure that a user cannot participate in a conjoint study whose deadline has already passed.
R7	The smartphone application must be robust against interruptions, i.e. the user can leave the application at any time, return to it later and continue exactly where he/she left of.

Next, we developed a prototypical implementation of the smartphone application that fulfills the elicited requirements above. We chose the Google Android system as our implementation platform because it is currently one of the leading mobile operating systems in the world [11], supported by a multitude of vendors and available on devices with different form factors, particularly smartphones and tablets. The Android SDK also comes with a comprehensive documentation and development toolset and is available free of charge.

B. Architecture

The basic architecture of our smartphone application prototype is shown in Figure and can be partitioned into three layers: business logic (colored in red), user interface/controller logic (colored in green) and utility service layer (colored in blue).

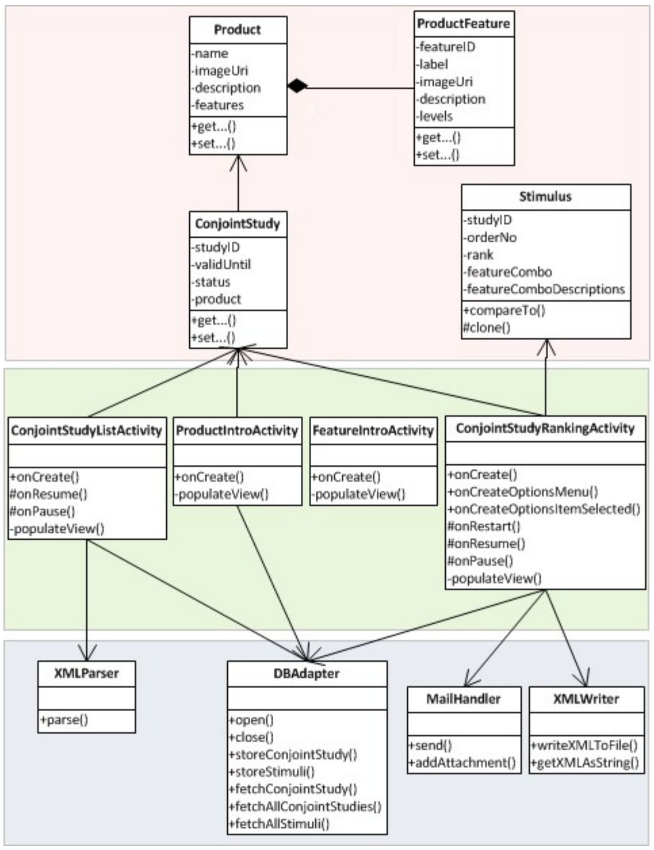

Figure 5: Architecture of the smartphone application prototype

The business logic layer of the architecture models concepts from the application domain which in our case are full-profile conjoint studies. A single conjoint study is defined through the *ConjointStudy* class which is modeled after the XML document structure shown in Figure 3. A product is described through the *Product* class which has a binary relationship with the *ConjointStudy* class. Because a product is composed of multiple features the *Product* class is also associated with the *ProductFeature* class through a one-to-many composition relationship. The *Stimulus* class represents a product profile card which consists of a combination of the products' features. During the ranking step of the conjoint study, respondents are asked to assign ranks to each of the product profile cards according to their preference. The ranked product profile cards form the basis for the calculation of part-worth estimates and relative importance of features.

The middle layer of the architecture is the core of the prototype. Classes in this layer provide a visual interface to the user and guide him/her through all the steps of the conjoint study. Each class is a so-called activity that is implemented as a subclass of the Android *Activity* base class. In Android, each *Activity* presents a visual user interface for one focused endeavor the user can undertake [12], in our case one step of the conjoint study. The class *ConjointStudy-ListActivity* functions as the entry point of the user interface. Its responsibility is to display a list of all available conjoint studies including their deadline and status and to notify the user about the arrival of new conjoint studies (requirements R1, R2). The class also checks whether a conjoint study can still be carried out based on its deadline (requirement R6). After selecting a valid conjoint study from the list, the user is provided with a visual and textual introduction to the product and its features through the *ProductIntroActivity* and *FeatureIntroActivity* classes (requirement R3). The ranking task of the conjoint study is handled by the *ConjointStudy-RankingActivity* class which constructs product profile cards, supplies users with a user interface to rank order them, calculates the study statistics and sends them as a XML document to the marketing researcher (requirements R4, R5). It also locks completed conjoint studies through an entry in the SQLite database to prevent users from executing the same conjoint study twice.

The bottom layer of the architecture consists of a set of utility classes that are used for database storage, XML document handling and email management. The *XMLParser* class parses XML documents that contain conjoint study information (see Figure 3) and creates corresponding instances of the *ConjointStudy* class. The *XMLWriter* class is used to construct the XML document that contains the conjoint study results depicted in Figure 4. The *DBAdapter* class provides a facade to the SQLite relational database that comes integrated as part of the Android operating system. It provides methods for storing and retrieving *ConjointStudy* instances as well as smartphone application state information from the SQLite database. The *MailHandler* class is responsible for creating and sending emails to the marketing researcher with the conjoint study results attached as an XML document.

C. Development Challenges

An important consideration during the development of the smartphone application prototype was the potential interruption of the application due to user or system activities (e.g. the user needs to exit the application to answer an incoming call or the system kills the application due to low memory). In these cases it is paramount that the application state is preserved so in the case of the user resumes the application at a later time he/she can continue exactly where he/she left of. For our prototype, we used the integrated activity lifecycle methods and SQLite database of Android to save and restore the application state. As can be seen in the middle layer of the architecture in Figure 5, each Activity class contains one or more methods starting with *on…()*.

These are lifecycle methods which are called by the Android runtime as the application transitions from one state to another. For example, the *onCreate()* method is called, when the activity is first created, the *onPause()* method is called whenever the activity is no longer visible to the user because another application has received the focus and the *onResume()* method is called when the application resumes from a paused state. By overwriting these methods and using the SQLite database as a storage backend, we were able to deal with interruptions in a controlled manner and thus provide a continuous user experience (requirement R7).

Another challenge we faced during development was that after finishing a conjoint study, the user interface would always block for a few seconds leaving the user wondering whether the application crashed. The reason for this blocking behavior was that the calculation of study statistics and sending of the result email were handled in the main GUI thread. We were able to solve this problem by moving the calculation and email processing task to a separate background thread which allowed the user interface to remain responsive to user input.

Different screen sizes and resolutions of smartphones posed another challenge. In order to provide a consistent user experience across multiple devices, we had to make sure our application would be able to deal with these differences. Android already provides developers with a range of methods to adapt an application to different screen environments [13]. In our application, we used density-

Figure 6: User interface of the prototype

independent pixels instead of hard-coded pixels to express the position of elements in a density independent way. For individual views in a layout container we used “wrap_content” and “fill_parent” as dimension parameters to guarantee that views will automatically adjust their size according to the size of the smartphone screen. We also created size and density specific images and icons and used Androids’ resource directory qualifiers to automatically select them at runtime.

D. User Interface

The entry point for the user interface of our prototype is depicted in Figure 6(a). It shows the user a list of all available conjoint studies and notifies him/her about the arrival of new studies. Each list entry has an image thumbnail visualizing the product of the conjoint study as well as two lines of text indicating the deadline and the status of the conjoint study. Pressing the “Participate” button of a list entry will take the user to the first step of the corresponding conjoint study in which the product and its features are introduced. The user interface screen for this step is shown in Figure 6(b). Besides a visual depiction and a textual description of the product, the product’s features are listed and introduced with an image thumbnail and a short text. By pressing the “Details” button, the user can view more detailed information about a particular product feature and its corresponding feature levels as shown in Figure 6(c).

Pressing the “Next Step” button in Figure 6(b) will take the user to the second step of the conjoint study, where he/she is asked to rank a given set of product profile cards. Before the actual ranking task starts, however, the user receives some instructions on how to complete the task (see Figure 6(d). After pressing the “Ok” button, the set of product profile cards that need to be ranked is presented to the user. Figure 6(e) shows the corresponding user interface. Each product profile card is displayed as a table. By tapping on the “Choose rank” button of a product profile card, the user can select a rank from a dropdown list and assign that rank to the product profile card. If the user decides to leave the application in the middle of the ranking task, the current state is automatically saved to the SQLite database. When the user returns to the application at a later time, the rankings will be restored and the user can continue with the ranking task.

After all product profile cards have been ranked, an options menu is displayed at the bottom, allowing the user to finish the conjoint study (see Figure 6(f)). The menu can also be brought up by pressing the dedicated “Menu” button on an Android phone. Pressing the “back to product description” button will save the current rankings to the SQLite database and take the user back to the previous step where he/she can view the product and feature description. The “Finish Study” button will cause the application to calculate the conjoint study statistics, create the corresponding XML document (see Figure 4) and send it to the marketing researcher via email. After the XML document has been send, the user is taken back to the list of conjoint studies where the finished conjoint study now has the “Completed” status as shown in Figure 6(g).

V. DISCUSSION AND FURTHER RESEARCH

In this paper we proposed a system architecture and implemented a prototype of a smartphone application that allows marketing researchers to conduct mobile conjoint studies. To our knowledge, the prototype represents the first application of conjoint analysis on a smartphone. Transferring the established method of conjoint analysis to smartphones makes a contribution to mobile marketing because it demonstrates that smartphones can be used as an additional channel for conducting conjoint studies and gathering customers’ contributions in terms of preferences for products, services or bundles of products and services. Compared to traditional methods of conducting conjoint studies where paper product profile cards are used in an onsite setting, our prototype allows conjoint studies to be carried out in a shorter timeframe with a large number of distributed respondents.

To test its reliability, we plan to evaluate our smartphone application prototype with customers. Specifically, we will set up a conjoint study with a complex product (large feature set) and another one with a simple product (small feature set). We will then perform each conjoint study twice, once using the traditional method with paper product profile cards and once using our own smartphone application prototype to determine whether there are any significant differences in the results.

A limitation of the current prototype is the restricted number of product profile cards that can be displayed and comfortably ranked by respondents on the small smartphone screen. Because the number of product profile cards depends on the number of product features and feature levels, complex products with many features are difficult to evaluate with the full-profile approach on our prototype. Furthermore, our prototype currently doesn’t allow researchers to collect socio-demographical characteristics such as age, income or education from users who participate at a conjoint study.

In the near future, we plan to use our architecture to implement other approaches of conjoint studies that will allow us to display and handle more complex products on smartphones. Especially promising seems to be the paired-comparison method in which a series of paired product comparisons are made and the respondent is asked to state which of two displayed products he/she prefers. This method seems to fit the need for limited screen size of smartphones quite well as there are only two products to be compared at once. An example for the application of the paired-comparison method is the smart design contest matching game developed by Daimler AG [14]. The game lets users play multiple rounds in which they are shown two different car designs and they have to state which one they prefer.

We also consider extending the application with an additional user interface screen that will allow researchers to collect socio-demographical characteristics from users using a simple questionnaire. This information could later be used in the analysis stage, e.g. to identify common preference patterns among users with a similar socio-demographic background. Furthermore, we plan to make use of other smartphone hardware in our application such as the GPS sensor. Integrating the GPS sensor in our prototype would allow researchers to place geographic restrictions on the execution of conjoint studies and enable them to gather consumers' preferences in specific areas, e.g. a country, region or city.

Tablets represent another interesting application area for our prototype that we plan to further investigate. In contrast to smartphones, tablets feature much larger screen sizes which would allow for more complex conjoint study designs. We already designed our prototype to handle different screen sizes and resolutions and used the Google Android as our implementation platform which is also available for tablets. Therefore, we should be able to extend the use of the prototype to tablets with minimal changes.

Further research is also needed in terms of psychological aspects such as motivation. According to research about activation-supporting components for IT-based ideas competitions [15], we need to understand factors which influence the motivation of customers for contributing in activities along the innovation process by using mobile devices. Single and multiplayer games, e.g., could be an interesting vehicle for gathering customer contributions with the help of mobile devices which could be investigated in further research.

While our prototype only implemented the conjoint analysis method, we see great potential for transferring other existing traditional and virtual customer integration methods to the smartphone. This potential stems from the current and upcoming technical capabilities (dual-core processors, NFC chips, 4G data connections) of smartphones which widens interaction possibilities as well as from the increased penetration of smartphones which provide companies direct access to large numbers of customers. While some of them simply move paper-and-pencil methods to mobile devices, others provide new capabilities that were not feasible previously. According to web-based methods for gathering customer input, methods for integrating customers along the innovation process by mobile devices, such as smartphones or tables, will replace existing methods but in most instances they will complement existing methods for expanded capability [3].

ACKNOWLEDGEMENT

We thank the German Research Foundation (Deutsche Forschungsgemeinschaft – DFG) for funding this project as part of the collaborative research centre 'Sonderforschungsbereich 768 – Managing cycles in innovation processes – Integrated development of product-service-systems based on technical products'.

REFERENCES

[1] R. G. Cooper, Winning at New Products, Accelerating the process from idea to launch, Perseus Publishing, Cambridge 2001.

[2] K. E. Gruner and C. Homburg, "Does Customer Interaction Enhance New Product Success?", Journal of Business Research, Vol. 49 (2000) No. 1, pp. 1-14.

[3] E. Dahan and J. R. Hauser, "The virtual customer", Journal of Product Innovation Management, Vol. 19 (2002) No. 5, pp. 332-353.

[4] E. Dahan and V. Srinivasan, "The Predictive Power of Internet-Based Product Concept Testing Using Visual Depiction and Animation", Journal of Product Innovation Management, Vol. 17 (2000) No. 2, pp. 99-109.

[5] E. von Hippel and R. Katz, "Shifting Innovation to Users via Toolkits", Management Science, Vol. 48 (2002) No. 7, pp. 821-833.

[6] IDC, Shipments of mobile devices to wireless service providers are expected to grow by a meagre 4% in 2009, the lowest growth rate in five years, IDC Canada's Mobile Device Tracker latest forecast reveals, Link: http://www.idc.ca/about/pr_2009_03_18.jsp, Retrieved on January 25, 2011.

[7] P. E. Green; A. M. Krieger; Y. Wind, "Thirty years of conjoint analysis: Reflections and prospects", Interfaces, Vol. 31 (2001), No. 3, pp. S56-S73.

[8] P. E. Green and V. Srinivasan, Conjoint Analysis in Consumer Research: Issues and Outlook, *The Journal of Consumer Research*, Vol. 5 (1978) No. 2, pp. 103-122.

[9] P. E. Green and V. Srinivasan, "Conjoint Analysis in Marketing: New Developments with Implications for Research and Practice", Journal of Marketing, Vol. 54 (1990) No. 5, pp. 3-19.

[10] H. Gatignon, Statistical Analysis of Management Data, Springer, New York 2009.

[11] Gartner, Gartner Says Worldwide Mobile Device Sales to End Users Reached 1.6 Billion Units in 2010; Smartphone Sales Grew 72 Percent in 2010, Link: http://www.gartner.com/it/page.jsp?id=1543014, Retrieved on April 15, 2011.

[12] Google, Android Application Fundamentals, Link: http://developer.android.com/guide/topics/fundamentals.html, Retrieved on February 4, 2011.

[13] Google, Supporting Multiple Screens, Link: http://developer.android.com/guide/practices/screens_support.html, Retrieved April 17, 2011.

[14] Daimler AG, Smart Design Contest Matching Game, Link: http://www.smart-design-contest.com/matching-game, Retrieved on February 6, 2011.

[15] J. M. Leimeister, M. J. Huber, U. Bretschneider and H. Krcmar, "Leveraging Crowdsourcing: Activation-Supporting Components for IT-Based Ideas Competition", Journal of Management Information Systems, Vol. 26 (2009) No. 1, pp. 187-224.