A Mobile Product Recommendation System Interacting with Tagged Products

Felix von Reischach
Auto-ID Labs ETH Zurich and
SAP Research CEC Zurich
Switzerland
freischach@ethz.ch

Florian Michahelles
Auto-ID Labs
ETH Zurich
Switzerland
fmichahelles@ethz.ch

Dominique Guinard
Auto-ID Labs ETH Zurich and
SAP Research CEC Zurich
Switzerland
dguinard@ethz.ch

Elgar Fleisch
Auto-ID Labs
ETH Zurich and University of St.Gallen
Switzerland
efleisch@ethz.ch

Abstract — **This paper presents a concept that enables consumers to access and share product recommendations using their mobile phone. Based on a review of current product recommendation mechanisms it devises a concept called APriori. APriori leverages the potential of auto-ID-enabled mobile phones (barcode/RFID) to receive and submit product ratings. Since mobile users cannot be expected to have the patience and time to compose text-based reviews on mobile phones, we introduce a new rating concept that allows users to generate new rating criteria. The concept is tailored to the limited attention and input options of mobile users in real-world environment. This work describes the architecture, implementation, and evaluation of APriori. For an evaluation we have taken the approach of interviewing 26 users in the frames of a formative user study, with the goal to further improve the system for an application in the real world. In addition, the paper discusses open issues regarding community-based product recommendations on mobile phones and proposes solutions.**

Pervasive Shopping Assistance, Recommender Systems, Mobile Applications

I. INTRODUCTION

Mobile devices are evolving into permanent companions of consumers. In many developed countries the mobile phone penetration is well above 90%, meaning that almost everybody is using a mobile phone. In addition, recent handsets provide extended functionalities such as a mobile Internet connection, mobile barcode recognition or NFC (Near Field Communication). The latter provide intuitive means of interaction by allowing the coupling of products with mobile Internet services, as today almost all products have been tagged with barcodes and RFID might be its successor [1].

In parallel, the web is going social. The widespread use of accelerators such as Ajax, Wiki, RSS, and Atom, which allow for rapid content generation and distribution, have changed the media consumption habits of Internet users and increased the desire for interactivity, creation and participation in online communities, as well as the willingness to share personal information. Especially younger age groups express themselves in online communities, share preferences and experiences, engage in discussion forums and interact with peers. They generally have less hesitation to reveal personal information online. While this trend certainly has to be observed with care (concerning inappropriate content, exposure, and defamation) it offers great opportunities for aggregating small contributions of a large number of individuals into new rich sources of information. We particularly believe in the value of harvesting decentralized consumer experiences. Participants should be enabled to express their own values and thoughts, and at the same time benefit from mutual experience sharing. Recommendation functionality has already been successfully introduced, for example by Epinions.com and Amazon.com. They have proven that users are willing to share and contribute information outside professional routines for the sake of connecting with peers and achieving a certain level of fame and prestige [2]. These concepts also have been researched. Especially marketing research has extensively measured the effects of product recommendations on sales [3, 4].

The availability of handsets with Internet capabilities empowers people for the first time to generate content and share experiences with products independent of computers fixed to specific locations. Emerging auto-ID capabilities, such as 1-D barcode recognition and NFC, simplify linking information to products and thus lower the barriers for users to provide this content.

Research in mobile computing has already focused much on travel recommendation [5, 6, 7]. In addition, a lot of work has been done in the area of mobile shopping assistants a few years ago in the hype phase of m-commerce (see for example [11]). We develop an application framework for mobile phones to collect and retrieve everyday knowledge and experiences from various consumers about products they have purchased or will purchase. In section 2, we survey current concepts of product recommendation systems. We show why they cannot support mobile users, i.e. consumers in shops, in an appropriate

way. The result is the need for a product rating system for the pervasively networked world. Section 3 is devoted to APriori, a novel approach towards product rating, which is tailored to the needs of mobile users. In section 4, we describe first user experiences with the prototype. In section 5, we discuss real-world challenges of APriori. We conclude with an outlook on future work in section 6.

II. Product Recommendation in a Nutshell

Current approaches supporting consumers in their buying decision are, amongst others, provided through web-based product recommendation systems (e.g. Ciao.com and Epinions.com). They allow users to submit experiences they have made with particular products and to share them with other users in a community-like fashion. We distinguish between the following types of community-based recommendations:

Product Ratings: Product ratings are usually visualized on a scale of one-to-five stars. They allow users to get an at-a-glance assessment of a product. Ratings can be made based on specific predefined criteria (e.g. price performance ratio and quality) or as an expression of the overall satisfaction with a product.

Product Reviews: Product reviews allow users to describe their experience with products as continuous text. In this context, different levels of details can be allowed. At Epinions, for example, users can submit short reviews (up to 100 words) and regular reviews.

A combination of both recommendation types is common on Internet-based recommendation platforms: Easy at-a-glance assessment of a product and differentiated experiences of consumers written down textually in parallel seem to be a good combination, as the number of users participating shows. Nonetheless, product recommendation systems in the Internet do not meet the needs of customers in physical stores; they do not meet the needs of mobile users. Consequently, consumers turn on their computers and make use of the systems mainly if they have a high involvement with a product or when they plan to purchase the product in the Internet anyway (for example for balancing the pros and cons before buying a camera). Studies however suggest that three out of four buying decisions are actually taken within shops [8].

How can mobile users be enabled to actively recommend products and to receive product recommendations? Whereas tailoring today's rating portals for handheld displays might be a straightforward approach, product reviews are not suitable for recommendation systems used on mobile phones. Due to hardware restrictions it is still difficult for users to enter longer texts on their mobile or even just read longer text on the small display of their mobile phone. Furthermore, competing real-world tasks consume the attention, time, and patience of mobile users. Pure general product ratings however are not expressive enough for the user. They usually only provide information about few, predefined criteria. Accordingly we introduce the so called dynamic rating criteria. The idea is to leverage the advantages that product ratings provide compared to textual reviews (quick entry, easy to aggregate and arrange on small displays), while at the same time reducing the shortcomings they have (limited expressiveness).

III. APriori: Pervasive Product Recommendation

This section is devoted to APriori. APriori is a pervasive product recommendation system empowering consumers to actively share experiences about products at the point of use. In the following, we outline the concept of dynamic ratings, which APriori is based on. Accordingly, we describe how the system is used. We present a visual tour through its user interface, and finally we provide details on the architecture and the implementation of the APriori prototype.

A. Rating Concept

APriori features the concept of dynamic rating criteria. This reflects the fact that we consider today's product reviews not suitable for mobile phones and classical product ratings as not expressive enough. It extends current approaches for product rating.

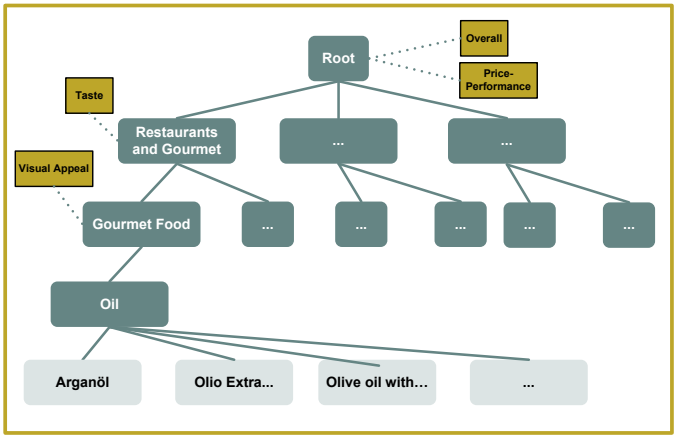

Figure 1: Dynamic rating criteria attached to nodes in APriori's product tree

The idea is straightforward and can be summarized as follows (see Figure 1): As in most existing recommendation systems, products in APriori are arranged in a tree-like hierarchy. The leaves of the tree represent product types, and all inner nodes are product categories. The availability of criteria for products depends on where in the tree (which node) the criterion is attached to. General criteria such as overall or price-performance, which can be applied to every product, are attached to the root node. They are not created by users, but are offered by the system initially. Accordingly, a criterion which only applies for a certain product type will be applied to a leaf of the tree. In the product tree example depicted in Figure 1, the criterion visual appeal applies only for gourmet food. It does not apply for restaurants. The criterion overall however applies for all products kept in APriori.

The improvement compared to conventional ratings comes through the following step: APriori allows users to create their own rating criteria. In a dialogue they are asked, which node the criterion of the product should be attached, resulting in the

availability of the criterion for the specified product category. APriori holds a persistent mapping of criteria to nodes in the product tree. The result is that users can freely define values which describe a certain type of product, while being freed from spending time on structuring their opinion like product reviews demand. Because the actual ratings for a given criterion are structured and aggregated, these can be easily understood by the human brain.

B. *Using APriori*

In order to get a feeling for the capabilities of APriori and to see how it can actually support consumers in their buying decision, we will navigate through the user interface of APriori in this section. Using Apriori can well be described by outlining its core processes: Receiving product recommendations made by other users on the mobile phone (see Figure 2) and actively submitting a rating for a product to the APriori server platform (see Figure 3).

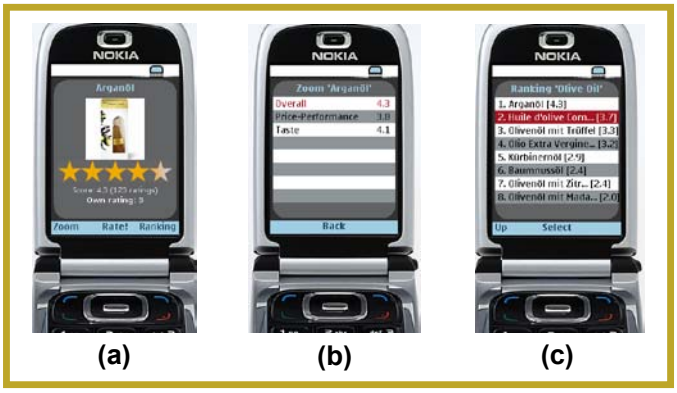

Figure 2: Receiving product recommendations with APriori

To receive a rating, the mobile application is started by the user by scanning the tag attached to a product. Without further interaction, a product overview screen of the scanned product is displayed (Figure 2 a). It shows an at-a-glance product overview for the considered item: static product data such as product name, a product picture and an overview of the submitted overall ratings. Now the user has three options. The first option is to zoom in and get a more comprehensive view on how the product was rated by other users. Accordingly, all criteria for the product and an average score for each criterion will be shown. This is visualized in Figure 2 b. For scalability reasons, there cannot be more than 10 criteria per product type. The second option is to get a ranking of all products in the product category (see Figure 2 c). Looking for olive oil, this ranking will tell the user which oil was rated by other consumers as the best, the second, and so on. Selecting a product in the ranking will navigate to the overview screen of the product.

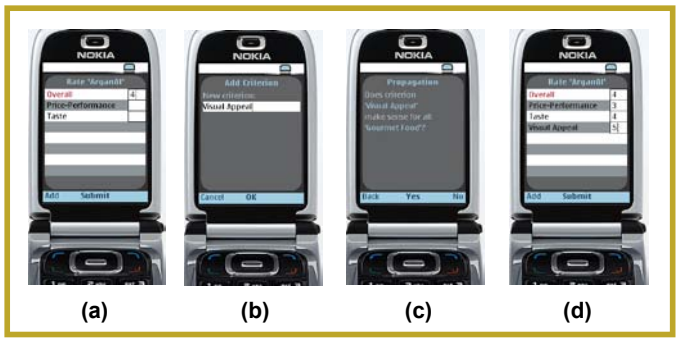

Figure 3: Recommending products with APriori

The third option after scanning a product is to switch to rating mode for this product. We see great potential for the generation of ratings at the point of use, where the user is temporally and emotionally connected to the experience of product usage. On the main screen of the rating mode of the APriori mobile application, a list of criteria is displayed and the user can decide for which criteria he would like to submit a recommendation and enter a value (Figure 3 a). In case the user is not willing to make a comprehensive rating for a product, or wants to provide additional information, he can rate selected criteria. If the user feels there is a criterion missing which is important to express his experience with the product, he clicks the add button and is shown a text field which allows him to enter a new criterion (Figure 3 b). Having entered this, the application will ask the user whether he wants to propagate the criterion for the next higher product category (dialog will ask until root node is reached or user clicks no) (Figure 3 c). Getting back to the rating screen, the user enters values between one and five for all criteria he wants to describe and submits the data by pressing the submit button (Figure 3 d). Accordingly, the user is shown a confirmation screen, the new criteria and ratings are sent to the APriori server and will be made persistent.

C. *Prototype*

In order to prove the applicability of our concept, we have implemented a comprehensive prototype of APriori (see Figure 4). It consists of the following components:

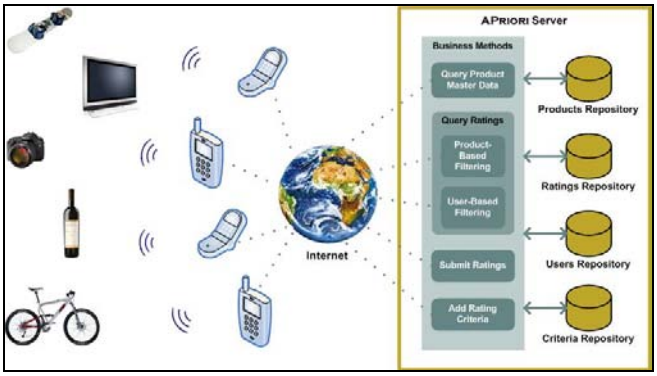

Figure 4: APriori's general architecture

Products and Tags: As a sample product type we chose olive oil. It is a gourmet food product, thus comparatively expensive (average price of the selected bottles: 14.82 USD) and offered in a broad range of quality. The quality however is not always in relation to the price. We assume that except if bought from a trusted dealer, the quality of olive oil can only be judged after having experienced its taste. This makes olive oil a high-involvement product, i.e., consumers spend considerable time on comparing products before taking a buying decision. This is why we think consumers will appreciate product recommendations on the spot especially for gourmet food products like olive oil. We equipped different types of olive oil bottles with Raflatac ISO14443A tags (Rafsec Round 38mm). The tags were applied to the bottles as a stick-on label. Despite the fact that today barcodes are commonly used for consumer products, we decided on NFC as a tag technology due to its more intuitive touch-based user experience. However, for deploying APriori to real environments today a barcode-based implementation would be important to foster adoption.

Mobile Phone and Mobile Application: As a mobile device we used the Nokia 6131 NFC. It includes a runtime environment for mobile Java applications and a reader for NFC tags. Technically speaking, it implements MIDP 2.0, CLDC 1.1 plus a range of extensions such as JSR 257, which allows Java applications to deal with NFC tags. The APriori mobile client was developed as a Java MIDlet. For the communication between the mobile client and the server application we used the MobileIoT Toolkit developed at our lab [9]. It facilitates transforming Java objects into simple strings which are used as parameters for HTTP requests on Java Servlets in a REST-like manner. In addition, it gives the possibility to reconstruct Java objects on the server side and offers abstraction towards the auto-ID technology used (e.g. barcode/RFID/NFC).

APriori Server Application: The server application was developed using the NetBeans IDE (V6.0.1). It is a Java Enterprise Edition (EE) 5 application, running on the GlassFish Java Application Server (V2 Update Release 1). The business logic of the recommendation server is encapsulated in Java Session Beans. The Session Beans depicted in Figure 4 provide all functionality to support the scenario as described above. The persistence of ratings, user data, rating criteria, product master data, and product categories is managed by Java Persistence Entities, which allows communication with the underlying JavaDB database through plain old Java objects. There are a few key advantages of using Java EE as a platform for the APriori server. These include better performance of queries through object pooling, scalability, data management from within Java, and helper services provided by the Java EE application container (e.g. security, logging, transaction control).

IV. First Evaluation

To better understand consumer needs and the impact APriori can have, we conducted a formative survey at the 1st Internet of Things conference in March 2008 (see Figure 5). During the demo track of the conference we presented our prototype to 26 participants who had never used APriori before. It is worth noting that all of the participants were from the Internet of Things domain, which means they have a higher affection for new applications in this area. Firstly, we introduced the participants to the subject and explained the usage scenario of APriori. Then we encouraged the participants to take the mobile phone in their hands and imagine they were in a retail shop in the search of good olive oil. The participants used APriori and got a feeling for what APriori can do for them. After the users had experienced the functionalities of APriori, we asked a few questions in a structured format and recorded their answers.

Figure 5: Survey participants testing APriori

1) Would you appreciate product recommendations of peer consumers in front of the shelf? The feedback of the participants was rather positive towards APriori. Almost all (22) users stated they would appreciate the APriori application on their mobile phone. Two participants said they would be reluctant towards APriori. The reason was they would rather rely on advertisements and sales-staff than on other consumers when it comes to buying high-involvement goods. Two others said they were generally reluctant towards mobile applications, but would probably try APriori in practice once and decide afterwards if they considered it useful.

2) What are the products you consider peer-user recommendations most helpful for? Asked the above question, twelve participants answered they would use APriori to get pre-purchase information about consumer electronics. They argued APriori would encourage them towards impulse buying of cameras, televisions, books and DVDs. Four participants said they would see a use for APriori when buying gourmet foods like wine or olive oil, whereas two participants explicitly stated they do not see a use for APriori when it comes to food. They consider it safe to buy delicacies from a trusted dealer. Several participants tried to give a general answer to the question and stated they would appreciate APriori for all products where the quality is not transparent for the user before buying it, for all products where well-known

brands do not exist and in general things they buy for the first time.

3) Would you be motivated to actively recommend products using your mobile phone? In contrast to the positive feedback on the usage of APriori, only roughly half of the participants (14) said they would actively recommend products. Asked for their motivation to recommend, some said they would generally recommend products if they were bored and wanted to kill some time. All of the above stated they would only use APriori if they were explicitly asked to recommend a product. Others said they would recommend products if they wanted to express extreme emotions such as extreme annoyance about a product or if they were extremely convinced of the performance of a product. Twelve participants explicitly said they could not imagine actively recommending a product. Asked if they could be motivated by monetary means to submit a rating, six participants were convinced and said they would participate.

While more work is required to evaluate the potential of the system and its adequate design, this first evaluation already emphasizes a few important points. First of all there is the apparent divide between people wanting to consume the ratings and those who incline to also generate ratings for products. In addition, there is a tendency for people to rate a product if and only if their experience with the product is extreme (hate/love). Both these points have to be dealt with in terms of getting the critical mass of users to participate with ratings on a critical mass of products. Furthermore, the system needs to be interaction-wise extremely simple and straightforward in order not to annoy people in their shopping experience. We will further discuss these points below.

V. DISCUSSION

Will APriori or a similar system be applied in practice soon? Will this change the way consumers use their mobile phones, generate content and take buying decisions? Based on the implementation of APriori and first user feedback we discuss real-world challenges of pervasive product recommendation.

A. Quality Management

A general criticism against user-generated content is that the quality of information may not compare with findings of more established and trusted sources, such as consumer associations, testing magazines, specific journals. Nevertheless, technology as shown in the previous sections lowers the barriers of entry and can for a first time empower people to publish information and experiences with products promptly. While this may possibly yield a lot of low-quality content being generated - intentionally or unintentionally – interviews with administrators of similar websites have shown that there is (i) content being created that would not have been available otherwise, and (ii) intentionally posted wrong content is not a major issue. A classic approach to however prevent intentionally wrong and defamatory content would be to introduce a registration process where users have to reveal and verify personal information (an SMS response containing a verification code would be even more trusted than an email due to the one-to-one user-simcard relationship). An even stronger approach would be to establish a web of trust that allows calculating a level of credibility based on the number of friendship links established between participants, as various social networking platforms have shown successfully. Furthermore, deployed mechanisms of pre- and post-production moderation (content release by approval/allowing for changes by a moderator after release) in combination with a code of conduct and defined steps of enforcement may be applied if needed. Another possible approach is the automatic deletion of products and criteria that have not been used for a certain time, some kind of 'garbage collection'. Practice shows that sharing of previously tacit knowledge of large user-bases outweighs the efforts of prevention of inappropriate content. In order to provide a credible product rating service it is a key to preserve freedom of expression among users, to preserve openness and to avoid filtering and censorship. This clearly suggests running such service independently from product manufacturers or store owners.

B. Motivation of Users and Critical Mass

As a collaborative product rating system works on a mutual give-and-take basis, another crucial question is how to motivate users to participate and contribute ratings. A first approach is to design the 'add rating' step for the user as hassle-free as possible. The provision of product master data obtained from commercial platforms such as Sinfos (www.sinfos.com) should release users and administrators from the formal descriptions of an item. Additionally, the client application on the mobile phone could pro-actively remind the user to add a rating for a purchased product. One way the mobile phone could recognize the point-of sale is when the mobile phone would be also used to pay the article (e.g. NFC-payment). Then the mobile phone could remind the user to add a rating at a later time. The mobile phone could also store recently-scanned items and thus allow the submission of ratings even if an item is currently not in the vicinity of the user. Another approach is to introduce credits that are consumed when retrieving ratings of other users. Initially, new users could be supplied with a seed credit allowing for retrieving a certain amount of ratings to familiarize and show the benefits of the system. Later, users can earn new credits by generating own ratings. The actual ratio between credits spending and credits earning for a rating (e.g. 1 credit for retrieving, 2 credits for adding) would have to be determined in larger field-trials. Another approach is to utilize the wish of some users to present themselves. This way, hard-working contributors could be rewarded with certain status-levels, which could be made public to the user community accordingly (e.g. Epinions.com has introduced that successfully). Additionally, for reaching the critical mass of ratings it might be necessary to offer a web-based interface in addition to the mobile application.

C. Service Launch

A further question is how to successfully launch such a rating system, how to initially provide enough content that motivates the first-movers to participate in the system. First of

all a selected amount of users could be paid to contribute, this could be real money or the perspective of winning a prize in a lottery. Furthermore, the rating system should be item-data carrier free, meaning it should work with the available barcodes today (e.g. Batoo [10] reads 1D barcodes) as well as with future technologies such as NFC, or the integration of image recognition (e.g. Kooaba, www.kooaba.com). A manual input interface (for the number printed below the barcode) based on SMS should be integrated to also target users with less advanced mobile phones during ramp up.

D. Privacy Concerns

A prominent concern towards open, collaborative systems is a lack of privacy. Collaborative network platforms in general encourage users to share their personal information and experiences in publicly viewable areas. We believe that users deliberately choose to participate in such network because they see value in benefiting from the experiences of others. The contribution of personal information would be just part of exactly that deliberate choice.

E. Business Model

Concerning the business model and funding of the rating application, experiences have to be gained for selecting and combining the most promising models from: (1) Voluntary donations which requires to limit efforts, but Wikipedia shows that this model can work. (2) Charging for services/bundling with others is an option which has largely failed in traditional web contexts but could be promising when partnering with mobile network operators. (3) Advertising-based models could be an option. They have proven successful in traditional Internet contexts, however advertising on mobile phones is yet evolving.(4) Licensing of content (e.g. to manufacturers, market researchers) could be commercialized at a later stage. (5) Selling of goods to the rating community and exploiting the presumable lead-users as test markets could be another source of revenue if applied with care.

F. Product Tree and Dynamic Ratings

In chapter III a concept of dynamic ratings has been proposed. Although we try to cover as many aspects to this concepts as possible, a few questions to dynamic ratings will have to be tackled. For example the question of what part of the tree will be initially provided by the system and which part will be added by the user. Our approach is to provide an initial product tree with standard criteria for each product, like we know it from Amazon or similar websites. This tree can be extended by the user. It can also be questioned if a tree-like structure is the right structure, or whether product types should be allowed to be in several product categories at once.

VI. Outlook

For future work we see a number of meaningful technical extensions and emerging social questions. Technically, we have so far assumed that products to be rated have already been added to the system. An important extension will be to enable users to add new product master data to the Products Repository by submitting product images and product descriptions. This however will require some means of garbage collection. Furthermore, we see potential for a bookmark function, which allows the storage of products that have been scanned and for which recommendations have been received. This might be useful for rating the product at a later stage, when the tag might possibly have been removed from the product already. The possible integration of information of professional sources (e.g. independent consumer organizations) has already been mentioned. Furthermore, browser functionalities on mobile phones will evolve. This means, the implementation of the mobile APriori application as an applet or as a dynamic web-page, optimized for mobile devices, could simplify the deployment of the rating application significantly. From a social perspective it will be interesting to study the rebound effects of using mobile rating services in real contexts: How responsive will consumers be to APriori? How fast will consumer-generated content be propagated among peers? Will consumers base their decisions more on experiences of (even personally unknown) others? What will be the reactions of product manufacturers and store owners? Will the quality of products increase?

References

[1] Nath, B.; Reynolds, F.; Want, R.; RFID Technology and Applications; IEEE Pervasive Computing; Vol. 5; No.1; Jan.-March 2006; pp. 22-24.

[2] Participative Web and User-Created Content - Web 2.0, Wikis and Social Networking; OECD; ISBN: 9789264037465; Oct 2007.

[3] Cooke, A.; Sujan, H.; Sujan, M.; Weitz, B.; Marketing the Unfamiliar: the Role of Context and Item Specific Information in Electronic Agent Recommendations; Journal of Marketing Research; Vol. 39; No. 4; 2002; pp. 488-497.

[4] Senecal, S.; Nantel, J.; The Influence of Online Product Recommendations on Consumers' Online Choices; Journal of Retailing; Vol. 80, pp. 159-169. 2004.

[5] Cheverst, K.; Davies, N.; Mitchell, K.; Friday, A.; Efstratiou, C.; Developing a Context-Aware Electronic Tourist Guide: Some Issues and Experiences; In Proceedings of Computer-Human Interaction (CHI) 2000; pp. 17-24.

[6] Abowd, G.D. et al.; Cyberguide: A Mobile Context-Aware Tour Guide; ACM Wireless Networks; Vol. 3; No. 5; Mar. 1997; pp. 421-433.

[7] Bellotti, F.; Berta, C.; de Gloria, A.; Margarone, M.; User-Testing a Hypermedia Tour Guide; IEEE Pervasive Computing; Vol.1; No.2; pp. 33-41, Apr-Jun 2002.

[8] How to annoy your customers; The Economist; Jan 2008.

[9] Guinard, D.; von Reischach, F.; Adelmann, R.; Michahelles, F.; MobileIoT Toolkit: Connecting the EPC Network to Mobile Phones; Workshop on Mobile Interactions with the Real World at MobileHCI 2008, Sep 2008.

[10] Adelmann, R.; Langheinrich, M.; Floerkemeier, C.; A Toolkit for Bar-Code-Recognition and -Resolving on Camera Phones – Jump Starting the Internet of Things. Workshop Mobile and Embedded Interactive Systems (MEIS'06) at Informatik 2006, Oct 2006.

[11] Miller, B.; Albert, I.; Lam, S.; Konstan, J.; Riedl, J.; MovieLens Unplugged: Experiences with an Occasionally Connected Recommender System. In Proceedings of the Conference of Intelligent User-Interfaces (IUI) 2003.