Ubiquitous Computing and Socially-Aware Consumer-Support Systems in the Augmented Supermarket

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ABSTRACT

This paper considers the possibilities and implications of using ubiquitous computing to augment retail stores with information on critical consumer-driven issues, such as health and food safety, environmental and ethical concerns. The main hypothesis is that the availability of such socially conscious consumer information at point-of-purchase is expected to modulate consumer product choice criteria towards socially responsible consumption and increase their capabilities of negotiation with retailers and producers. This would effect changes in marketing strategies and production processes of retailers and producers towards more socially-conscious practices which still have a sound commercial basis. We oppose the common assumption that such consumer-support systems would benefit only the consumers at the expense of retailers, hence making them non-realistic. To this end we present scenarios and a model for a consumer-support system that supports the interests and value propositions of different actors involved in the retail chain. The relevance of the proposed approach is supported by findings from the sociology of consumption and studies on the influence of consumer opinion forums on marketing strategies of companies. Critical issues for technological realization, such as unobtrusive interfaces and contextualised information presentation for highly-situated interaction are also discussed.

Author Keywords
Ubiquitous Computing, Social Computing, Situated Interaction, Intelligent Interfaces, Consumer Communities

ACM Classification Keywords
H5.3. [Information interfaces and presentation]: Group and Organization Interfaces

INTRODUCTION

In considering the application potential and social implications of ubiquitous computing in everyday life, the activity of shopping has been an often considered example. On one hand, different future visions and scenarios of the potential of ubiquitous computing technologies to modify existing patterns of commercial exchange and induce new models have been discussed. They include individualized pricing, new forms of personalized marketing and smart objects directly negotiating commercial transactions without human mediators [1].

On the other hand, more down-to-earth applications are already being explored in practice by supermarkets and retail chains, largely in the USA and recently also in Europe. Experiments with mobile personal shopping assistants in form of PDAs, interactive screen add-ons on shopping carts or in-store information kiosks abound both in research and in commercial practice of retailers such as WalMart, IKEA and METRO.

While often technologically quite sophisticated, the majority of existing approaches tends to pay relatively little attention to social aspects of the shopping activity and adopts primarily the perspective of producers and distributors: e.g. considering new forms of interactive advertising or the rationalization potential in the logistics chain (see RFID). The consumer perspective is treated mostly in the context of pragmatics and convenience such as navigation aid, personalized price-discounting and "intelligent", context-aware shopping list managers (e.g. [6], [9]).

This paper considers the possibilities and implications of using ubiquitous computing to realize customer-support systems that take a broader view of the shopping process. Instead of relying on purely economic criteria, the goal is to support the awareness and expression of socially conscious values as important criteria of shopping and consumption. The basic idea is to augment retail stores with information on critical consumer-driven issues, such as health and food safety, environmental and ethical concerns of company practices. To this end, we present a concrete model for realizing such a system in a way that supports both the interests of consumers as well as pragmatic commercial goals of retailers and producers. We consider social implications of such a ubiquitous socially conscious consumer-support system and discuss critical issues for its technological realization.

RESEARCH APPROACH

Viewing shopping and consumption within their broader social context reminds us that the act of purchase represents a mediated interaction between the consumer and a complex system of "invisible" actors – retailers, producers, governmental regulators, consumer protection agencies and local production systems. Choosing and buying a product creates aggregated effects which go beyond individual consumption: they influence the life and work of many other subjects such as the environment or local economies.

Recent contributions in sociology of consumption point to an increasing importance that consumers attribute to these issues. They emphasise the emergence of the so-called „new consumer", who is "knowledge-intensive" and socially engaged [3]. Such consumers are concerned with health aspects of the products, the origins and nature of the ingredients the eco-compatibility of the production processes, fair trade and ethical practices of the companies. The notion of the "new consumer" refers to the spread of this phenomenon beyond individual preferences of a few to a new trend influencing large consumer segments.

Against this background, supporting the awareness and expression of social and ecological values in the shopping process becomes an important issue also for producers and retailers. The task of providing such information has traditionally been addressed by consumer protection associations and governmental agencies. The latter have been devising sophisticated safety regulations for production processes, while the former have been increasingly establishing online consumer information platforms (e.g. altroconsumo.it, online-label.de). This has been accompanied by consumer opinion forums supporting direct exchange of information and experience among consumers (e.g. epinions.com). Online marketplaces such as ebay and amazon have introduced collaborative reputation systems for verifying the quality and ethics of buyer and supplier practices. While such information is easy to find in online portals and communities, it is virtually non-existing in physical places where the majority of shopping activities takes place: shopping malls and supermarkets.

The basic idea of our approach is to augment retail stores with information on critical consumer-driven issues, such as health and food safety, environmental and ethical concerns of company practices. While the scenario of providing in-store information on critical consumer-driven is-sues is not new [11], a common assumption is that the provision of such in-formation would benefit only the consumers at the expense of retailers, hence making such scenarios non-realistic. In our opinion this is due to a missing holistic analysis of the issues and problems involved, based on considering different points of view: social, economical and technological. We believe there is significant potential for the development of cooperative scenarios for such consumer-oriented systems, which can benefit all actors involved.

The main hypothesis is that the availability of such socially conscious consumer information at point-of-purchase can reinforce and activate latent aspects of consumer product choice criteria towards socially responsible consumption at a wider scale. This in turn would provide a tangible motivation and commercial basis for retail stores and producer companies to adopt socially-conscious production and marketing practices.

The research challenge is then to find ways for creating and providing such information in a way which makes it a means of communication and knowledge sharing between the different actors involved in the broader social context of shopping and consumption. Consumers can not only access information from verified consumer-credible sources (such as consumer protection associations) but also leave their own feedback such as the personal importance of specific social criteria (health, ecology, ethics), quality ratings or product experiences (similarly to current consumer opinion forums).

This feedback represents voluntarily disclosed information that is aimed not only at fellow consumers but also at the retailers and producers. The retailer's in-store warehouse system can access the user profiles, feedback and preferences (the ones that users made publicly available) in order to create personalized product offers suitable both for a given user and his current need, directly at the supermarket.

Thus, from the consumer perspective, the availability of such a system would satisfy a previously non-considered information need and allow them to "communicate" their concerns to the retailers and receive a "response" in form of personalized offers. From the retailer and producer perspective, this would allow them to gain previously unavailable information on customer preferences and provide ways for realizing new forms of collaborative marketing for improving customer satisfaction, developing new product lines and increasing sales of higher quality products. The next chapter introduces a scenario of such a ubiquitous consumer-support system.

SCENARIO: SOCIALLY CONSCIOUS CONSUMER SUPPORT IN THE AUGMENTED SUPERMARKT

In the following scenario the supermarket is equipped with ubiquitous computing infrastructure that supports all actors in presenting their value systems and perspectives to each other. Smart products contain information processing and communication capabilities which allow them to react to physical events in the environment and communicate with the information systems of different actors such as the in-store information system or the personal information devices of the consumers. The in-store information system provides open access services for (trusted) devices of other actors. This includes a wireless Internet connection which can be used both by internal store devices (smart products) as well as by the user devices to access services of other actors (e.g. consumer associations). The shopping cart is equipped with a touch-screen interface which communicates with smart products, the in-store information system, the user's personal devices and other internet-based services. The consumer carries a personal digital assistant (smartphone, PDA) that communicates with ubiquitous services in the supermarket.

In such a supermarket, the consumer has access not only to the producer and distributor-based product information but also to information from consumer protection associations and from consumer opinion forums. Moreover, this access is actively supported by the distributor and the socially-conscious producer companies. The distributor provides the necessary in-store technical infrastructure such as wireless Inter-net access for (trusted) third-party services to the in-store information system. The consumer opinion forums are not seen as a threat but rather as a chance by socially-conscious producers. The consumers can now easily leave feedback on a specific product at a time at which it aroused their interest: whether it made them satisfied, angry or frustrated. The feedback is automatically fed into consumer opinion forums which can be consulted by the consumers onsite through their personal digital assis-tant, or online in the pre- and post-shopping phases. For the producers and distributors this is a valuable source of information on voluntary disclosed consumer preferences.

This feedback is also evaluated by an in-store recommendation system which is used both by consumers as well as by distributors and producers. The consumers can specify their personal profile not based only specific usage or product-based preferences but also through expression of their social values and expectations. These profiles are managed by the personal assistant and automatically updated based on the consumer's shopping activities: this now comprises not only the products bought, but also the feedback left through interaction with smart products that ranges from simple text and voice annotations to quality ratings to personalized negotiations based on consumer value preferences (see Vignette 1, 2). The distributors and producers can evaluate this feedback in order to modify their product offerings and production processes – which are now based not only on purely economic consumer purchase patterns, but also on clearly expressed social values and expectations. The recommender system uses such profiles to recommend products which are contextualized to a specific person's need in a given context. Smart products can represent producer and distributor interests and generate real-time personalized product offerings. The recommender system integrates user profiles representing long-term preferences with the current context of consumer's actions in the store and enters into negotiation of personalized product offerings with smart products. It attempts to provide the socially-conscious consumer with a product which satisfies a complex pattern of his current need and personal values and preferences. In this way, an implicitly consentual cooperative relationship, between consumers, distributors and producers is established.

Vignette 1: *A mother is passing by a milk products shelf. Her little son grabs his favourite bifidus drink, but Mum's assistant sounds an instant alert: the producer company has been accused of using milk from cows fed by genetically manipulated food. The warning does note "No legal ban. Scientific opinions divided.", but no way she is going to feed her baby with this stuff!. "Good thing I completed the children section in that personal profile and checked the highest safety option for my little boy!", a thought crosses her mind. But how is she going to explain this to the little one ? His favourite cartoon character is on the bottle! She taps the "help" button on her touch-screen and gets a list of alternatives, based on real-time created personalised offers. One includes a double pack option of the bifidus and an ice cream in his son's favourite taste, at a discounted price. Oh yes, so that's why they call them "smart products". OK, this will do the job..Leaving the shelf she signs up for a children-adapted illustrated report on genetically modified substances in milk products. The little one has to learn, dhe cannot go on bribing him with an ice-cream every time something alike occurs…*

Vignette 2: *Passing by the non-food department, she sees a pair of jeans on special offer, but as she picks them up the assistant warns "non ethical working practices: child labour in south asian sweatshops", accompanied with an image from a newspaper clip. She sighs: "Terrible. You really cannot trust anyone anymore." She leaves a voice annotation saying she'll never ever buy anything from people who have children earn their profits. She makes sure a copy goes to the store owner and her buddy list for an "instant petition". The annotation would appear in the consumer opinion forum automatically, but still. Better make sure it makes a difference as soon as possible; her friends' votes on the petition will take care of that.*

But how realistic are such scenarios? And what could be their implications ? In order to answer this question we need to consider them both from a technological as well as social and economical point of view. The theoretical underpinnings for the social motivation have been briefly sketched in the introductory chapter. A more detailed

analysis is out of scope of this paper (see [2], [3], [8]). The next chapter outlines the possibilities of the technological realization and open research issues based on the integration of existing ubiquitous computing technologies with technologies and interfaces for community-based knowledge sharing systems. The last. chapter then considers the possible socio-economic implications.

TECHNOLOGICAL REALIZATION

A typical ubiquitous computing infrastructure for the supermarket consists of smart products, different local services providers and a central in-store warehouse system [6]. Smart products are physical objects enhanced with information storage, processing and communication capabilities. They are universally identifiable through machine readable tags such as bar-codes and RFIDs. While bar codes are already omni-present and can be easily created and decoded by laser scanners, RFIDs is can be rewritten and hence store dynamic information.

Local service providers are shelf-based computing and communication infrastructures that allow the communication and interaction between the smart products and the central in-store warehouse system, and between the smart products and the user interfaces. They allow the information from smart products to be displayed on the user interfaces, process requests from the user clients and dispatch them to the central service and warehouse system when needed. Commercial technologies for RFID identification and services for communication with the central backend are already being commercially deployed(e.g. WalMart, Metro Future Store). So are user-interface devices such as on-cart touch-screens, in-store information kiosks, bar-code and RFID readers for mobile phones and PDAs [9], [10].

The critical aspect for the realization of the described scenario lies in the integration of such infrastructures with global physical annotation systems, community-based collaborative filtering and recommender systems and intuitive user interfaces for situated computing [4]. Global physical annotation systems such as [10] enable the linking of online content to physical objects using commercially available PDAs, bar-code scanners, wireless networks and web-services. Using such systems users could scan a product and get product information both from the in-store information system (distributors) and from the memory of the smart product itself or the producer's online database, as well as from consumer association portals (e.g. online-label.de) and consumer opinion forums (e.g. epinions.com, amazon.com).

Furthermore, such systems allow users to leave text, voice or other annotations attached to the physical products. This can be used to provide the described user feedback functionalities. Incorporating appropriate search services the database of user feedback can then be manually queried by user interface applications. Fig 1. shows our current architecture design for such a system.

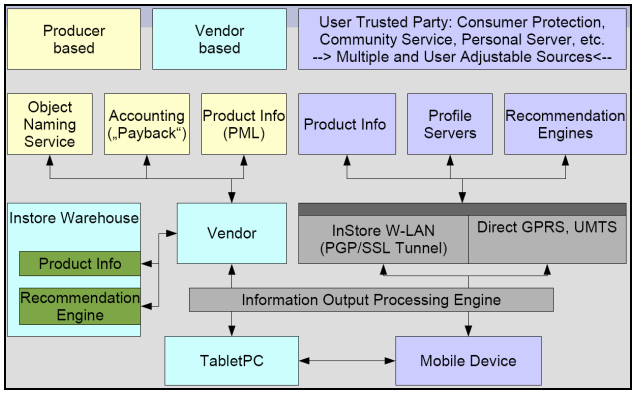

Fig 1. Preliminary architecture of a socially-aware consumer-support system for the augmented supermarket

During the first registration each user selects an initial profile (e.g. quality aware vs. bargain hunter) or specifies his preferences manually, hence defining the main criteria upon which the system will base his warnings and recommendations. This profile consists of a public and a private part. The public part is accessible by all parties (community recommenders, retailers and producers). It contains basic selection criteria such as price, quality, health, ecology and ethics. The private part concerns more specific issues such as allergies, diet preferences (e.g. vegetarian, kosher) and child friendliness. The private part is accessible only for the user's personal recommender on the (trusted) community server. Other implicit ways allow the retailer's recommender system to generate suitable offers without having to know user's specific private preferences (see further below).

When a product is chosen or inspected by the user the system reads the RFID, extracts the unique product code (EPC) and retrieves the product information server address by querying the object naming service. It then collects product information (specified in the product markup language, PML) from the product information server of the producer, from the in-store warehouse system of the vendor and from the consumer community platform. This information is filtered, composed and formatted for presentation by the Information Output Processing Engine which considers the current use context (interaction with physical product vs. interaction with a digital device) and available devices (PDA, on-cart tablet-PC). Accordingly the appropriate information is presented to the user.

But all of this takes place in a highly situated context loaded with constraints and expectations. The shoppers already suffer from a continuous information overload. They want knowledge, control and convenience [9]. Instead, shoppers are already confronted with complex, manipulated and often unintelligible information in the existing supermarkets. As a result they use cognitive shortcuts and often switch between premeditated and impulsive behaviour. The store is also an enormous repository of multimodal information (visual, tactile, olfactory). Not only are the shoppers minds overloaded, so

are also their eyes and hands. Thus, shopping is a time-consuming, knowledge-intensive, physically and mentally overloaded activity. So, how do we embed an additional source of information in such an already complex situation? How do we design an interface that integrates itself seamlessly in user's familiar patterns of use?

This challenge is referred to by situated interaction and situated computing: "The integration of human-computer interaction and the user's situation in a particular working context in a mobile [ubiquitous] environment" [4]. This leads to the research problem of developing intuitive interaction designs and ubiquitous knowledge interfaces that complement situations encountered in the scenario of ubiquitous socially aware consumer-support systems.

Our situated interaction model is based on unobtrusive interfaces and contextualized multimodal information presentation. The user's tactile interaction with physical products is in the foreground (taking products, touching, looking them over, smelling). The digital interfaces are waiting unobtrusively in the background. They are activated only when a need for specific information arises from the user's current context (e.g. warning alert) or upon a user's specific request (e.g. more info). Based on the given state of user's interaction, appropriate styles and channels of information presentation are selected.

For example, in the scenario presented in Vignette 1, the personal digital assistant issues a warning only when the user indicates a particular intention and context of use by picking up a product. The user need not engage into explicit use of the PDA for the verification of product adherence to his personal criteria. Furthermore, since in this particular situation the haptic interaction with physical products is in the foreground, an acoustic warning signal is issued. Simultaneously a visual warning is displayed on the on-cart touch screen and on the PDA.

To this end we employ a "semaphore" metaphor, with familiar visual cues: red light is for danger, yellow for attention, green for okay. (see protoype mockup in Fig. 2) This is followed by a short alert message so that a brief glance suffices for the user to get the information needed for deciding upon further action. At this point the user can continue by choosing another product (haptic interaction with products). In this way the use of the system has been unobtrusively embedded into the shopping situation. At the same time, by tapping the "more info" button on the touchscreen or on the PDA the user can seamlessly effect a switch of context. Looking up more detailed information and suggestions on alternative products the user engages into explicit interaction with the digital devices, which is now in foreground of his attention.

The presentation of information and interaction are adapted accordingly and take more advantage of visual navigation. As a way of dealing with potentially conflicting interests of different actors (e.g. consumers vs. retailers) we adopt the approach of "information transparency". The results of the

Fig 2. Prototype interface mockup for warning alerts and alternative recommendation list

recommendation systems of different actors are displayed simultaneously (Fig 2.). The list of alternative products presented to the user is divided in two parts. The first one presents a list generated by the user's personal recommender service. These recommendations contain products which satisfy the criteria from user's private profile, ranked on the basis of recommendations (ratings) from the community collaborative filtering system (e.g. consumer opinion forums).

The second part of the recommendation list includes special offers endorsed by the retailer selected in accordance with the current user need (the originally selected product) and the publicly available parts of the user's profile. Furthermore the retailer system is able to provide special offers on any of the items from the products in the first part of the list – those that have been selected based on user's private profile and community rankings. In this way the retailer's recommender system implicitly gets to know which products might interest the consumer, without needing to access consumer's private preferences. It can create offers of products that are both high on the retailer's list of priorities as well as matching a consumer's need.

SOME SOCIO-ECONOMIC IMPLICATIONS

The main hypothesis of the described scenario and its technological realization has been that providing consumer-credible information on critical consumer issues (health, environment, ethics) at point-of-purchase is expected to modulate consumer product choice criteria towards socially responsible consumption and increase capabilities of their negotiation with retailers and producers. As consumers become aware of product quality attributes regarding effect on personal health, the environmental impact of their production and consumption, as well as the ethical as-pects of producer's work practices, they will develop a stronger preference for products with high ratings on these attributes. Such effects have been empirically confirmed in previous studies on effects of health-risk product labels on consumer food purchase choices [5].

As a result, this change in consumer behaviour may indeuce the producers and retailers to pay more attention to such aspects of both their products and their work practices. Since economic studies have shown that companies tend to follow product attributes on which consumers are willing to pay a premium, especially high-quality product companies would be interested in answering to the expressed consumer needs [1]. Above all, the ability of the consumers to perceive these "socially conscious" attributes better than currently, means that they are now able to voice the value they attribute to them – both by buying them but also by providing their feedback during in-store shopping.

In this way, companies would gain a valuable channel of consumer-related information. Those companies who score better on the socially-aware attributes valued by users, will have additional stimulus to cooperate with the consumers (e.g. producing more socially-aware products or providing genuine product information), while those who score especially low will be increasingly penalized [1]. This means that the actions of the consumers would directly influence the greater supply of better products. Hence, the fact that the companies are able to track consumer preferences with respect to these criteria, could be perceived as a positive effect by the consumers. As a consequence the privacy concerns may not present a problem.

In contrast to existing customer feedback schemes (e.g. loyalty cards) which provide no way for the consumer to actually voice what their concerns with the products are, here the consumer feedback is intentional and often explicit. Instead of one-way "being spied out", the consumer has the means of effecting perceivable reactions to the concerns he voices in his purchase decisions. Admittedly, as for the "non-intended use" of consumption profiles by the companies, the privacy problem still persists. Sophisticated schemes might be needed to ensure that the transactions between consumers and smart products (Vignette 1) remain unlinkable to specific consumer identities.

The findings from the sociology of consumption regarding the trend of the knowledge-intensive and socially-conscious consumer point to an existing need for the described scenario and its congeniality with current consumption patterns (see Introduction, [3]). Game-theoretical studies on the influence of consumer opinion forums on competition and marketing strategies of companies support the relevance of hypothesized influence on changes on strategic behaviour of companies [1]. These studies demonstrate that consumer opinion forums mostly aid high-quality producers who are thus incentivated to support (fund) the creation of such forums and discourage their manipulation. Furthermore, they show that even taking into account forum manipulation (e.g. by false recommendations and promotional chat created by companies themselves), the forums retain their informativeness: consumers are able to deflate online ratings and infer the "true" difference in quality between competing products [1].

Finally, the increasing use of consumer forums reduces the relative effectiveness of advertising in influencing consumer beliefs. Due to such effects, the circulation of knowledge from consumer communities at point of sale would effect changes in behaviour of retailers and producer companies. They would adopt more socially-conscious practices as a means of achieving their commercial goals and deliver better customer value in the process. . In other words, such insights from consumer research and economic studies provide plausible grounds for the validity of the approach proposed in this paper.

REFERENCES

1. Dellarocas, C.; The Impact of Online Opinion Forums on Competition and Marketing Strategies, MIT Sloan School of Management Working Paper, dell@mit.edu
2. Drivers of consumer behaviour, The State of Queensland, Department of Primary Industries, January 2003. http://www.dpi.qld.gov.au/businessservices/11364.html
3. Fabris, G.; Il nuovo consumatore: verso il postmoderno, Franco Angeli, Milano, 2003.
4. Hewagamage, K.P., Hirakawa, M.; Situated Computing: A Paradigm to Enhance the Mobile User's Interaction. Handbook of Software Engineering and Knowledge Engineering, Vol. 0, No. 0, 2000
5. Lang, J. et al.; Use of a supermarket shelf-labeling program to educate a predominantely minority community about foods that promote heart health, Journal of the American Dietetic Association, Vol. 100, No. 7, July 2000
6. Leben in einer smarten Umgebung – Auswirkungen des Ubiquitous Computing. http://www.smart-environment.de, Gottlieb Daimler and Karl Benz-Foundation Colloquium, led by Prof. Dr. Friedemann Mattern, ETH Zürich.
7. Mattern, F.; Vom Verschwinden des Computers – Die Vision des Ubiquitous Computing; in Mattern, F. (Hrsg), Total vernetzt, Springer, 2003.
8. Morace, F. (ed.); European Asymmetries: The 6 trends in consumption that are shaping the New Europe", Libri Scheiwiller, Milano, 2002.
9. Newcomb, E.; Pashley, T.; Stasko, J.; Mobile Computing in the Retail Arena, Proc. of CHI 03, ACM Press, April, 2003
10. M.A.; Davenport, D.; Hwa, H.; Mui, L.; The Annotated Planet: A mobile platform for object and location annotation, in Proc. Of Ubicomp Workshop on Suporting Social Interaction and Face-to-Face Communication in Public Spaces, 2003
11. Smith, M.A.; Some Social Implications of Ubiquitous Wireless Networks, Mobile Computing and Communications Review, Vol. 4, No. 2, 2001