Consumers and Pervasive Retail

Panos Kourouthanasis
ELTRUN-Athens University of Economics and Business
Evelpidon 47A
Athens 11362
Greece
pkour@aueb.gr

George Roussos
Birkbeck College
Malet Street
London WC1E 7HX
UK
g.roussos@bbk.ac.uk

1. Introduction

The most innate changes that pervasive computing will bring about are in our day-by-day situation. In Mark Weiser's words: "The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it" [13]. Over the past decade, researchers have been trying to understand the ways pervasive technologies would affect different aspects of everyday activities including learning, entertainment, collaborative work and the home environment [1]. Ultimately, new technologies are used for conducting business and conceptualizations of pervasive commerce opportunities exist in abundance, but so far little attention has been concentrated towards consumer perceptions of pervasive commerce systems.

In this article we present the front-end and formative evaluation studies carried out as part of the development of MyGrocer[1] a second-generation pervasive retail system. Our initial motivation for the development of a retail system using pervasive computing technologies was the investigation of grocery supply chain optimization, a point of view we develop in the following section. Research carried out to support conceptual design and implementation evaluation of the system indicated that–although indeed efficient in addressing the problems it was designed to solve—it would also have an immediate and clear effect on the grocery shopping experience.

2. A Business Case for Pervasive Retail

Since the early nineties it became evident that pervasive computing offers clear benefits for retail (see Sidebar) both for the consumer and the supplier. An activated world offers distinct opportunities for shopping: products can describe themselves to the consumer and bid competitively for the consumer shopping cart; a ubiquitous agent can offer cognitive

[1] MyGrocer has been partially supported by the European Commission under research contract IST-1999-26238. The MyGrocer Consortium consists of the following members: Nokia Corporation, Procter and Gamble, Unisys Corporation, ATMEL Corporation, Pouliadis Associates Corporation, Athens University of Economics and Business, Helsinki University of Technology, S-Markt and Atlantic Supermarkets.

assistance to the consumer, removing the need for the stressful and error prone tracking of replenishment requirements and home inventory levels; during a supermarket visit the consumer can plan their course through the aisles with accuracy avoiding wasted time and frustration to collect the items in their shopping list; consumers can control the cost of a shopping trip via continuous price tracking of the products in their shopping cart as well as increased visibility of offers and promotions; at the same time, the supermarket can create personal profiles and thus improve the success of offers and promotions which are tailored to the individual consumer situation as well as respond to individual profiles of persons and objects with whom it has established no previous relationship; the retailer can optimize supply chain logistics by having access to consumption information earlier on in the consumption cycle instead of at the point of sale; product recalls can be executed easily and new possibilities for consumer relationship management are created through replenishment and preventive maintenance without customer orders; last but not least, grocery shopping anywhere and anytime becomes possible.

However, deploying pervasive computing systems outside the laboratory poses significant challenges [5] and in the case of retail, requires the deployment of new infrastructure, primarily broadband wireless connectivity for mobile devices inside the store and electronically tagged grocery products with unique identifiers following a global classification scheme. MyGrocer aimed to study consumer perceptions of pervasive retail by designing and implementing a prototype system which would cater for the consumer on the move via mobile telephones, at home using "smart" appliances that capture consumption information and most importantly, to provide a richer shopping experience on the supermarket floor (the later usage scenario is depicted in Figure 1).

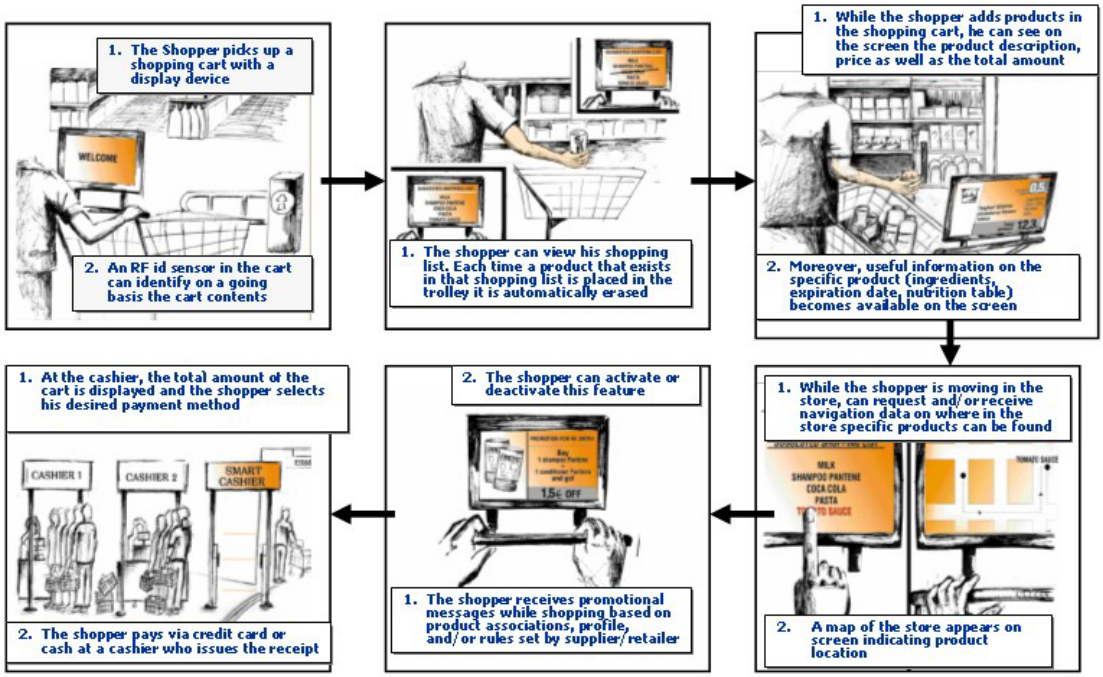

Figure 1: A usage scenario of pervasive retailing. The sketches are taken from the material used for the focus groups during the requirement elicitation phase of the project.

The new information sources made available by pervasive retail can offer significant benefits for business [7, 8, 9, 10]. Indeed, decades after the introduction of information systems in production and logistics control there are still significant inefficiencies in modern supply chains, in particular for fast moving consumer goods, which adversely affect the efficiency of retail operations. Upstream supply chain inefficiencies affect the relationships of all trading partners and result in high out-of-stock conditions at the point of sale, a high returns rate as well as long lead times. On the other hand, inefficiencies in the downstream direction affect negatively demand forecast accuracy which results in low on-shelf availability and thus loss of revenue despite the fact that products are available on site. Furthermore, information-sharing ineffectiveness between trading partners reduce the accuracy of demand forecast and the scheduling of the replenishment process. A direct consequence of low demand forecast accuracy is that trading partners have to maintain increased inventory levels to address unpredictable increases which in turn result in increased logistics costs. Common practice today is forecasting consumer demand by processing historical point of sale data, using decision support systems that utilize data warehousing and data mining techniques. However, using point of sale data to make forecasts, results in lower accuracy because demand patterns are changing rapidly [3] and such fluctuations cannot be captured at the point of sale but have to be identified earlier in the consumption process. Moreover, historical forecasts cannot effectively take into account the influence of promotions and other marketing instruments since the success rate of such mechanisms is generally hard to quantify beforehand. A quantitative description of this situation according to a recent study by Andersen Consulting (now Accenture), a management consulting and technology services firm, estimates that 53 percent of out of stock conditions are due to store replenishment inefficiencies. Even worse, a further 8 percent of on the floor out of stock conditions occur despite the fact that the necessary supplies are in storage on site.

Typically per store replenishment strategies are based on regional distribution center level estimates and are not driven by real-time consumer demand data. To cope with this limitation, grocery stores usually hold high levels of anticipatory inventory to prevent out-of-stock conditions. A direct consequence of this fact is high supply variability and thus unstable process cycle times. The difference between true and estimated product demand is compensated through time, inventory and capacity buffers at the cost of additional capital investments. To alleviate this problem specific inventory policies such as just-in-time (JIT) and vendor-managed inventory (VMI) have been established upstream [12] where real-time data is easier to obtain. For example, the VMI approach has proven particularly successful in improving efficiencies in the manufacturer-supplier link. With VMI the manufacturer is responsible for maintaining the suppliers inventory levels and for generating purchase orders rather than the reverse, which is the traditional practice. The same approach is being adopted in the supplier-retailer relationship through the work done at the MIT Auto-ID Center (see Sidebar). MyGrocer explored the suitability of the same technique in the retailer-consumer relationship by extending the visibility of actual end user consumption data collected by two additional sources to those currently available: supermarket shelves and the home. This approach requires significant modifications on current retail information systems that work on the basis of store keeping units (SKU) rather than the individual item.

Last but not least, pervasive retail offers the opportunity for personalize shopping. An extensive recent study carried out for the Coca-Cola Retailing Research Group [4] found that mass marketing is facing long-term erosion and will eventually be replaced by mass-

customization, which is increasingly becoming a necessity. Individual product identification is key for the delivery of mass-customized services. The current model for the supply chain, which is based on the SKU rather than the individual item, cannot address customization effects since the individual item is not represented in the system as a separate entity.

Cost savings due to optimizations of the supply chain should be naturally passed on to the consumer as better value. But this is not the only benefit that pervasive retail has to offer to the consumer. Indeed, the Coca Cola study has also found that the existing food shopping process is frequently perceived by consumers as a chore, frustrating and unenjoyable. The availability of rich information about products as well as consumption patterns allows for the development of new applications that improve the shopping experience. The main focus of this article is primarily on consumer perceptions of the new types of services and applications that have been developed using pervasive computing technologies. Applications that become possible by MyGrocer during a shopping visit include the provision of detailed product information and comparisons between similar brands, tracking the cost of items in the shopping cart, navigational assistance to locate particular products, delivery of personalized offers and promotions, the ability to place orders for home delivery anytime and anywhere, to check inventory levels and to be notified of product recalls, and finally, significant reduction of the waiting time at the check out due to the instantaneous scanning of the shopping cart contents.

3. MyGrocer Pervasive Retail System

One of the first design decisions of MyGrocer was to specify and develop a radio frequency identification (RFID) system. To facilitate a robust architecture it was deemed necessary to acquire early experience with RFID using one of the commercially available designs the Philips I*Code (see Sidebar). MyGrocer designed and developed a passive RFID solution based on the IONAS chip design by Atmel Corp. The IONAS operates at 13.56 Mhz and is ISO/IEC 14443-2 compliant. It supports password and write lock protection, programmable send and receive protocols and an anti-collision mechanism. It can store an ID of 4 and 19 bytes length. For MyGrocer each tag holds a 96-bit universally unique identifier following the electronic product code specification (cf. Sidebar). The chip itself contains an internal tuning capacitor and thus for a complete tag only an external antenna is required. Ordicam, a French radio frequency engineering firm, designed the associated antennas as well as the corresponding RFID readers. The reader developed is based on the Ordicam DSC V.61, which uses the NEC PIC16F876 processor, and with size 100x50x15 mm and weight 2.5kgs with battery included is one of the lightest RFID readers available. Strict limits on radio emissions imposed by consumer electronics regulations in Europe[2] and size restrictions on the antenna, which has to be small enough to fit on product packaging, resulted in a rather medium range for RFID. Finally, each reader communicates with a host computer via RS-232 port.

Several issues had to be addressed during the design and implementation of the system including (a) the design of a compelling interface enabling seamless interaction between the

[2] The EU Directive EN-50082-1 published in 1995 on "Generic immunity standards for equipment used in residential, commercial, and light industries" and the CENELEC European Committee for Electrotechnical Standardization Directive prENV 50166-2 on "EMF radiation standards for 10 KHz - 300 GHz" define significant restrictions on the power output of radio frequency equipment.

shopper and the system, (b) the implementation of a product scanning mechanism that would minimize the shopper involvement and (c) the design of an integrated information system that would enable the provision of retail services. We will briefly discuss some of the characteristics of MyGrocer here and the reader interested in full details can consult [11]. Two elements of the supermarket user interface are of particular interest that is, the shopping cart and the sensing of product related actions for example, placement and removal of an object in the shopping cart, consumption of goods at the home and so forth.

The shopping cart was equipped with a Fujitsu Stylistic LT P-600 tablet PC running Windows 2000 with applications developed using Java 2 (Figure 2). Five distinct interaction areas were developed to support the shopping experience:

- *Shopping cart content:* lists products placed in the shopping cart;
- *Total cost:* shows the total value of products in the cart and the total amount of reductions due to promotions and offers;
- *Shopping list:* lists products that are marked as regular buys and those that have been indicated as for replenishment due to consumption;
- *Offers and promotions:* details offers and promotions for the particular shopper;
- *Additional information:* displays either detailed information on the last product scanned (for example weight, cost, nutritional value and so forth) or on the terms and conditions of the last triggered promotion.

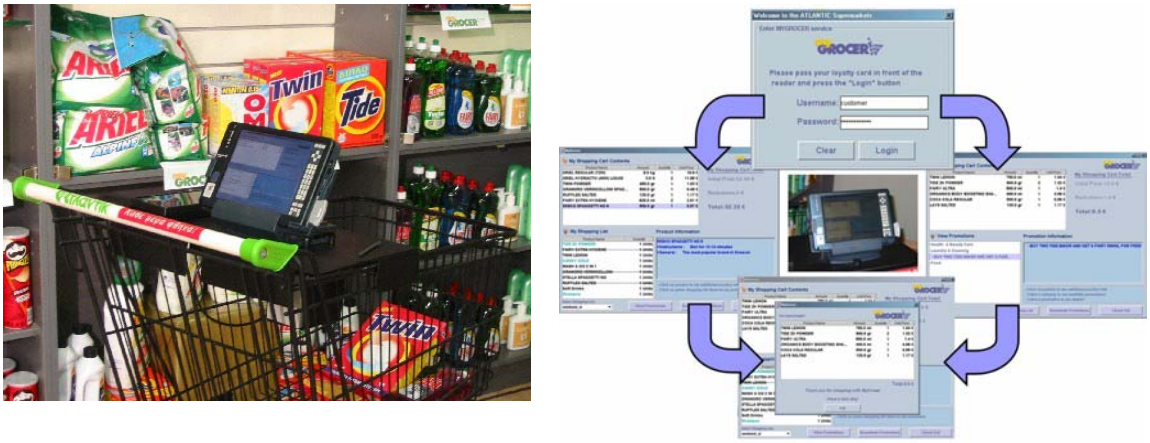

Figure 2: Prototype shopping cart implementation: Shopping cart with tablet PC, wireless network and RFID reader (left). User Interface: Login screen, shopping options including shopping cart content monitor, shopping list, total shopping cart content cost, offers and personalized promotions, additional product information and finally, fast check-out (right).

An RFID reader was also installed on the shopping cart to record product related events. Unlike barcode which is the commonly used technology for product identification today and requires significant involvement on the part of the user, RFID offers several advantages (a) it senses events and captures related data in a way that does not require line of sight visibility between the tag and the reader, (b) it is more resistant to hostile environments and can survive the effects of excessive levels of dust and moisture, (c) it can store more information and thus it may be programmed to hold a unique product identification number, and finally (d) it provides anti-theft capabilities to support electronic article surveillance (EAS) that can verify that cart contents have been paid for on exit.

On the other hand RFID is a relatively new technology and still considered too expensive for very large-scale use. This limitation has restricted our ability to field test the system with multiple concurrent users and dictated that the shopper would need to place each product within the range of the RFID reader to register its identity. Although this solution does not provide for a completely seamless experience it still has considerable advantages over barcode scanning and represents an acceptable tradeoff between cost and functionality. The shopping cart was also connected to the wireless local network available throughout the supermarket shopping area and enabled it to communicate with the retailer back office systems. To facilitate content delivery to different consumer devices including the shopping cart a purpose built middleware was developed (see Sidebar). The wireless network was also used for location sensing and navigational assistance on the supermarket floor.

4. Conceptual Design

Given the relative lack of experience with MyGrocer type systems it was deemed necessary to conduct a front-end evaluation study with the aim of understanding on the one hand consumer perceptions of its value proposition and on the other to collect functional requirements that would lead to appropriate system design. To this end participants to the study were introduced to the full pervasive retail scenario, which extends from the on-the-floor shopping experience to remote shopping via mobile devices and automatic replenishment through consumption monitoring at home. Of particular interest was the investigation of consumer expectations and impressions of pervasive retail; their interest in the system as a whole and in its different subsystems; their ability to understand the key concepts; and their motivations for using the system for example the perceived impact of system use in consumption patterns. The approach adopted was qualitative in nature and the method employed was focus groups.

Market Analysis, a market research firm, was commissioned to conduct the field study in Athens, Greece, over two consecutive days in June 2000. The target audience consisted of: women between the age of 25-34, responsible for grocery shopping within their household who demonstrated some familiarity with information and communication technologies, either as regular users of personal computers and mobile telephony at home or at work; women with the same background but from the 35-50 age range; married couples with both partners between the ages of 25 and 34, both responsible for shopping and with similar background as groups one and two; and, couples as in the previous group but from the 35-50 age range. Participants were first introduced to pervasive retail concepts through a presentation based on concept drawings with explanatory text, which the moderator used to develop the usage scenarios. Following the introduction, participants were encouraged to discuss their thoughts, feelings and reactions to this new approach to retail as well as to express their anticipated reactions, attitudes and potential purchase behavior in this environment. The discussions of all groups were recorded in audio and video with the permission of the participants. Transcripts of the discussions were produced and analyzed using the QSR NVivo software. At the end of the discussions participants were offered a voucher for the supermarket participating in the project.

The pervasive retail proposition attracted significant interest from most participants as a shopping option in addition to the ones available today. In particular the in-store scenario received the most favorable response with the main benefits perceived to be the

improvement of the shopping experience, which was understood to be faster, easier and offering better value for money. In summary, features that proved most attractive were:

- The constant awareness of the total cost of the shopping cart content which offers to the opportunity to accurately control spending during a shopping trip.
- Access to complete and accurate descriptions of products including price, size, ingredients, suitability for particular uses and so forth.
- The ability to compare the value of similar products.
- The provision of personalized, targeted promotions that reflect the individual consumer profile in addition to the usual generic promotions as well as the fact that consumers could access all offers available in the specific supermarket at a single interaction point.
- The proposed in-store navigation system especially in the case of hypermarkets where orientation is particular difficult.
- The smart checkout and the ability to bypass queues and reduce waiting time.

However, this study also discovered that one of the main concerns of the participants was the use of personalized purchase statistics by the retailer and the collaborating service providers. A large proportion of participants were particularly concerned about the collection and storage of personal data, even though they were aware of the provisions (albeit not the practicalities) of the European data protection directive. Their negative reaction to data collection was triggered primarily after the eponymous authentication during the initial use of the shopping cart when, after entering personal identification credentials, they were presented with a personalized shopping list derived through the analysis of their purchase history. This reaction related to the immediate recognition that for the construction of the personalized shopping list their data is recorded, processed and stored for further use and was more pronounced when trust of third parties was also involved –a core requirement for pervasive retail. The main source of their concern was that private data, collected in the sheltered space of the home could be delivered to external sources without the explicit consent of the consumer. The vast majority of participants did not trust a service mediator to protect their privacy, irrespective of whether it was a contractual obligation or not.

Another major concern related to the overall shopping experience, which was perceived to point towards a technology controlled, fully standardized life-style. Two issues interrelate on this point: On the one hand, participants rejected the claim that a software system could predict accurately their wishes just by collecting historical data and monitoring habitual purchases. Indeed, due to its ability to pre-empt their wishes, this aspect of the system appeared patronizing and overtly rationalized but most importantly contrary to the experience of being human. In fact, the majority of participants discarded the possibility of a computer system that could successfully predict their wishes, while some of them were offended by this suggestion. On the other hand, the participants of the study perceived that the ubiquitous retail system reviewed promoted primarily the interests of the supplier while the consumer only received marginal benefits.

Finally, several participants observed that adoption of pervasive retail would result in a fundamental transformation of the traditional family roles. They emphasized that product selection and maintenance of appropriate home inventory levels are a means to establish roles within the family unit and the responsibility to carry out these activities is an integral part of the identity of the person or persons in charge. Elimination of this responsibility was

perceived to undermine the status quo and pervasive retail was consequently treated with mistrust and hostility in these cases.

5. Implementation Evaluation

The results of the front-end evaluation were used to inform system design and as a result significant modifications were made to the initial usage scenarios. In particular, the strong consumer resistance to the home scenario due to privacy concerns led us to implement this only in a laboratory environment and not test it in the field. After an initial prototype of the system was developed and deployed in two branches of the participating supermarkets in Athens, Greece, and Helsinki, Finland, a formative evaluation study was conducted focusing on the on-the-supermarket-floor and mobile shopping scenarios. The aim of the study was to understand how supermarket shopping augmented with pervasive computing capabilities influences the shopping experience and to compare it against the traditional supermarket environment.

Sixty male and female members of the supermarket loyalty club were selected to take part in the study. All were from the 25-65 age range with varying degrees of expertise in using personal computers and mobile telephones and were responsible for shopping in their families. Loyalty club members were selected because they are familiar with the terms of use of their personal information by the supermarket and have accepted it in a trade-off for better value through discounts, gifts and so on. For the trials, two aisles of the supermarket stores were reserved and where it was clearly indicated that a research study was taking place. A selection of products (approximately 100 different product categories) was equipped with RFID transponders. Participants were contacted over the telephone and 45-minute slots were booked for each individual. Upon arrival participants were introduced to the system, completed a demographic questionnaire and were then invited to use the system independently. They were able to select products placed in the two aisles used for the study and receive offers and promotions according to their profile. Finally, participants were asked to complete a questionnaire to evaluate the system services, express their views of their experience and compare it against traditional shopping.

Several aspects of the system received favourable responses especially these features that help save time and money. Minimizing checkout time appears to be the most attractive feature with second the capability to continuously monitor the total value of the shopping cart contents. Other services that attracted significant interest were the ability to inspect additional product information and the automated construction of a regular shopping list. Indeed, the ease of access to offers and promotions and the navigation features of the system were valued highly by the vast majority of participants since they were seen as improving the effectiveness of the shopping visit. At the same time, they considered the fast checkout features to be particularly desirable since waiting time at the checkout was identified as a significant factor in their decision to shop at a particular store.

Figure 3: Prototype pervasive retail application: Log-in (top-left), product selection (top-right), scanning (bottom-right) and fast checkout (bottom-left).

Participants expressed their perceptions of different aspects of the system including usefulness, usability, trust, intention to use and service quality. The majority (49 out of 60) of participants regarded pervasive retail as a useful addition to current supermarket shopping options, expressed the view that it significantly improves the shopping experience and found the system to be user friendly and intuitive to use. Having resolved the issues of fair use of personal information by selecting members of the loyalty club no other significant issues relating to trust were raised. In fact, a significant number of the participants stated that they would trust the system to shop and that they would trust it more than Internet commerce. Overall, participants were satisfied with the service quality of the system and the majority (54 out of 60) expressed their willingness to use it when it becomes widely available.

Some of the most interesting results related to changes to the shopping experience. The most conspicuous response was that pervasive retailing has a high entertainment value with the majority (53 out of 60) of participants stating that they found the experience enjoyable while more that half considered pervasive retail an exciting activity. In addition to this, participants overwhelmingly considered that the use of the system reduces their stress levels and their sense of time pressure while shopping.

6. Discussion and Conclusions

Our experience with MyGrocer has indicated that there are several technical challenges to be met in deploying a pervasive retail system. First, technologies that capture information about interactions between physical objects are not yet mature enough for the consumer market as they are relatively costly. Even when such data becomes available the task of interpreting it is often as challenging as its registration, since no standardised classification scheme or appropriate taxonomy exists. Several efforts to create standards are underway but are still at least years away. Although in the relatively controlled environment of the MyGrocer project it has been possible to address this problem on an ad-hoc basis it is hard to envision a situation where widely deployed pervasive retail services can operate without such standards. A related problem is that new systems must be integrated in existing retail infrastructures, which often operate using legacy and incompatible systems. Moreover, the deployment of pervasive retail causes significant growth in electronic transaction loads which current systems are unable to cope with. Last but not least, pervasive services like MyGrocer should

be available on whatever device consumers have at hand. Although considerable advances have been made in this area, developing and maintaining such applications is still a major challenge.

Technical challenges aside, the main question we tried to address in this article is the effect of such a system on the user experience. Privacy and the use of personal data have been identified as two of the main issues in this respect. These problems may be exacerbated by considerable cultural and legislation differences between different localities. For example, in Europe protection of personal data is enforced by strict legislation while in the US organisations that maintain repositories of personal data are self-regulated. A more in-depth study of the interplay between personal data, identity and privacy protection mechanisms is required as well as the development of a suitable conceptual framework to understand them.

The evaluation studies have also indicated that pervasive retail may offer the opportunity to reduce several of the negative factors found in today's supermarkets and thus decrease the levels of stress associated with replenishment shopping. Indeed, current consumer expectations are not being met by the shopping experience due to several negative factors, including but not limited to the store ambience (for example, environmental conditions, scents, background music and so on), service quality and branding [2]. There is some indication that the primarily consumer oriented nature of pervasive retail will reduce anxiety levels and improve the shopping experience through features like continuous awareness of total cost of the shopping cart contents, information-enabled spatial navigation of the supermarket and opportunities to maximize the value of a shopping trip by context aware offers and promotions.

Despite the fact that several issues have been highlighted by the evaluation studies many others could not be addressed given the relatively sort duration of the project but require longer-term involvement with the system. Indeed, we understand pervasive technologies as technologies that become part of our everyday lives and thus disappear in the background. However, this requires a relatively long period of familiarization which could not be catered for in the sort interaction period available in this project. Long-term interaction would allow for the novelty of the system to ware off and for system operation to become tacit. Studies of this type would show what is the effect of the system when consumers become truly familiar with it and discover their own uses of it, without the barriers placed by the research team. Another issue that should be addressed is use of the system in a social situation where the system affects communities rather than the individual. Indeed, social practice during a supermarket visit may be as significant to the shopping experience as the personal agenda of the individual consumer. Last but not least, a more extensive study in more locations would indicate differences due to different cultures.

The introduction of pervasive computing technologies in retail has profound implications for the consumer shopping experience. Some of the issues involved have been explored in the front-end and formative evaluation studies conducted during the development of the MyGrocer pervasive retail system. Significant implications have been identified that affect issues of personal identity and privacy protection while at the same time these studies have indicated that consumers find value in pervasive grocery retail primarily due to the improvement of their shopping experience. A critical challenge for the successful introduction

of pervasive retail services to consumers will be to balance the value offered by new shopping opportunities against potential negative effects on privacy and identity.

7. Acknowledgements

We would like to thank S.S. Duri, H.Lei, T. Moussouri and anonymous reviewers for many useful comments that significantly improved this work.

8. References

1. G.D. Abowd, E.D. Mynatt, and T. Rodden, "The Human Experience", *IEEE Pervasive Computing*, vol. 1, no. 1, 2002, pp. 48-57.
2. J. Baker, "The role of the environment in marketing services: The consumer perspective", in J. A. Czepeil, C. A. Congram and J. Shanahan (Eds.), *The Services Challenge: Integrating for Competitive Advantage*, American Marketing Association, Chicago, IL, 1986, pp. 79-84.
3. A. Brewer, N. Sloan and T. Landers, "Intelligent Tracking in Manufacturing", *J. of Intelligent Manufacturing*, vol. 10, 1999, pp. 245-250.
4. Coopers and Lybrand, *The Future of the Food Store: Challenges and Alternatives*, Coca Cola Retailing Group, London, 1996.
5. N. Davies and H.W. Gellersen, "Beyond Prototypes: Challenges in Deploying Ubiquitous Systems", *IEEE Pervasive Computing*, vol. 1, no. 1, 2002, pp. 26-35.
6. S. L. Jarvenpaa and P. A. Todd, "Consumer reactions to electronic shopping on the World Wide Web", *International Journal of Electronic Commerce*, vol. 1, no. 2, 2000, pp. 59-88.
7. M. Kärkkäinen and Jan Holmström, "Wireless product identification: Enabler for handling efficiency, customisation, and information sharing", *Supply Chain Management: An International Journal*, vol. 7, no. 4, 2002, pp. 242-252.
8. P. Kourouthanassis, L. Koukara, C. Lazaris, K. Thiveos, "Last Mile Supply Chain Management: MyGROCER Innovative Business and Technology Framework", in *Proceedings of the 17th International Logistics Conference*, 2001, pp. 264-273.
9. M. Levy and B. A. Weitz, "Retailing Management", 4th Edition, McGraw-Hill, 2001.
10. G. Roussos, L. Koukara, P. Kourouthanasis, J. Tuominen, O. Seppala, G. Giaglis and F. Jeroen, "A case study in pervasive retail", *ACM MOBICOM Second International Workshop in Mobile Commerce*, 2002, pp. 90-94.
11. G. Roussos, D. Spinellis, P. Kourouthanasis, E. Gryazin, M. Pryzbliski, G. Kalpogiannis and G. Giaglis, "Systems Architecture for Pervasive Retail", *Proc. 17th ACM SAC,* Melbourne, Florida, USA, 2003, pp. 631-636.
12. J. Smaros and J. Holmstrom, "Viewpoint: Reaching the consumer through e-grocery VMI", *International Journal of Retail and Distribution Management*, vol. 28, no. 2, 2000, pp. 55-61
13. M. Weiser, "The Computer of the 21st Century", *Scientific American*, vol. 265, no. 3, 1991, pp. 66-75.

Sidebar: Pervasive Retail

In December 1998, IBM's Project Smart Pad first introduced pervasive computing on the supermarket floor [4, 5]. The aim of the project was to enhance consumers' experience by combining their in-store and on-line purchases to create services delivered on a customized mobile device equipped with a bar code scanner. The system is available today in most Safeway supermarkets in the UK as the Easi-Order consumer appliance, a Palm based device. A year later the first system using RFID tags was introduce by Philips Semiconductors at a

trial at the El Corte Ingles supermarkets in Madrid, Spain, as part of the ESPRIT project Albatros [7]. Albatros produced two commercial RFID retail solutions, the I*Code from Philips Semiconductors and the Tagflow by Informatica El Corte Ingles, both based on the same design. An interesting predecessor to pervasive retail was the Personal Shopping Assistant [1], an early laboratory prototype developed at AT&T Bell as part of the Personal Mobile Terminal Project, which used RDIF for location based services, a barcode reader for product reading and offered some of the Smart Pad personalization features.

Connecting new and legacy systems to deliver pervasive retail services is in itself a considerable challenge. A blueprint for developing multiple fixed interfaces for mobile retail shopping has been developed in [2]. An adaptive, context-aware alternative is offered by [3].

One of the major challenges forward for pervasive retail is integration of existing infrastructures with pervasive retail systems and interoperability. The Automatic Identification (Auto-ID) Center at MIT [6] has developed the electronic product code (ePC) to provide for universal product identification. Unlike the Universal Product Code currently in use, which identifies a product's make or model, the ePC identifies an individual item. ePCs are encoded on RFID chips using the GTAG (Global Tag) specification an ISO sponsored EAN-UCC System RFID standardization activity for communications, data and performance. The center is also responsible for developing the Object Name Service (ONS) that resolves an ePC to a URL that contains the product description represented in Product Markup Language (PML).

1. R. Asthana, M. Cravatts and P. Krzyzanowski, "An indoor wireless system for personalized shopping assistance", *Proc. of IEEE Workshop on Mobile Computing Systems and Applications*, Santa Cruz, California, IEEE Computer Society Press, 1994, pp. 69-74.

2. J. Buckhardt, H. Henn, S. Hepper, K. Rindtorrff and T. Schaeck, *Pervasive Computing*, Addison-Wesley, 2001.

3. E. A. Gryazin and J.O. Tuominen, "The SMART Environment for Easy Shopping", *Proc. Int. ITEA Workshop on Virtual Home Environment*, February 2002.

4. V. Kotlyar, M. Viveros, S.S. Duri, R.D. Lawrence, and G.S. Almasi, "A Case Study in Information Delivery to Mass Retail Markets", in T. Bench-Capon, G. Soda and A M. Tjoa (Eds.): DEXA'99, *LNCS 1677*, pp. 842-851, 1999.

5. G.S. Lawrence, V. Almasi, M.S. Kotlyar, M. Viveros and S.S. Duri, "Personalization of Supermarket Recommendations", *Data Mining and Knowledge Discovery*, vol. 5, 2001, pp. 11-32.

6. S. Sarma, D.L. Brock and Kevin Ashton, "The Networked Physical World Proposals for Engineering the Next Generation of Computing", *Commerce and Automatic-Identification*, Whitepaper WH-001, Auto-ID Centre, MIT, Cambridge, MA.

7. C. Trigueros, "ALBATROS: Electronic tagging solutions for the retail sector", *Informatica El Corte Inglés*, Madrid, Spain, 1999.