Building Consumer Trust in Pervasive Retail

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Abstract

At the core of the vision of pervasive computing lies the ability to augment physical artefacts with electronic properties and to create physical manifestations of electronic entities. The first widely available technology to offer this capability is RFID. When combined with the EPC Global network it is possible to track products from the time of manufacture until the consumer waste bin. To be sure, this development offers unique opportunities for the transformation of the shopping experience. Yet, it also brings considerable dangers in that consumers' activities can also be tracked and their privacy violated. Even worse, this can happen without any visible sign and thus completely transparently to the consumer. It is no surprise then that RFID use has generated considerable concerns across the globe. In this lecture, I will explore consumer perceptions of pervasive retail and discuss approaches that can help develop consumer trust in RFID-based systems.

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1 Introduction

To be a consumer is to know about needs and how to satisfy them by searching for, selecting, acquiring, using and enjoying objects and services. Which particular objects individuals perceive as necessary and why, is an issue open to argument: needs are frequently seen as natural and self-evident or more commonly as arbitrary and subjective. But need is also a fundamentally social concept, not in the trivial sense of social influences and socialization, but rather in two important ways: first, in the sense that needs are dictated by a particular choice of lifestyle, social interests as well as politics and second, in the sense of setting a claim on particular social resources. Indeed, modernity has witnessed the manifestation of consumer culture as a major shaping force of social structure and for this reason, it is frequently judged by its ability to sustain desired ways of life and meet perceived needs [8, 21].

More importantly, consumer culture has emerged as a social system for resource allocation that is evaluated on the basis of its ability to meet the conflicting needs defined by autonomous social groups and communities for themselves. Indeed, consumer culture can be valued on its effectiveness to relate questions of lifestyle to questions of social organization and its implications for everyday life: where and how we live, the food we eat the cloths we wear, the scarcities and inequalities we suffer, leisure and employment. In this paper we will discuss the changes in consumer culture brought about by the emergence of ubiquitous computing and in particular of automatic product identification using RFID.

2 Supply Chain Optimisation for Consumer Value Creation

Among all retail sectors grocery is the most competitive as it operates at minimal profit margins. It is thus important that grocery retailers exploit any possible efficiency improvement opportunities offered by technology and indeed over the past fifty years they have pursued this objective with considerable success. In particular, the supply chain of grocery products – or else, Fast Moving Consumer Goods (FMCG) – has attained considerable operational gains through the implementation of a number of technologies including bar codes, resource-planning software and optimised logistics. This need has also produced Efficient Consumer Response (ECR), a voluntary and industry-wide initiative to raise performance levels across the entire retail sector [14]. ECR aims to carry out a continuous and in-depth self-examination of processes and procedures for the industry as a whole, recommend improvements and oversee the implementation of recommendations. ECR was initiated in the United States but its distinct advantages from a business perspective have rapidly extended its scope to the rest of the world, with national and regional initiatives in action.

ECR have identified three priorities: (i) to increase consumer value, (ii) to remove costs that do not add consumer value, and (iii) to maximize value while at the same time minimizing inefficiency throughout the supply chain. In prac-

tice, these priorities are used to identify and fulfil specific goals for example providing consumers with the products and services they want, reducing inventory, eliminating paper transactions and streamlining product flow. To meet these goals distributors and suppliers are making fundamental changes to their business processes that can only be enabled through the implementation of novel information and communication systems.

In this context, the new information sources made available by ubiquitous retail can offer significant benefits for business. For example, decades after the introduction of information systems in production and logistics control there are still significant inefficiencies in modern supply chains, which adversely affect the cost 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 and long lead times. 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. Moreover, information-sharing ineffectiveness between trading partners reduces 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 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 (currently 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. Ubiquitous computing technologies applied to this problem space can provide the necessary consumption data early on in the replenishment process so as to allow for greater prediction accuracy which leads to reduced inventories and optimised supply chains both upstream and downstream.

One contribution towards the ECR goals is the so-called Vendor Managed Inventory (VMI) approach where the vendor, rather than the customer, specifies delivery quantities sent through the distribution channel. This reversal in the procurement process has become possible only through the deployment of Electronic Data Interchange (EDI) systems, a computer-to-computer exchange protocol for business data. VMI had succeeded in reducing stock-outs and inventory buffers in the supply chain. Common features of VMI include reduction in supply chain length, centralized forecasting and frequent communication of

inventory levels. From a fleet management perspective, delivery vehicles are loaded in a prioritised manner: items that are expected to stock out have top priority, then items that are furthest below the targeted stock levels, then advance shipments of promotional, and finally, items that are least above targeted stock levels. In addition to EDI a second technology critical for VMI is the Universal Product Code (UPC), a standard for constructing bar codes to automatically identify products. This technology plays a core role in the automated creation and entry phases of the order cycle and can take days out of the total cycle time. The two technologies together can help develop collaborative relationships in which any combination of retailer, wholesaler, broker and manufacturer work together to seek out inefficiencies and reduce costs by looking at the net benefits for all participants in the relationship.

Overall VMI has been successful in significantly reducing inventory levels and the number of stock-outs. The latter issue is particularly important not only because of lost sales but also because shelf availability is central to supermarket strategy. Indeed, a significant proportion of supermarket profit margins are due to interest free periods for products already available on the selves. Thus, one of the main concerns of retailers implementing VMI has been the perception that reduced inventory will result in less product being available on the shelves at any one time and therefore loss of market share. A partial solution to the problem is to fill shelf space with other stock-keeping units (SKUs) from the same vendor but this approach does not fully address the problem.

3 The Emergence of the New Consumer

At the same time when suppliers and retailers aim to optimise their supply chains, there are also very significant social and market changes that directly affect consumer behaviours. Indeed, there are several forces in action that dictate a major shift in the current food retailers' core business processes. For example, competition in the FMCG sector is growing and forces retailers to continuously lower profit margins. At the same time, socio-demographic changes such as increased number of dual-income, single-parent and technology-familiar households, have significantly altered shoppers' expectations, demands and spending patterns during their traditional shopping experience [10]. Among other factors identified, a recent survey highlighted the decline of the "traditional family" [4]: It is estimated that by 2021 the average household size will be 2.21 persons compared against an average of 2.70 on 1981). Moreover, an increase of 30% of one person households is expected followed by a decrease of 33% for married couples. Finally, it is exstimated that the share of total retail expenditure accounting to groceries and food will decrease to 40% by 2004 compared to 50% in 1984.

These findings indicate that forging stronger consumer relationships and establishing successful consumer retention strategies will become increasingly important. Thus, appropriate consumer relationship building strategies will be the fundamental building block for the successful economic future of tomorrow's

food retailers. A core component of such strategies is the development of attractive consumer experiences. It is worth observing that the overall consumer shopping experience is affected by a number of store-related factors which include ambience (temperature, scent, music and so on) [3], service quality in the store [2], store perceived image [12] and situational elements such as crowding, time and budget availability by the consumers and so on [6]. Failure to provide an effective consumer experience result in increased consumer stress levels [2] which translate into consumer rejection of shopping and have been seen to conspire to create apathetic shoppers, that is consumers who have no interest in, or actively dislike, shopping and appear to endure rather than enjoy the whole experience [16].

At the heart of the matter lies the fact that in the new consumer situation traditional factors of competition, for example price level, selection and location, although still important, are no longer sufficient in order to achieve competitive differentiation. As a result, retailers must concentrate on enhancing the end-to-end shopping experience aiming to win customer loyalty by inventing innovative ways of satisfying the new consumer needs.

4 Revisting the Retail Experience

In the previous two sections we discussed in detail how the changing market situation and the emergence of a new type of consumer are exerting pressure on retail shopping. In this section we discuss solution offered by the new technical development in computing and wireless communications technologies often referred to as ubiquitous or pervasive computing. We believe that appropriate use of these technologies can make significant contributions towards meeting the new market and social requirements identified previously.

According to traditional retail management theory, a shopping experience can be driven towards the maximization of efficiency or towards entertainment [13]. Yet, the current situation demands that both these objectives must be met, clearly a challenging task. Thus, it becomes imperative that stakeholders of the retail value chain should jointly discover the actual consumer needs and implement new shopping experiences. The rapid evolution of new technologies presented both opportunities and risks for those retailers thriving to innovate. It should be emphasized that the retail sector is very technology oriented, constantly experimenting with new technologies promising to streamline and optimize core operations within the store or the warehouse and communication within the entire value chain.

In previous sections we identified the relatively late collection of sales data at the POS as one of the main factors for the low accuracy in forecasting demand and as a barrier in developing effective replenishment strategies. For this reason the next natural step for ECR is to extend the use of technology to the collection of data directly from the selves and even more, to consider extending the supply chain to the consumer home. Indeed, the replenishment process starts when the consumer runs out of a particular product. Gaining such early information and

using it in supply chain optimisation can potentially increase considerably the accuracy of predictive replenishment strategies to a degree that is well beyond what is possible today. Ubiquitous computing technologies can fulfil exactly this requirement. Several projects have attempted to explore this space, here we will discuss MyGrocer one of the earlier attempts (for a review of work in this area see [11]).

MyGrocer was primarily aimed at creating an early prototype and identifying some of the core issues in this context while several more recent projects examine specific aspects of ubiquitous commerce systems. More recent work has focused in other aspects of the system, for example the Auto ID centre at MIT developed some of the standards required for the facilitation of business data exchanges in the new retail environment, now taken over by EPCGlobal. EPCGlobal has defined three new standards as extensions of its existing UPC bar code and EDI initiatives with a view of facilitating optimisations to the supply chain. For example in the so-called Electronic Product Code (EPC) uses Radio Frequency Identification (RFID) tags to store information about specific product items (rather than SKUs) and relate them to product descriptions written in Product Mark-up Language (PML) retrieved through the Object Naming Service (ONS) [19]. The Super Market of the future developed by the Metro Group in Germany aims to quantify the operational gains from this new infrastructure and identify the exact cost of its deployment in a controlled environment. An ongoing research project at Intel Labs, Portland, is exploring cultural aspects effecting the deployment of ubiquitous retail systems.

Nevertheless, extending the supply chain in this way has significant repercussions for the consumer who is now involved in the data processing pipeline. Ubiquitous commerce services use personal data associated with individual consumers in intimate ways and that can be used to reconstruct their private activities at an unprecedented level of detail. Moreover, as evidence from our recent studies corroborates [11] the implementation of these technologies, may cause fundamental transformations to the consumption experience due to the continuous replenishment process at home and, on the other, it creates a novel retailtainment experience on the supermarket floor. This change can be seen as a shift from particular retail ecology to another [18] and thus it should come as no surprise that consumers show considerable scepticism to ubiquitous commerce value propositions.

The argument developed in this section points to the significance of adopting ubiquitous computing technologies in FMCG retail. The success of such technological offerings depends heavily on their adoption by consumers and thus the development of trust between the service provider, the consumer and the systems is of paramount importance. Indeed, the role of trust in developing particular markets has been clearly identified in [7] and has been one of the core issues affecting the slow adoption of both electronic and mobile commerce in recent years [15].

5 Ubiquitous Retail Usage Scenarios

Despite the fact that ubiquitous commerce was perceived as potentially having a major impact on improving retail efficiency, the different technologies available made possible the implementation of very different systems. Due to the diverging views of project partners the first step in creating consensus was to develop and agree on three usage scenarios. To this end, a workshop was held where the different interests and options were discussed and consensus was reached on the development of three usage scenarios. These seemed to satisfy the requirements of all the participating organizations. The scenarios were subsequently used to collect functional requirements for the system.

The three scenarios agreed upon related to the usage of the system on-the-floor during a supermarket visit, while on the move using a mobile device and finally at home, to monitor consumption:

Supermarket Scenario. The consumer enters the supermarket and selects a "smart" shopping cart equipped with radio frequency identification (RFID) readers and a tablet PC. She identifies herself to the system with her username and password. The system logs her in, responds with a welcome message and then proceeds to present a "suggested" shopping list, based on monitored home inventory and actual consumption data. The consumer walks in the supermarket aisles and picks up products from the shelves. For example, she may decide to buy a shampoo, which she picks up and places inside her shopping cart. The cart identifies that the shampoo bottle has been placed in it and triggers the following event sequence: the product ID is sent to the back end system which retrieves related information that is used to update the shopping list and the total cost of the shopping cart contents. Next, the consumer decides to buy a brand of hair conditioner that the retailer is promoting for customers with her profile. When the consumer places the product in the cart, the system displays the relevant offer on the screen together with instructions on the shortest path to the aisle and shelf where the associated products are held. Later, the consumer decides to remove one can of orange juice from her cart and replace it on the supermarket shelves. The system updates the shopping list with the new total amount and the new contents of the cart. When the items on the shopping list are exhausted, the consumer proceeds to check out. When she approaches the till the system rescans all the items in her shopping cart, calculates the total value of the products, displays that information on the till display and prints out a receipt. The consumer pays at the till or charges everything to her account.

Home Scenario. The consumer returns home and places her shopping in her RFID enabled storage (including her fridge, cupboards and so on). New product information is recorded by her home server and consolidated to the home inventory data. The home maintains data on inventory levels as well as consumption. Periodically, the consumer gives permission to her home server to upload her new shopping list to the system.

On-the-move Scenario. While on her way to work, the consumer uses her mobile phone to check which products she needs to replenish before the weekend. After logging in, the system displays her current home inventory and/or her

shopping list. The consumer decides to add new items to her shopping list for the dinner party she gives on Saturday night. The consumer is happy with her new shopping list. The system displays the total cost of her shopping list at her usual supermarket. The consumer is unhappy with the price and she decides to look for a better price, thus initiating a reverse auction. The system forwards her list to participating retailers and prompts the consumer to define the duration of the auction, which she does. The system sends a confirmation message that the process has been initiated. A short while later the consumer receives offers by different retailers and selects the best. The consumer selects "home delivery" and confirms the order. Later in the day, the system notifies the consumer via SMS to her mobile, that baby diapers are going to run out in the following hours and request confirmation of instant replenishment order. The consumer confirms and the order is placed.

6 Ubiquitous Retail Case Study

Several issues had to be addressed for the design and implementation of the system including (a) the design of a compelling interface enabling seamless interaction between shopper and 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. The technical development of the system has been detailed elsewhere [17] and here we will only touch upon the design of two of the main elements of the user interface 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 modelled around a touch-screen mounted on the shopping cart 1.

Figure 1: 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).

Five distinct areas were identified to facilitate 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.

Unlike general-purpose product browsing appliances where the design should address all possible user cognitive processes, adopting the so-called appliance argument offers several benefits. The consumer may still perform all the activities usually associated [20] with web browsing and shopping that is, finding products, information and general browsing, transacting and communicating. However, the particular focus of the system implies that all of the user goals may be achieved much more efficiently. Whenever additional computing power or storage resources are required such problems may be offloaded to a central server and results exchanged wirelessly.

Product related events are sensed via the use of radio frequency identification (RFID) technologies. Contrary to barcode, the current most commonly used technology for product identification which requires significant involvement on the part of the user RFID (a) senses events and captures related data in a way that does not require line of sight visibility between the tag and the reader, (b) is more resistant to hostile environments and can survive the effects of excessive levels of dust and moisture, (c) can store more information and thus it may be programmed to hold a unique product identification number, and finally (d) provide for anti-theft capabilities. On the other hand RFID is a relatively new technology and thus more expensive and more difficult to produce in large quantities. This is a significant limitation and has restricted our ability to field test the system with multiple concurrent users. Indeed, the initial design was for the RFID field to fully cover the volume defined by the shopping cart sides (80x40x60 cm). However, this was deemed economically unfeasible with regard to the cost of the shopping cart as well as the recharging of the cart batteries we opted for a single RFID reader. Thus, the shopper has to bring each product within the range of the RFID reader to register the product identity. Although this solution does not provide a completely seamless experience it still has several advantages over barcode scanning (no need to search for the barcode label and align it with the scanner to register it, anti-theft mechanisms).

Collection of user requirements aimed at understanding both how to integrate ubiquitous retail with the systems of the supply chain actors as well as how to cater for the needs of the end users. To this end research was carried out to

assess the appeal of ubiquitous retail as a value proposition to the consumer as well as to identify barriers to acceptance. The approach adopted was qualitative in nature and used focus groups. Market Analysis a market research firm, was commissioned to conduct the field research. 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. During the discussion the participants were first introduced to ubiquitous retail concepts through a presentation based on concept drawings with explanatory text, which the moderator used to discuss selected usage scenarios. Following the introduction, participants were encouraged to discuss their thoughts, feelings and reactions to this novel approach to retail as well as to express their response regarding attitudes and purchase behaviour in this environment. The discussions of all groups were recorded in audio and video with the permission of the participants. At the end of the discussions participants were given a voucher for one of the retailers participating in the project.

The ubiquitous 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 favourable 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. The features that proved most attractive were:

- 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 they could access all offers available in the specific supermarket at a single contact point,
- the proposed in-store navigation system especially in the case of hypermarkets where orientation is particular complex,
- the smart checkout and the ability to bypass queues and reduce waiting time.

However, the findings highlighted one of the main concerns of the participants to be the use of personalized purchase statistics by the retailer and collaborating service providers. A large number 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 data protection act. 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. The two main issues arising related to the immediate recognition of the fact that for the construction of the personalized shopping list their data is recorded, preserved and processed. This reaction was more pronounced when trust of third parties was also involved –a core property of fourth generation systems. The main source of 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 provider 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.

Figure 2: Access to retail m-services via cellular wireless mobile devices: user authentication (left) and shopping list editing (right) on wireless enabled personal digital assistant and cellular mobile telephone (both Java 2 Micro Edition capable).

Finally, several participants observed that adoption of ubiquitous 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 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 ubiquitous retail was consequently treated with mistrust and hostility.

Following the results of the design-stage research, extensive modifications were made and the supermarket scenario was selected as a more feasible alternative to be considered for system implementation. A new study was conducted focused on the particular characteristics of this scenario. The aim of the study was to understand how ubiquitous retail influences the shopping experience compared against the traditional supermarket environment. Members of the supermarket loyalty club were selected to take part to the study. The participants were sixty men and women responsible for shopping in their families from the 25-65 age range with varying degrees of expertise in using personal computers and mobile telephones. Loyalty club members 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. The trials were carried out in one of the stores of the supermarket chain that participated in the project be separating two isles and clearly indicating that a research study was taking place. A selection of products was equipped with RFID transponders and the systems infrastructure was installed in the back end room. Participants were contacted over the telephone and 45-minute slots were booked for each individual. Upon arrival participants were introduced to the system by and then invited to use the system independently. They were able 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 the 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 content. 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 who, at the same time, considered the expedited checkout features to be particularly desirable and they considered waiting time to be a significant factor in their decision to shop at a particular store. Moreover, the display of the cumulative value of the shopping cart and detailed information about offers and promotions was seen as improving the effectiveness of the shopping experience.

Participants expressed their perceptions of different aspects of the system including usefulness, usability, trust, intention to use and service quality. The

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

majority (49 out of 60) of participants regarded ubiquitous 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 and, in fact, a significant number of the participants stated that they would trust the system to do their shopping and that they would trust it more than they trust Internet shopping. 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 available.

The most interesting results related to the changes of the shopping experience of the participants. The most striking response was that ubiquitous 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 ubiquitous retail an exciting activity. In addition to this, participants overwhelmingly considered that the use of the system reduces their stress level and sense of time pressure while shopping. We will return to this point later but, first, we would like to point out that the entertainment value of ubiquitous retail makes it a particularly good candidate towards new ways to shop since it addresses most of the drivers for change in food shopping experiences.

7 Consumer Trust and Privacy Protection

Despite concerns about privacy protection and the security implications of ubiquitous commerce, the value proposition of MyGrocer did indeed attract substantial interest by consumers. At the same time it was also evident that, if implemented as described in the user scenarios, several aspects of the system would create considerable friction and would pose barriers for the wider adoption of the system. In the sort term, and so that we could further develop and evaluate ubiquitous commerce with MyGrocer, we opted to restrict the use of the system to the supermarket floor and carry out testing with members of the loyalty card program of the participating supermarket. In particular, the home scenario which received the strongest resistance, was subsequently implemented only in a much-restricted scale than originally planned and was seen only as proof of concept and without a view to test further or deploy.

Asking loyalty club members to test the system offered two distinct advantages: it capitalized on the established trust relationship between consumer and the supermarket and allowed for the regulation of the relationship via a contractual agreement. Indeed, participation in a loyalty program often implies a relationship built over a longer period of time, which fosters mutual trust and helps develop a set of reasonable expectations. Furthermore, having agreed on a contract the two parties clearly understand their rights and responsibilities to each other and have an explicit set of rules for interacting. It is thus easier to explore the extension of the relationship to include the new ubiquitous commerce services. In practice, this approach proved very successful and allowed for the evaluation of the deployed system in conditions where security and privacy where not the dominant factor.

Arguably, some of the research findings of the previous section should be seen within the context of the study, especially with respect to the evolution of retail practice in Greece. To this end, we will briefly discuss the timelines of the emergence of supermarkets as the dominant retailing option and of the adoption of credit cards in this country. Until the early 80s most grocery shopping was done in small, neighbourhood shops with very few large supermarkets, primarily located in the two main metropolitan areas in the south and the north. Over the decade this situation changed in accelerated pace with most of the local shops disappearing and by the end of the decade almost completely being replaced by super and hypermarkets. Today, even in rural areas most grocery shopping is done in supermarkets that belong to one of the five national chains. The end of the eighties also witnessed the rapid adoption of credit cards for electronic payment. Deregulation of consumer loans at the beginning of the decade played a key role in making credit cards common place and accessible to most within a few years. Since the mid-nineties, supermarket shopping and payment by credit card is as common as in any other Western European or US country, although middle-aged Greeks still prefer to use cash and would opt to shop from a smaller grocer if possible. At the same time, the traditional family roles have also changed significantly. With the urbanisation of the population in the fifties more women entered higher education and joined the professions.

Today, especially in urban areas and with younger couples, the norm is that both partners work outside the home and share the responsibility of running the household. In particular, it is likely that either the husband or the wife would be responsible for the replenishment of home supplies although women take up this role more often than men, certainly in middle-aged couples.

This work highlighted several aspects of researching ubiquitous computing systems which may have wider implications. Unlike more traditional information systems where interaction is mediated by a computing device, for example a desktop or mobile computer, in ubiquitous computing things seem to happen transparently in space that cannot be approximated through a real or even a representational one. Thus, users are confused by their lack of appropriate language to describe it and will need other abstractions to be offered to replace the device. In our case, consumers attempted to express their opinions by anthropomorphising system behaviour so as they could relate it to their existing experiences.

One aspect that appears to be highly relevant but we were unable to investigate in depth, is the question of how pre-existing attitudes towards privacy affect consumer views of ubiquitous commerce. Previous studies have indicated that there are considerable variations in how people deal with such issues and there is a reasonable expectation that some of these attitudes would directly affect their perceptions of ubiquitous commerce.

The novelty of ubiquitous computing means that for more significant observations to be made, one has to allow for an extended period of interaction with the system. Unlike system functionality, habits and practices take much longer to develop and often what seems novel and threatening at first glance, quickly becomes part of the routine. Longer-term implications of use cannot be discovered without ethnographic studies. Of course, the problem with this approach is the very high cost for deploying and maintaining the required infrastructure at the required scale and time frame.

This last observation points to another aspect of trust that is often overseen. Indeed, trust in information systems is often seen in the tradition of cognitive psychology, which was also the basis for machine learning and artificial intelligence in the early sixties. While this approach has made considerable contributions to computer science and systems engineering, we expect that it may not facilitate further development of our understanding of trust. Indeed, in the technical literature trust is considered as a purely cognitive process. It is often treated as a utility function that system users try to maximise for their own benefit. We believe that this approach is better suited as a measure of trustworthiness, which is quite different from trust and moreover that trust is a non-cognitive function that cannot always be approximated well by mathematical constructs. Hence, in the intimate computing context of ubiquitous commerce the development of concepts of trust on this basis is of restricted use.

Approaching trust within its social context may provide a more productive alternative. To this end, in the following paragraphs we will use the principles introduced earlier to interpret some of our findings and provide insight in the reasons behind some of the observed attitudes. It appears that this is partic-

ularly relevant in cases where there is little information on which to make a judgement of the trustworthiness of the other party and thus the decision to trust or not depends mainly on non-cognitive elements. Clearly this aspect of trust played some role in the case of our studies where the information to make an unambiguous and provable trust judgment were not available. In fact, the system frequently created significant levels of stress to the participants, which they could not justify in concrete and objective terms.

In this context, we believe that the enacted view of technology adoption has a critical role to play. In this view, the reciprocity and understanding principle bears on issues of privacy protection, personalization and consumption monitoring. It implies that collecting personal data by tracking the activities of individuals will be unacceptable if it is not reciprocal. That is, not knowing who is the organisation collecting the data, how the data will be used, how to correct errors in the data and whether to expect a return describes the relationship as non-reciprocal and introduces asymmetry making it unacceptable for the consumer. The fact that our profile is formed under circumstances that are well beyond out control, we cannot influence and that are invisible to us introduce considerable stress to the relationship irrespective of whether the profile is accurate or not. Moreover, this principle implies that consumers need to understand the service provider as well. Thus, although ubiquitous computing technology may allow business to offer new ubiquitous commerce services, consumers may choose to engage in business activities with parties for whom they have access to a comprehensible company identity and thus a clear set of expectations of trust.

Another aspect that creates considerable tension is the fact that persons using the system are seen as having a single dimension, that of the consumer. This view is not restricted only to the space where the actual shopping activities are carried out but extends into their own home. But following the principle of context and locality consumers in ubiquitous commerce cannot be expected to be comfortable with a single identity profile in relation to ubiquitous and pervasive services. Rather, we can expect a strong preference to maintain different identities attached to different functions, roles, communities and spaces, and to exercise control over these. This would explain the overall negative reaction of the participants of the focus groups to ubiquitous retail since users of the system were characterised and treated singularly as consumers.

The communication and interaction principle implies that rather than focusing singularly on the trustworthiness of a system design should also address the affective aspects of interaction between ubiquitous commerce services and the consumer and addresses the emotional impact of system usage. It accepts that since emotions are akin to strategies -even while they remain inarticulate and non-deliberate-they can be brought into the realm of rationality and have to be taken into account for the development of a trust relationship.

Last but not least, our findings have specific implications for the current discussion on the value of ubiquitous retail systems. With several major retailers currently making significant investments in RFID infrastructures the issue of user acceptance is widely discussed. The common approach to this is that

consumers will find the value proposition of ubiquitous commerce so attractive that they will disregard any privacy concerns. Such comments anticipate that adopting the strategic approach will indeed provide the required mechanisms to commercialise this technology. We find that two issues indicated by this study are in conflict with this view. First, ubiquitous retail systems are clearly viewed as being for the benefit of the business rather than the consumer. Looking at the benefits and costs for all involved parties it is easy to see that consumers have marginal benefits that would probably not be justified by the huge investment required to develop and use the infrastructures. Moreover, most benefits to the consumer are indirect and thus not visible and easily discounted. More importantly, it is unlikely that without allowing some degree of control over the system consumers will be persuaded to use it. Indeed, controlling the flow of personal data was seen as a core element in developing a trusting relationship between consumer and retailer.

In the long term, developing a trusting relationship between ubiquitous commerce and consumers is critical for its wider acceptance. To be sure, there are several examples of technologies that were eventually rejected by the market due to the attempt to capitalise on public apathy and withhold information about their true operation. Attempting to develop ubiquitous commerce by following this approach may well have the same result.

Rather surprisingly we did not find any major differences between the perceptions of the system across the four groups. Differences were mainly in the elected ways for expressing their concerns but the concerns themselves were on very similar issues. There were only two areas were significant differences were found, the implications for family roles for older women and overall trust to information technology.

Ubiquitous computing has been described as "invisible, everywhere computing that does not live on a personal device of any sort, but is in the woodwork everywhere, and makes a computer so imbedded, so fitting, so natural, that we use it without even thinking about it". Its potential for transforming everyday activities is indeed considerable especially in the context of retail.

Ubiquitous commerce is emerging and its wider acceptance by consumers depends centrally on forces that may manifest themselves in new shapes and forms, and while a re-examination of these factors and their relationships may be required, the issues themselves have not gone away. In this paper we advocate that in designing ubiquitous commerce systems that inevitably incorporate trust management as a core component, the enacted view is the appropriate basis for analysis. Indeed, the level of involvement of human factors in discussing trust is crucial. We expect that widening the discussion on trust in ubiquitous commerce will be essential for the development of appropriate service provision models.

8 Conclusions

Ubiquitous commerce is no longer a vision, but over the past few years it is gradually becoming a reality. This can be mainly attributed to the recent tech-

nological advances, which made the deployment of pilot initiatives technically and economically viable. In effect, 62 of leading retailers in North America and Europe have expressed their plans to deploy new IT-enabled convenience schemes for consumers (such as info-kiosks, RFID enabled check-outs, navigation assistance and so on) within the next 3-5 years according to a survey carried out by IBM and the National Retail Foundation [9]. It should be noted that over the past few months we have already observed an increasing number of retailers willing to embed innovative technological solutions and shopping schemes into their store environment. Price Chopper is planning to deploy self-service info-kiosks providing access to accurate product information; Wal-Mart is working with its top 100 suppliers to deploy new RFID tags for tracking crates and pallets in the supply chain beginning in January 2005; Marks & Spencer will install new self-checkout schemes in eight additional stores following a successful three-store pilot. The benefits deriving from the deployment of ubiquitous commerce systems are apparent. Retailers will have a tool that enables them to "work with their consumers" making them an indistinguishable part of their operations and reaching them in a way that they become a real stakeholder, part of their vision for an optimized value chain. The direct benefits for the retail value chain deriving from the incorporation of leading edge technologies in the retail value chain include among others:

- Real-time information provision regarding the products' lifecycle within the value chain optimizing the forecasting process of future demand.
- Real-time information provision regarding the shopper's consumption behavior providing the ability to identify and model shoppers' emerging needs.
- Introduction of personalized marketing/promotional programs including accurate monitoring of promotions effectiveness.
- Elimination of out-of-shelf /out-of-stock conditions.
- Elimination of thefts within the store.

However, the most important benefit deriving from the deployment of ubiquitous commerce systems is the creation of new shopping experiences and consequently, enthusiasm for the consumers. This is particularly true especially in our era where recent advances in manufacturing, distribution and information technologies combined with the urbanization of modern society have created the so-called new consumer who is more knowledgeable about comparable product costs and price; more changeable in retail and brand preferences; showing little loyalty; self-sufficient, yet demanding more information; who holds high expectations of service and personal attention; and is driven by three new currencies: time, value, and information. Although there are still several challenges to the wider deployment of such integrated shopping schemes - especially those relating to issues of personal identity, security and privacy but also standardization

and engineering - the results of our prototype implementation indicate that consumers would accept the introduction of innovative information systems when they become commercially available.

Our research revealed that the issue of trust and privacy is extremely important considering the fact that we constantly need information regarding the consumers' current location in-store, past consumption patterns, household information, demographic data and so on in order to provide fully personalized services. An initial critical appraisal of this situation would indicate that application designers must make some compromises on the extent they offer personalized services. Traditionally, data protection legislation in most EU countries prohibits the capture and storage of any person-related data and only allows exceptions for clearly defined purposes after which the data must be destroyed. In our case, we allowed consumers to deactivate the provision of personalized services and at the same time participate to the system without providing their full set of personal information. However, this is not the solution to the general problem of trust and privacy. We expect that users will eventually be willing to adopt such applications only if they perceive that they are getting better shopping experiences in return for letting go some of their privacy. Finally, the full involvement of the end-users during the design and development of the ubiquitous commerce system ensures the adoption and actual use of it after its commercialization. Our experience from MyGROCER revealed that the production of mock-up demos (in the form of concept sketches and non-functional interface screenshots of selected system functionality) and their exposure to real supermarket shoppers helped us identify potential barriers of acceptance and provided us with the necessary feedback to redesign the system according to the actual user needs and expectations.

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