A Case Study In Pervasive Retail

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ABSTRACT
In this paper we discuss the rationale for the development of MyGrocer, a second-generation pervasive retail system, as well as its implications for the fast moving consumer goods (FMCG) sector. We will only touch upon the technology infrastructure and the required technical developments since these have been discussed extensively elsewhere. The focus here is on the one hand, on the analysis of the business forces that dictate the development of pervasive retail and on the other, the implications and the opportunities for innovative business models offered by the dis-intermediation effect of pervasive retail on the supply chain of FMCG. The MyGrocer system has undergone two phases of field-testing and is expected to be fully operational by the end of this year. The development of the MyGrocer architecture is a collaborative effort between industry and academia within Europe.

Categories and Subject Descriptors
J.3 [**Computers in other Systems**]: Consumer Products. H.4 [**Information Systems Applications**]: Miscellanious.

General Terms
Economics, Experimentation, Security, Human Factors, Standardization, Legal Aspects.

Keywords
Pervasive computing, retail systems, trust, mobile, GSM.

1. INTRODUCTION
Over the past seventy years, supermarkets and grocery stores have evolved into some of the most convenient and diverse businesses in the world. This evolution would not have been possible without effective supply chain management [3, 7]. This management must be present at all levels of the supply chain and in all aspects of business in order for it to be truly effective and foster growth and success within the industry. Recent technological and logistical advancements have made supply chain management within the grocery industry even more successful. Advances such as electronic data interchange [14, 19], third party logistics provision [8], supply chain modeling [10], and customer relationship management have all helped to further the growth and success of the grocery industry. With the increasing availability of information systems and enterprise resource planning software, supply chain management in the grocery industry is becoming an even more effective tool to help businesses grow. In the future, the most successful businesses in the grocery industry will be those who manage their supply chains most effectively. Nevertheless, many supply chains, especially those of Fast Moving Consumer Goods (FMCG), still present significant inefficiencies, mainly regarding the collaboration between trading partners.

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2. SCENARIOS
IBM has introduced pervasive computing in the context of retail [6, 13, 15] and the concept was further developed by project Albatros [20]. Our aim is to extend the reach of such information and communications environments in two ways: to include the consumer home through ambient intelligence devices and to provide a richer shopping experience within the supermarket space [1, 9, 16]. The extended reach of this system required the development of several novel technological components that are discussed briefly in the second half of this section since they have been detailed elsewhere [17]. There are two main infrastructure components required for the following scenarios: wireless connectivity for mobile devices with broadband characteristics inside the store [2], grocery products are tagged electronically with unique identifiers following a global classification scheme [12].

2.1 In-store Scenario
The consumer enters the supermarket and selects a "smart" shopping cart (a smart shopping cart is equipped with radio frequency identification (RFID) readers) and an on board personal digital assistant (PDA). She identifies to the system using her

RFID enabled loyalty card (her user ID is read into the PDA and transmitted to the authentication server) on the cart and gains access by entering her personal identification number (PIN). 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. By doing so, the RFID readers identify the shampoo bottle being put in the cart and trigger the following sequence: the ID is sent to the back end systems, the systems retrieve information about the specific product and update the display of the shopping list and of the total cost of the shopping cart content. Next, the consumer decides to buy a hair conditioner where the retailer has placed a discount promotion for customers with her profile. When the consumer places the product in the cart, the system displays the promotion on the PDA screen as well as instructions on the shortest path to the aisle and shelf where the product is 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. According to the items added to the cart, special offers and promotions are displayed and when accepted the system navigates the consumer to the relevant section of the supermarket.

When the items on the shopping list are exhausted, the consumer proceeds to the 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.

2.2 In-store Scenario

The consumer returns home and places her shopping in her RFID enabled storage (fridge, cupboard etc). 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.

2.3 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 in the vicinity 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 an instant replenishment order. The consumer confirms and the order is placed.

3. FMCG supply chain inefficiencies

FMCG supply chain inefficiencies can be found in both upstream and downstream directions. Upstream inefficiencies result in high out-of-stock conditions, high returns rate as well as long lead times. Downstream inefficiencies affect demand forecast accuracy, low on-shelf availability and thus loss of revenue despite the fact that products are available on site. Furthermore, information-sharing restrictions between trading partners reduce the accuracy of demand forecast and the scheduling of the replenishment process. In the following paragraphs we discuss these issues in more detail.

A direct effect of low demand forecast accuracy is that trading partners have to maintain increased inventory levels to address unpredictable increases, thus resulting in increased logistics costs. Common practice today is forecasting consumer demand by processing historical point of sale (POS) data [4], using decision support systems that utilize data warehousing and data mining techniques [5]. However, using historical results on which to base forecasts result in low accuracy because demand patterns are constantly changing [6]. Although it is reasonable to assume that consumption patterns will be repeated [5] fluctuations within the patterns themselves make such forecasts of little use for optimizing logistics. For example, historical forecasts do not effectively take into account the influence of promotions and other marketing instruments since their success rates are generally hard to quantify, while at the same time competitive pressures in the supply chain might not offer enough time for effective in-depth analysis [6].

Indeed, per store replenishment strategies are typically based on center level estimates and not driven by true consumer demand data. To cope with this limitation grocery stores usually hold high levels of anticipatory inventory to prevent out-of-stock conditions [7]. A direct consequence of this fact is high supply variability as a consequence of 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), vendor-managed inventory (VMI), and so on have been established [7] but have small effect in FMCG due to the low availability of real-time information about individual store as well as warehouse inventory levels.

A quantitative description of this situation according to a recent study by Andersen Consulting [18] 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.

Another factor contributing towards supply chain inefficiencies is the limited visibility of the supply chain caused by disconnected or incompatible computer and communications systems, limited collaboration among trading partners as well as reduced information sharing due to regulation. It appears that there is plenty of opportunity for innovation in this area especially by

effectively leveraging the information technology advances. MyGROCER, which started out as an attempt to remove at least some of these inefficiencies, having identified the opportunities, aims to provide innovative and practical solutions. These objectives are in full alignment with the industry wide Efficient Consumer Response (ECR) [10] objectives that is, to deliver better value to the grocery consumer. This can be made possible by using radio frequency identification (RFID) technologies to track movement of product across an extended supply chain that includes manufacturers, wholesalers, retailers but also the consumer as a partner. Furthermore, mobile networking technologies provide the required substrate for automatic product identification, for efficient grocery shopping, and product promotion to the extent of automatic home replenishment. The direct result of this approach championed by MyGROCER supports services aimed at enhancing the supply chain with rich information about consumer needs and behavior as well as with product identification within the store.

4. EMERGING BUSINESS MODEL

In the previous section we have discussed the inefficiencies in the FMCG supply chain that make the proposal for pervasive retail attractive to all involved parties. In this section we discuss the market forces shaping the FMCG landscape and we find that our proposal fit well with current trends [11].

The past decade has marked a significant change in FMCG retail away from the traditional model of smaller shops in every neighborhood and towards out of town shopping centers. In the following discussion we refer to three type of FMCG outlets: Hypermarkets are stores that function through self-service and cover an area 2,500 square meters or more. Hyper markets can be further classified as large (+15,000 s.m), medium (7,500-15,000 s.m) and small (2,500-7,500s.m). Supermarkets are stores that function through self-service, cover an area of 400 – 2,500 s.m. and can be classified as large (1,000-2,500s.m), medium (400-1000s.m) and small (100-400s.m). Finally, traditional food stores cover an area smaller than 100s.m. with a single sales person facilitating the sales.

Table 1 Number of retail food stores per million inhabitants (Source: RC NIELSEN Self-Service Magazine, 2001)

Country	1990	1995	2000
Greece	2814	1665	1578
Europe	1741	1324	1136
Belgium	1383	1275	1115
Finland	1192	891	633

In tables 1, 2 and 3 we review trends in the number and their markets of supermarkets in the countries where the trials are running and in average in Europe during the past decade. An important observation is that there seems to be a strong tendency for higher concentration in the food retail sector with the exception of Finland where concentration is high and the rate is dropping. On the other hand, the number of small retail stores is continuously decreasing. In some cases this means in practice that certain locations especially in rural areas are not well supplied. In many cases the traditional retail stores have been substituted by smaller discount stores that are part of a supermarket chain.

Table 2 Number of Hyper Markets and super Markets per million inhabitants (Source: RC NIELSEN ibid)

Country	1990	1995	2000
Greece	55	81	109
Europe	120	142	164
Belgium	191	208	210
Finland	252	236	235

Table 3 Turnover Share of the five largest supermarket chains (Source: RC NIELSEN ibid)

Country	1990	1995	2000
Greece	12%	34%	36%
Europe	49%	56%	67%
Belgium	54%	57%	65%
Finland	97%	95%	93%

The degree of competition has risen sharply. Increased price competition is directly affecting the balance of the supply chain. This has resulted in high concentration not only in the retail sector, but also in production. For example, within the period of four years in France the thirteen leading supermarket groups have been reduced to just five through mergers and acquisitions. In Italy, the production units for food and drinks have dropped 8% within the period 1996-2000. Price competition has contributed in hard discount stores to increase their market share. Hard discount is the only part of the grocery retail sector that shows steady increase in sales and in the number of stores.

As far as the supermarket categories are concerned and despites differences between countries, there has been a respite in the establishment of very large supermarket units. In developed countries, such as Germany and the UK, this is due to market saturation, while in the other countries it is because the life conditions in the city do not favor the establishment of such large supermarket stores.

Thus, it becomes evident that there exists a need to develop supermarkets in two directions: on the one hand sharp cost cutting through logistics optimization and taking advantage of every opportunity to increase revenue and on the other, enhancing the perception of the consumer of best value for money with offers and promotions and augmenting the user shopping experience. Means to improve the user experience include personalized shopping, access to large out-of-town hypermarkets, and minimization of wait time at POS queues as well as convenient delivery of products. Regarding the last point, Finland offers a unique example of how this might be achieved: drop off boxes exist on customer premises and shopping can be delivered even during their absence. In this case it is cost effective to supply home drop boxes with goods from central warehouses rather than local shops which in turn reduce the need for a supermarket to be a local store. Indeed, retailing is transformed into an information-processing node in a fully networked supply chain.

This is the value in the MyGrocer proposition. In this context, attracting and maintaining consumers is an information mediation process, including keeping track of consumption patterns, preferences and catering for their needs as well as offering the

best value for money proposition via increased competition re-enforced through reverse auctioning.

This model transforms the replenishment and shopping process into one that is conducted via a novel info-mediation platform. Furthermore, the system acts as a hub to manage and integrate the multiple information streams generated from the various shopping sources (physical, web, mobile), processes it and uses it to provide value-added services for the benefit of the consumers as well as the entire business network.

5. CONSUMER PERCEPTION OF PERVASIVE RETAIL

In previous paragraphs we discussed the business rational for the development of pervasive retail. However, the success of such a system depends primarily on the reception it receives by consumers [4, 5]. To assess consumer perceptions of the MyGrocer service we conducted extensive focus groups during the different phases of development. In this section we discuss some of the findings that guided the development of MyGrocer.

The MyGrocer proposition attracted significant interest from most participants as a shopping option in addition to the ones currently available. For the in-store scenario the main perceived benefits referred to making shopping faster, easier and giving better value for money. The features that proved most attractive were:

- Constant awareness of the total cost of the shopping cart content.
- Access to complete and accurate descriptions of products.
- The ability to compare the value of similar products.
- Personalized, targeted promotions to fit the consumer profile.
- The proposed in-store navigation system.
- The smart checkout and the ability to bypass queues and reduce waiting time.

On the other hand, the service was treated with considerable skepticism regarding the use of personalized purchase statistics. A significant proportion of the participants were particularly concerned about the collection of personal data. This reaction was triggered primarily by the eponymous customer identification during login at the shopping cart when after entering personal credentials they were presented with a personalized shopping list derived through the analysis of their purchase history.

A second barrier to acceptance lies in the fact that the overall shopping experience created seems to point towards a hi-tech, fully standardized life-style. In addition to this, the concept of a preference list or a historical monitor of customary purchases appeared patronizing and much too rationalized; but also limiting to the experience of being human. Indeed, the majority of participants rejected the possibility of a computer system that could successfully predict their wishes and further some were offended by this suggestion. Last but not least, they considered the social implications of the practice of this scenario, as the proposition was understood, would reduce employment levels inside a store.

The participants in the survey were also asked to make suggestions for possible alterations to the proposed scenarios. Overwhelmingly, the response to this was targeted at bringing the system under the control of the user. A small percentage suggested that the system include an option for anonymous usage by just having an augmented in-store shopping facility rather than having an integrated shopping environment that extends from the store to the consumer home. On the other hand, most participants were less radical in their approach: being provided with a system that they could switch on and off provided a sufficient sense of control. Furthermore, protection of their privacy and their personal data was of paramount importance.

The home scenario caused much more debate and further concerns about privacy protection. Participants did however perceive the scenario as having value. Indeed, the benefits of the home scenario were clear: the availability of up-to-date, accurate inventory levels for specific product categories, the convenience and low overhead of mobile shopping without the need to manually check inventory levels especially in special circumstances (for example for the elderly, for people with special needs or for very busy professionals). Also, a valued property of the system is the ability to negotiate the price for goods as well as the expected reduction in prices due to the increased competition between retailers. Other benefits perceived by consumers as important included the possibility for maintaining lower home inventories since replenishment is easy and the independence of the consumer in cases of temporarily restricted physical mobility.

However, participants expressed deep concerns about matters of trust. The main source of this is that personal data, collected in the private space of the home, are being delivered to external sources without the explicit control of the consumer. The vast majority of participants did not trust a service provider to protect their privacy whether or not it was a contractual obligation. In fact, the act of signing a contract by itself increased the mistrust of the consumers.

Figure1. Concept sketches for focus groups.

A second observation refers to the transformation that this system will bring to traditional family roles. In particular, product selection and maintenance of sufficient inventory levels is a source of identification and a means to establish the roles within the family. The removal of this responsibility undermines the status quo and is thus treated with mistrust and hostility.

Other perceived disadvantages of the system include the transfer of too much power to particular commercial organizations and the resulting increased probability of the emergence of monopolies; the establishment of a rigid structure in every day activities leading to more stress in everyday activities; the inability to turn on and off the sensors especially since they create a bi-directional data flow between the home and the rest of the world.

Overall, the participants did not regard the perceived benefits to be significant compared to the possible loss of privacy. They perceived the system as primarily for the benefit of retailers and manufacturers rather than consumers. It appears that if trust and privacy issues are not resolved beforehand, it will not be possible

to maintain a viable value proposition for the consumers. Although some aspects of the system would be accepted and used, a truly pervasive computing environment for retail –offering personalized, context aware functionality using data collected via sensors—will not be accepted in the short term. The primary barrier for acceptance of such a system can only be removed if sufficient warranties regarding privacy protection (either enforced by the law or self regulation) are in place and a long term trust relationship between the consumer and the service provider is established.

6. CONCLUSIONS

In this paper we have discussed the rationale for the development of MyGrocer, a second-generation pervasive retail system, as well as its implications for the FMCG market sector. We briefly discussed some interesting aspects of the developed technology infrastructure but the main focus here has been on the analysis of the business forces that dictate the development of pervasive retail and on the implications and the opportunities for innovative business models offered by the disintermediation effect of pervasive retail on the supply chain of FMCG. At the end of this year, MyGrocer will be fully deployed in a commercial environment and further results will become available on its sustainability as a value proposition.

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