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Adam P. Vrechopoulos
Editors

Consumer Driven Electronic Transformation

Applying New Technologies to Enthuse Consumers and Transform the Supply Chain

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With 49 Figures
and 16 Tables

Springer

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Foreword

In September 2003, Athens University of Economics & Business hosted the third in a series of international research symposia held under the auspices of the ECR Europe Academic Partnership and ECR Journal: International Commerce Review. Held first in Cambridge in 2001 and then at WHU Koblenz in 2002, the Symposia have become important, unique occasions in the international calendar of business research. No other event brings together in a university environment distinguished academics, business practitioners and consultants to explore the development of the consumer goods industry through collaborative management. The papers collected here, first presented in Athens, represent an important contribution to the research literature of modern business.

The wide-scale institutional development of collaborative practices in the European consumer goods business began in 1994 with the creation of ECR ("Efficient Consumer Response") Europe, a joint initiative of manufacturers and retailers working together to improve the quality and performance of the value chain. At the heart of ECR was a business environment characterised by dramatic advances in information technology, shifts in consumer demand, and the increasing movements of goods across international borders. This new reality required a fundamental reconsideration of the most effective way of delivering the right products to consumers at the right price. Non-standardized operational practices and the rigid separation of the traditional roles of manufacturer and retailer threatened to block the supply chain unnecessarily and failed to exploit the synergies that came from powerful new information technologies and planning tools. To better serve the consumer, ECR set out to invert the traditional model and break down non-productive barriers. The impacts were extensive and continue to resonate across industry.

As ECR rapidly penetrated the practice of European business, the Executive Board of ECR Europe moved to form an "Academic Partnership", a development programme designed to bring together academic research and teaching with the business needs of collaborative management. Founded in 1999, the Academic Partnership is now facilitating important ventures between universities and business that enhance both business school education and commercial management. Its publication, ECR Journal: International Commerce Review, together with the Research Symposia, have become primary contributors to international business thinking and practice.

The Athens Symposium represented an extraordinary compilation of diverse, challenging approaches to contemporary business. The presentations, collected in this book, are widely varied and represent the personal views of distinguished thinkers. By design, they are independent papers written to encourage understanding of the opportunities for collaborative business development. They are thoughtful, provocative, and at the heart of the principles of transparency and open debate that have characterised the ECR Europe Academic Partnership since its inception. They offer unique, often exhilarating perspectives on our industries' future.

Robert Wilkinson

Chairman, ECR Europe Academic Partnership
Member of the Executive Board, ECR Europe
Honorary Fellow, Athens University of Economics & Business

London, June 2004

Preface

The dominant role of Efficient Consumer Response (ECR) practices in the retail industry today has created a strong need for collaboration between business and research communities for the development of robust theoretical frameworks and intelligent technological solutions towards providing direct managerial implications to the retail industry players. To this end, this book aims to highlight the emerging trends, challenges and opportunities in the retail industry, under the perspective of the changing consumer and business behavioural patterns, the reconfiguration of intra and inter-organizational relationships and the evolving technological capabilities. Elaborating on the core ECR concepts, the book emphasizes the role of consumer behaviour research as the driving force for the configuration of the retail value chain processes. Along these lines, the application of the latest technological inventions to enthuse consumers through accurate targeting along with the identification of the potential of the new technologies, processes and strategies for transforming the supply chain constitute the main pillars of the book.

Specifically, the book focuses on the emerging techniques and technologies for supply chain management and collaboration as well as on the emerging relationships and the electronic transformations governing mutlichannel retailing. It aims at supporting retailers, consumer goods manufacturers and third parties applying the latest technological inventions to transform the value chain. It also attempts to guide practitioners to effectively proceed in employing new technologies to ignite consumer enthusiasm. Similarly, the book objective is to help companies target more accurately consumer and shopper wishes with focused investments, in shorter time, and with more success. Finally, the book underlines the great potentials for new technologies and processes from a supply and demand side perspective.

The book contains invited papers presented at the 3rd International ECR Research Symposium held at Athens, Greece (September 11-12, 2003). The third in a series of international research symposia held under the auspices of the ECR Europe Academic Partnership and ECR Journal: International Commerce Review and hosted by the ELTRUN Research Center of the Athens University of Economics & Business, Department of Management Science and Technology and the ECR Hellas. The symposium brought together the most active researchers and consultants in the Efficient Consumer Response field. In addition many retailers and suppli-

ers of the Fast Moving Consumer Goods industry participated in the Symposium.

We feel and hope that this book will be a valuable scientific source of information to practitioners, researchers and academics in the areas of conventional and electronic retailing both from a supply and demand side perspective as well as for students following MBA or relevant M.Sc. courses or undergraduate courses in supply chain management, e-business, retail management, sales management, management of information systems, etc.

We would like to take the opportunity to thank the authors of the chapters and the sponsors for supporting this effort. Finally, we would like to thank the Springer Verlag Publishers for their invaluable assistance.

Georgios J. Doukidis
September 2004 *Adam P. Vrechopoulos*

Contents

Introduction

The book contains four parts. Part 1 titled “Emerging Techniques and Technologies for Supply Chain Management” includes four chapters.

The authors of chapter 1 titled “Improvement Opportunities in Retail Logistics” Karel van Donselaar, Tom van Woensel, Rob Broekmeulen and Jan Fransoo from the Eindhoven University of Technology, describe how to increase both customer service and the capacity utilisation in retail chains. The improvement suggestions are based on observations at multiple Dutch retailers. These observations show that the logistic decisions taken by the retailer can be improved by increasing the level of differentiation, sophistication or integration in the decision-making process. Several examples are given to illustrate how these general guidelines can be translated into specific solutions for specific retailers and/or specific products. A special focus in this chapter is on the issue of ‘how to differentiate items when controlling goods flows in a retail environment’. For this differentiation, they introduce five product categories, and, for each of these categories, they discuss how to control the inventories and capacities in the retail chains. The fact that labor costs are the dominant logistic costs in retail chains is taken into account in their differentiation.

Chapter 2 is titled “A Dynamic Real-time Vehicle Routing System for Distribution Operations”. The authors of this chapter, Vasileios Zeimpekis and George M. Giaglis from the Athens University of Economics and Business argue that although vehicle routing software packages and telematic applications for real-time fleet monitoring are currently being used by logistic companies, there is still no guarantee that every vehicle will follow the initial pre-defined delivery plan. This is mainly happening due to unforeseen events that occur during urban freight movement, such as negative environmental conditions, traffic congestion, vehicle breakdowns, road works, lack of unloading space in the depots, and so on. The basic aim of this chapter is to present the inefficiencies that take place during standard deliveries and ex-van sales, define the vehicle routing parameters that should be taken into consideration in urban distribution management, and propose a generic architecture of an innovative dynamic real-time event-driven vehicle system that aims to re-route vehicles in order to avoid delivery crisis.

Then, the authors of chapter 3 titled “Bargaining and Alliances in Supply Chains”, Mahesh Nagarajan1 and Yehuda Bassok from the University of British Columbia and the University of Southern California, respectively, deal with negotiation as a common and an important activity in many organizations. They report that within an organization, pay scales, work

schedules, budgets etc. are often negotiated between various parties. From an inter-organizational view, negotiation is possibly the most common method of drawing up contractual terms, settling disagreements etc. between supply chain partners. The number of seminars and workshops that are designed to improve the negotiation skills of top-level management is ever on the increase. Indeed, considerable energy has been spent by academicians in characterizing the type and importance of negotiations between firms in various sectors. Thus, they support that adopting a negotiation framework to examine profit allocations among supply chain partners seems very natural. They concentrate in the retail industry providing a framework to analyze the negotiation process relevant to procurement contracts and offer some important results.

Finally, the authors of chapter 4 titled "Last-mile Supply Chain Integration: Easy Connection and Information Exchange between Suppliers and Retailers" William Drakos and Yannis Pantzis from Information Systems Impact, support that integrating and automating information exchange (e.g. orders, invoices, catalogues, etc.) across the entire Retail Chain by connecting Suppliers, Retailers, Warehouses, Retail Stores and other players has been a complicated, expensive and time consuming task and – as such – has only been employed by larger enterprises. They argue that a flexible Integration and Business Process Automation service, enabling rapid and intelligent consolidation of business documents exchange among business partners, is needed. They state that by utilizing the latest Internet technologies and standards, multiple disparate internal applications can "speak out" to business partners, resulting in a large business network of loosely connected business partners. Along these lines, they note that compatibility with existing systems and technologies (like EDI-based systems) secures the effectiveness of the solution. To that end, they propose an Enterprise Application Integration (EAI) service that has been specially designed so as to allow Small-Medium Enterprises (SMEs) effectively catch up with the new electronic business culture.

Part 2 is titled "Multichannel Retailing: Relationships, Integration and Electronic Transformations". It includes 3 chapters.

The author of chapter 1 titled "Multichannel Retailing and Brand Policy" Luca Pellegrini from Università IULM, deals with the implications of multichannel patronage on manufacturer-retailer relationships with a focus on brand policies. He notes that in the modern retail landscape, consumers can obtain the same product categories in several store formats, taking advantage of the differentiated service they offer. The results of a survey on consumer channel patronage are used by the author to explore the impact of buyer characteristics on the choice of channel and on purchasing patterns

across channels. He reports that since channels attract different consumers, for different product categories in different occasions, it is suggested that they can be used as a base for segmentation. He then considers the options for brand policies, in particular, looking at ways to differentiate both products and brands across channels. He concludes that this would create value to consumers through a more focused provision of products, and also improve manufacturer-retailer relationships through the development of channel-specific configurations of the supply chain.

Then, the author of chapter 2 titled "Designing Alternative Store Layouts for Internet Retailing" Adam P. Vrechopoulos from the Athens University of Economics and Business, adopts a methodological approach towards designing the three major conventional retailing store layouts (i.e. grid, free-form, racetrack) within a Web-based shopping interface. He reviews the existing hypermedia design methodologies and employs graph theory as a consumer navigation representation tool. Then, he proceeds by designing the concept that each of the three layouts should follow within the context of a virtual retail store on the Web. Several methodological steps were taken towards developing alternative virtual store layouts that retain distinct differences among each other, while simulating their corresponding concepts and rules from conventional retailing. Managerial implications to Internet retailers in terms of category management and store design issues as well as areas for further research are provided by the author at the end.

Finally, the authors of chapter 3 titled "In Search for Viable e-Solutions" Solveig Wikstrom, Bo Lennstrand, and Christian Persson from Stockholm University, Gotland University and Stockholm Royal Institute of Technology, explore the criteria for successful e-commerce. This is done by taking their previous research results on the benefits and shortcomings consumers experience from the e-channel, and comparing them with ongoing results on the service qualities of successful e-companies. By integrating these findings, they can identify qualities that characterize e-solutions that are useful for the consumers and profitable for firms. They conclude by suggesting two solutions. First, they support that in order to improve the functioning of the website, images of the traditional physical channel should be inserted into the website. Second, they propose a strategy whereby firms integrate the e-channel with the traditional channels, i.e. develop a multichannel strategy.

Part 3 is titled "Beyond CPFR: Defining the Future of Supply Chain Collaboration and includes 5 chapters.

The authors of chapter 1 titled "On Shelf Availability: An Examination of the Extent, the Causes and the Efforts to Address Retail Out-of-Stocks" Daniel Corsten and Thomas Gruen from the University of St. Gallen and

the University of Colorado, respectively, argue that with all the hype around ECR and the brave new world of technologies, one would believe that retail out-of-stocks have gone down over the last ten years. According to them, that is wrong. They report that retailers have been struggling with considerable out-of-stocks for decades – with little evidence of improvement. Along these lines, they note that a similar wrong belief is that shoppers are still willing to accept low service levels. In fact, increasingly, consumers switch brands when they don't find the brand they wanted. But retailers must be wary, because the results of their research show that, increasingly, shoppers switch stores quickly and may never come back. So, who is to blame? The supply chain. And where to tackle it? On the shop floor. Over the past two years, they have conducted a major, world-wide study of the extent, causes, and consumer responses to out-of-stocks in the fast-moving consumer goods industry. In this interesting chapter, they report these empirical findings and provide insight to solving this chronic industry problem.

Then, the authors of chapter 2 titled "Increasing Shelf Availability through Internet-Based Information Sharing and Collaborative Store Ordering" Katherine C. Pramatari and Panagiotis Miliotis from the Athens University of Economics and Business, underline that on-shelf availability is a critical issue for both manufacturers and retailers today, who associate out-of-shelf situations with lost consumer loyalty and missing sales. They report that from the sparse texts and empirical studies that are available, it emerges that the main reasons behind the problem are found in the retail store replenishment practices and, particularly, in errors and omissions in the ordering process. In this chapter, they suggest a new replenishment practice, enabled by Internet-based information sharing and collaboration between retail store managers and supplier salesmen, leading to increased order accuracy and, as a result, to fewer out-of-stock situations. The empirical results from applying this new replenishment practice and a quantitative analysis of the impact of shelf availability from a pilot running, showing more than 50% reduction in the out-of-shelf situations, are also provided by the authors at the end.

The author of chapter 3 titled "Towards the Development of an Algorithm to Discover Out-Of-Shelf Situations, Dimitrios A. Papakiriakopoulos from the Athens University of Economics and Business, investigates the possibility of developing an algorithm that identifies the OOS situations, utilizing information systems capabilities. In more detail, the author, having available the POS data, orders details, products assortment etc., develops a method for constructing an algorithm that will automatically discover OOS situations on a daily basis. He notes that currently, the identification of OOS rates is based on physical audits, which consumes

resources and is only an approximation to the problem. In the next section, he describes the factors affecting the OOS problem. He further discusses the accuracy of an existing method that identifies OOS situations, namely the European Out-Of-Shelf Index (EOI). Finally, he presents his method of work, followed by some preliminary empirical results.

The authors of chapter 4 titled "Food Value Chain Analysis" David Simons, Mark Francis and Daniel T. Jones from the Cardiff University underline that previous research has highlighted the importance of greater vertical co-ordination within red meat supply chains, to reduce risk and uncertainty and foster an environment of innovation and value creation. In this chapter they present the VCA project that calls for eight complete value chains to be studied and mapped in detail, with the primary objective being the mapping of value streams and the identification of opportunities for cost savings through the elimination of waste. They state that each of these chains will involve one or more producer, abattoir, processor, and supermarket or food service outlet. They also note that the value chains have been selected to encompass the maximum diversity, including the three product species (beef, lamb and pork) and different routes to market (retail and food service). Finally, they report that the results will be used to identify and prioritize intra- and inter-firm waste elimination opportunities.

Finally, the author of chapter 5 titled "Extending ECR into Product Innovation" Joerg Hofstetter from the University of St. Gallen states that little activity has been dedicated by practitioners so far to jointly improve the conventional product development and launch activities. He notes that while there is little doubt among top managers about the importance of product innovation, the ways of how to tackle this important field are still at question. To that end, he includes in his article recent research findings based on the investigation of several emerging collaborative business practices and experiences of several leading companies.

The last Part of the book (Part 4) is titled "Beyond RFID: Supporting Supply-Chain Management with Intelligent Tagging". It includes 3 chapters.

The authors of chapter 1 titled "Turning Signals into Profits in the RFID-Enabled Supply Chain" Nigel Green, Kurt Kammerer and Tim Shideler from VI Agents LLC, deal with Auto-ID/RFID as a technological tool that provides real-time material flow data. They report that distinguishing noise from relevant data signals, using these signals to identify supply chain bottlenecks and taking operational advantage of optimization opportunities, will be major prerequisites to supply chain improvement. They report that supply chains are value networks made up by network nodes (i.e. distribution centers, stores, etc.), which collaborate around material movement events and according to defined service levels and rules. They also support

that in a real-time world, success depends on both central and local decision-making. To that end, they state that whereas supply chains may be centrally governed, distributed control and execution of events are equally important as it is the only practical way to cope with the complexity of a real-time value network.

Then the authors of chapter 2 titled "Shopping in the 21st century: Embedding Technology in the Retail Arena" Panos E. Kourouthanassis and George M. Giaglis from the Athens University of Economics and Business, investigate the effect of the emerging information technology advances in consumer culture. They report that nowadays, the sociodemographic changes in consumer market (such as increased number of dual-income, single-parent and technology-familiar households) have significantly altered shoppers' expectations, demands and spending patterns. As a result, the traditional levers of price, selection and location – although still important - are no longer sufficient in order to achieve competitive differentiation for retailers. Moreover, they state that recent advances in Information Technology (such as wireless networking and RFID-based products' identification) can create technologically augmented environments, which consequently may lead to a new consumer culture in the form of enhanced shopping experiences within the retail outlet. This chapter presents an overview of these developments and their impact on the retail sector, and concludes with the results of a Greek case study illustrating the perceived adoption of the emerging shopping schemes by supermarket shoppers.

Finally, the authors of the last chapter (chapter 3) titled "Towards 'Smarter' Supply and Demand-Chain Collaboration Practices enabled by RFID Technology" Katerina C. Pramatari, Georgios J. Doukidis and Panos E. Kourouthanassis from the Athens University of Economics and Business, argue that the Internet has made it easier to share information among trading partners, enabling new forms of collaboration in the supply and demand chain management. They report that with the introduction of Radio Frequency Identification (RFID), this possibility takes on different dimensions, greatly expanding the information that can be shared and the collaborative processes that can be supported between retailers and suppliers. In this chapter, they discuss the evolution path of supply chain collaboration practices in retailing, and how these further evolve with the introduction of RFID technology. This interesting chapter gives an overview of internal and collaborative processes enabled by this new technology, and discusses the underlying infrastructure required to support it.

PART 1

EMERGING TECHNIQUES AND TECHNOLOGIES FOR SUPPLY CHAIN MANAGEMENT

Improvement Opportunities in Retail Logistics

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1 Introduction

This chapter focuses on inventory replenishment strategies and capacity utilization in the retail sector. In recent years, this sector has spent considerable amounts of time and money trying to improve its operations in such a way so as to respond efficiently to customers' needs. This has led to several developments like the introduction of automated store ordering.

The automation of the store ordering is generally done at one central point within the company, and the resulting ordering rules can be used in all stores. The retailers realize that it is of strategic importance to use this economy of scale to gather all existing knowledge and expertise on inventory control theory and retail operations in order to get the best set of ordering rules in the industry.

To further improve the inventory replenishments in the stores, Eindhoven University of Technology has executed several projects with FMCG manufacturers, wholesalers and retailers in The Netherlands. These projects often take an integral supply chain perspective when choosing the most appropriate inventory replenishment strategy for a particular group of products in the stores. Based on the experience obtained in these projects and other results reported in the literature, we aim to give an overview of improvement opportunities in Retail Logistics, which can be used to enhance Automated Store Ordering (ASO) systems.

In general, the logistic decisions taken by the retailer can be improved by increasing:

- the level of differentiation when controlling the operations;
- the level of sophistication in the Decision Support Systems;
- the level of integration of multiple decisions (made by the retailer company and/or its supply chain partners).

Below, several examples are given to illustrate how each of these general guidelines can be translated into specific solutions, taking into account the fact that different retailers and/or different products need different logistic solutions.

2 The Level of Differentiation when Controlling the Operations

Different types of items need different ways of replenishment. For example, general textbooks on inventory management (Silver et al., 1998) propose the so-called ABC-classification, based on the perception that items with large turnover (A-items) need to be treated differently compared to items with low turnover (C-items). While there is some value in this approach, we propose a different classification for retail-items. We distinguish the following five main product categories:

1. Phasing-in/out items (including items with a short Product Life Cycle)
2. Promotion items
3. Purchasing driven items
4. Capacity driven items
5. Regular items

Below, each of these five product categories is discussed in more detail.

The *phasing-in/out items* (including items with a short product life cycle) are different from other items since there is either very little demand history available, or it becomes very risky to carry inventory due to obsolescence. Thus, for these items, special attention is given to issues like demand forecasting and inventory management in an environment with high risk of obsolescence and/or markdown policies.

Improvement opportunities reported in the literature are:

- Using similarity in forecasts made by different individual people as an indicator of forecast accuracy when no sales data are available yet;
- Using early sales data to improve demand forecasts in the case of style goods;

- Using repeat rate information from customer cards to improve demand forecasts when new products are introduced;
- Using optimal markdown policies to reduce the risk of obsolescence.

Fisher et al. (1994 and 1996) show that demand forecasts for items with a short product life cycle (like style goods) can be improved substantially in two ways. The first improvement applies when an initial production or buy decision has to be made and no sales data are available yet for the new assortment. They show that when each member of a buying committee makes an independent demand forecast for every product, the variance in these individual forecasts is an almost perfect predictor of the overall demand forecast accuracy. This allows the manufacturer and/or retailer to select the items with a high demand forecast accuracy, which can be manufactured at the beginning of the production season. The production of items with low demand forecast accuracy is postponed until a group of large retailers placed their first orders (called the Early Write program). These first orders typically make up approximately 20% of the total orders. Fisher et al. (1994 and 196) show that these first orders can be used to improve the demand forecast for the whole product life cycle. They implemented this method at a supplier in the fashion-ski-apparel market, and showed that markdowns can be reduced substantially. While this procedure was first applied at a manufacturer, a similar procedure may also be used at a retailer, when he/she receives his/her first actual sales data in the new season. Fisher et al. (2001) report how the inventory replenishment of products with a short product lifecycle can be optimized for a retailer, when the retailer has two buying opportunities: an initial buy and a reorder opportunity.

Another tool to quickly evaluate the performance of items that are phasing in is applied by Dunnhumby at Tesco (Hill and Dowle, 2003). The strength of their approach is that they use detailed information on the buying behavior of individual customers. This is possible thanks to the retailer's customer card, which is providing them with information for more than 10 million customers. When a new product is introduced, they measure not only the sales rate, but also the repeat rate, which is defined as the proportion of customers who come back to the store for the new product. This information enables them to tell within weeks of the launch whether a product is successful or not. To forecast demand, they identify the 10 most similar product launches (in terms of how the repeat rate evolves over time) that have taken place in the same product category in the last 2.5 years. This concept is somewhat similar to the approach taken by Kurawarwala et al. (1996), although the latter approach is based on sales rather than on repeat rates.

Even with a good demand forecast, leftovers are likely at the end of a product life cycle. To prevent this, a markdown policy may be applied. Several models exist in the literature, which deal with issues like the size and the timing of the markdowns. A paper that considers this issue in the context of inventory control at retailers is Smith et al. (1998). An extensive overview on papers related to markdown policies is reported in Tsay (2001).

The *promotion items* are items that are part of the regular assortment, but are either offered temporarily at a reduced price or offered at the regular price but with additional visibility (e.g. via advertisements or via a special location in the store).

Improvement opportunities reported in the literature are:

- Using marketing intelligence and/or econometric models to forecast demand for the promotion items and their substitutes
- Using a push-strategy with two waves
- Coordinating the promotion with the supplier

For these items, demand should no longer be forecasted based on extrapolation of time series (e.g. via methods like exponential smoothing or moving average, which are typically used when the item is not promoted), but based on marketing intelligence taking into account price-elasticities and/or the impact of promotions and advertising on consumer buying behavior (see Cooper et al. 1999). Since the sales during promotions may well be a (large) multiple of regular sales, promotions should be typically coordinated with external suppliers to make sure enough products are available in time in the retailers' DC (see Pramatari et al. 2002). For items in the same product category as the promoted item, substitution effects may occur, which have to be taken into account when forecasting their demand (see Huchzermeier et al. 2002).

While regular items are typically pulled by the retail stores, promotion items are typically pushed by a central decision maker. For example, the shipments from the DC may typically be based on a so-called alpha-policy: the items are distributed in two waves, and, in the first wave, alpha % is pushed to the stores. Often, the optimal value for alpha is somewhere between 70 and 80%. A few days after the promotion started, the remaining 20 to 30% is distributed based on the early sales data. This kind of policy has been studied in a non-promotional context by Erkip (1984), Jönsson et al. (1987) and McGavin et al. (1993). An application of the alpha-policy at a Dutch retailer for items on promotion is reported by De Leeuw (1996).

The *purchasing driven items* are one-time-items that are not part of the regular assortment, but are bought by the Purchasing department. The reason might be that they spotted a special buying or selling opportunity. The

purchasers buy a certain quantity of the product, and when this lot is sold-out, no replenishment from the supplier takes place.

The amount purchased is often determined by purchasing considerations (e.g. based on discount-opportunities) rather than by demand forecasting. For the distribution of the purchasing driven items to the stores, a push-strategy with two waves, like the alpha-policy, may be adopted.

The *capacity driven items* are items used by the Operations department to smooth handling and/or transportation capacities. If, for example, the demand for these capacities varies within the week, smoothing may lead to a reduction in the total assets needed.

To smooth handling-capacities in the DC and the stores, the review period for items with sufficient excess shelf space[1] (see Broekmeulen et al. 2004) may be increased by decreasing the delivery frequency. For example, a store may order part of its assortment on a weekly basis, while another part of its assortment is ordered on a daily basis. The items ordered on a weekly basis can be ordered in the quiet part of the week, in order to smooth the handling capacity in the retail supply chain. Ordering with a lower frequency often leads to higher lot-sizes per item, implying also higher handling efficiency. Another way to benefit from reduced ordering frequencies is to redesign the retailer's DC. If all items ordered on a weekly basis are stored in a separate part of the DC, the total walking distance for the order pickers per week can be reduced substantially. A prerequisite for this is that all items in this part of the DC have excess shelf space in all stores.

To smooth transportation capacities, large volume/large sales items may be used. In groceries, these are typically items like soft drinks and beers. On Tuesday and Wednesday, the regular replenishment quantities ordered by the stores may be low, while on Thursday and Friday these quantities may be high. By ordering these items in advance on Tuesday and Wednesday instead of on Thursday and Friday, the capacity load is smoothed. If the retail store has little storage space available, this option may not be feasible.

The *regular items* are all items that are not phasing in or out, are not on promotion, and are not purchasing or capacity driven. Before discussing the operational control of the regular items in the store, a few notes should be made on the trade-off between inventory holding costs and customer service, and its impact on the control of the entire supply chain. In several projects with retailers, it has been noted that at the operational level (where the size of the store and the assortments are given), the space in the retail

[1] The items with sufficient excess shelf space are often slow-moving items and/or (physically) small items.

store should be considered as a constraint rather than a cost factor. Moreover, handling costs at the retailer's DC and particularly at the store level usually outweigh the relevant inventory holding costs for regular items by far. In addition, the inventory contributes most to the service level of the final customer, if this inventory is stored mainly downstream in the supply chain (Van Donselaar 1990). Therefore, the supply chain should often aim to handle goods as long as possible in the most efficient handling units (trucks or pallets (or even layers) when distributed from the manufacturer to the retailer's DC), and accept the higher inventory levels in the retailer's DC. The goods can be shipped as soon as they are produced. This concept is called Supply Driven Coordination (Van der Meulen (1997)) or Chain Synchronisation (Van der Vlist (2002)). Moreover, from the retailer's DC one might ship inventory as soon as possible to the store, when it fits on the shelves (given the number of facings, determined at the tactical level in the planograms).

In current ASO systems, the regular items often follow a traditional (R,s,nQ)-policy[2]. This means that every review period (R), the inventory position is checked to see whether it is below the reorder level (s). If so, n times Q items are being ordered with Q being the case pack size and n the minimal integer number of case packs needed to make sure that, after reordering, the inventory position is equal to or higher than s. These parameters still leave a number of options open to further differentiate the inventory replenishment strategies within the regular items.

For example, the review period R may be different for different items. In a supermarket environment, we noted that perishables and non-perishables have clear distinct sales and logistic characteristics. By definition, perishables have a smaller Shelf Life than non-perishables. As a result, when controlling perishables' inventories, the focus is more on reducing waste. For perishables with a very low Shelf Life, this reduction of waste may be achieved by decreasing the review period (i.e. by increasing the delivery frequency).

Not only the review period may be different for different items, but also the reorder level may be determined in a different way for different items. If we consider again the perishables with a very low Shelf Life, we note that apart from decreasing the review period, other options to reduce the waste are (see Van Donselaar et al. 2004): reduction of the lead-time (e.g. by using cross-docking or direct delivery), keeping average sales per item relatively high (by keeping assortments limited) and/or using the custom-

[2] Note that a full-service concept (fill the shelves as soon as a new case pack fits in) is a special case of (R,s,nQ) with s equal to the maximum shelf capacity minus the case pack size plus one consumer unit.

ers' willingness to substitute demand within a product category. Apparently, for these items, the reorder level should not only be based on small lead-times and high average demand, but also take into account the product substitution. Most ASO systems are primarily designed for non-perishables and do not take into account these substitution effects. For items with very high substitution rate (e.g. bread) this would lead to unrealistic reorder levels. Literature models that consider substitution effects are described by McGillivray and Silver (1978), Parlar and Goyal (1984), Smith and Agrawal (2000), Mahajan and van Ryzin (2001), Rajaram and Tang (2001), Netessine and Rudi (2003) and Kok and Fisher (2003).

For vegetables and fruit (see Van Donselaar et al. 2004), reduction of waste is also important, and this can be improved by increasing the quality of the demand forecast. Note that the demand forecast is a major factor in the reorder level. The demand forecast might be improved by taking into account price-elasticity, the quality of the inventory on hand and seasonal effects.

Finally, for perishables with multiple lots on the shelf, each lot having a different age, more complex models may be needed to determine the reorder level. There are numerous models in the literature dealing with perishable items. See Nahmias (1982), Raafat (1991), Silver, Pyke and Peterson (1998) and Goyal and Giri (2001) for an overview.

3 The Level of Sophistication in Reorder Systems

Thanks to economies of scale and cheaper and better information technology, large retail chains are trying to distinguish themselves from other retailers by increasing the level of sophistication of their reorder systems. At this moment, the quality of reorder systems varies greatly between retail chains, and, even within retail chains, it may differ substantially per retailer. The level of sophistication of their reorder system may differ with respect to:

1. the level of automation;
2. the quality of the input data;
3. the intelligence in setting the logistic parameters in the reorder system;
4. the ability to visualise economic trade-offs;
5. the ability of the personnel to make decisions or to evaluate proposed decisions.

In some stores, the reorder decisions are still made manually, without any support from a computer. In other stores, the computer may give ad-

vice on the timing and the quantity to be ordered for most items. But even in those stores, part of the assortment may still be ordered without the help of a computer. At a grocer's for example, we noted that the majority of non-perishables were ordered via an ASO system, while certain perishables were ordered manually, since they either required additional intelligence (like a judgment on the quality of the inventory for vegetables), or they had to be ordered via a separate ordering system (belonging to a particular supplier).

Even when automated store ordering is implemented, the data quality has a large impact on the success of the system. It is known from empirical research that inventory data are highly inaccurate (see Raman et al. 2001). One of the reasons for this is that sales data are not always accurate (e.g. when a strawberry yogurt and a banana yogurt are bought by the same customer, the cashier may scan only one of the two items twice). To increase the sales data accuracy retailers may either apply more strict rules on how to register sales, or they may attach an electronic identification device to each individual product, which is scanned automatically at the cash register.

The intelligence in setting the logistic parameters in the system (i.e. the reorder level and the order quantity) also differs a great deal. Sometimes, a fixed reorder level is applied, and sometimes the reorder level varies over time, taking into account weekly sales patterns (see Kahn 1989), seasonality and/or trends in sales. In some cases, the determination of the reorder level depends on many different variables like the weather, substitution effects, the review period, the price, etc. These more complex situations are often not dealt with by the ASO systems, but are often handled by store clerks who have considerable experience in their product category.

Also the order quantity is determined in many different ways. The simplest case is when the supplier determines the order quantity by fixing the case pack size (typically for most items in the supermarket). If, however, the item is made for one particular retailer only, the retailer can optimize the case pack size. This optimization should not only include the minimization of the inventory holding costs and the fixed ordering costs, but also take into account operational constraints like the maximum shelf capacity.

Ideally, the computer should not only calculate the optimal solution, but also offer insight to the decision maker on the economic trade-offs between important performance indicators. In the example of the case pack size, we can think of the following performance indicators: the number of orders per year, the total handling time needed, the expected total number of refills needed (if the case pack size is too big to put on the shelf), the total inventory and the resulting service level to the customers.

To be able to make these trade-offs, the personnel needs good training. Purchasers for example, who are often responsible for setting the case pack size in cooperation with the supplier, may be more focused on and trained in getting the lowest price than in making an overall evaluation of the impact of the case pack size on all performance indicators. In addition, at the store level, where store managers or store clerks are responsible for the determination of the order quantities, the level of education may differ greatly.

4 The Level of Integration of Multiple Decisions (Made by the Retail Company and/or Its Supply Chain Partners)

The decisions with respect to inventory and capacity management are often affecting many different performance indicators, organizational units and hierarchical levels within these organizational units at the same time. Often, in practice only partial effects are taken into account when decisions are being made. As a result, the quality of the decision-making can be improved by increasing the level of integration. We distinguish three types of integration:

1. Integration of all relevant performance indicators in the supply chain;
2. Integration of decisions made at different organizational units;
3. Integration or coordination of decisions made at different hierarchical levels.

Below some examples are given, which are related to inventory and capacity management and which were encountered in retail supply chains. Each example includes one or more types of integration.

Example 1

When deciding on the case pack size, a non-food-retailer used the classical Economic Order Quantity formula (Silver et al. 1998). This formula is almost a hundred years old and applied successfully at many companies in multiple industries. The formula is derived from a model, which only considers the inventory holding costs and the fixed ordering costs. Cost analysis in several retail supply chains (including this one) showed that, in fact, handling costs are often far more important than inventory holding costs, and should, therefore, be included in the decision-making. As a matter of fact, not only handling costs in the store, but also handling costs at the retailers' DC and/or the supplier may be significant and affected by the decision on the case pack size. In this case, the handling at the retailer's DC had to be taken into account as well, whereas the implications for the sup-

plier were only minor. Finally, note that even a focus on total relevant costs in the entire supply chain may be too narrow-minded. The customer service level for example may also be affected by the case pack size[3].

Example 2

Within retail chains, Marketing and Operations are often separate departments. Marketing typically decides on issues like the marketing strategy, target customer service level, the store layout, depth and breadth of the assortment, pricing, promotions and shelf space allocation (via planograms). Operations typically decides on issues like (in)direct delivery, delivery frequencies, replenishment strategies (pull/push), reorder levels, minimum lot-sizes, etc.

Sometimes the decisions from both departments are interdependent, but this is not always taken into account when the actual decisions are being made. For example, planograms and reorder levels should be matched. If the space allocated to a product is less than the space required for operations (which is mainly based on the reorder level and the case pack size), inefficient handling may be the result: if an order arrives at the store, it may not fit on the shelves, leading to leftovers, which are sent to the backroom and have to be taken back to the shelves again later on.

Example 3

A retailer typically aims for a particular market segment and designs his logistics strategy to meet the requirements of this market segment. For example, some retailers aim for high customer service (see Kok et al. 2003), while others primarily aim for low costs. To make their strategies work, the retail companies have to ensure that their long-term marketing and logistics strategies are in line with the replenishment strategies applied at the store level every day. If, e.g. at the shop floor, the replenishment strategy is to fill the shelves completely as soon as a new case pack fits in, this would be in line with a high customer service objective, but not with a low cost strategy. In case the inventory replenishment strategy is determined locally (at the store level) by individual people, there is a serious risk that either these people have different objectives, or they are simply not aware of the link between their decisions and the strategy of the retail chain.

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[3] The reasoning above does not imply that the best model is the one that includes all performance indicators in the entire supply chain. Such a model would typically be very complex and would require a huge amount of input data. The craftsmanship in decision making here is to find out the most relevant indicators and construct a model based on these indicators only.

5 Concluding Remarks

In this chapter, we have shown that both customer service and the capacity utilization in retail chains can be increased by improving the logistic decisions taken by the retailer. New technologies allow the retailers to improve their logistic decisions by increasing either the level of differentiation, the level of sophistication and/or the level of integration in their decision-making.

In many retail chains, different items need different logistic solutions. In this chapter, we distinguished five product categories: items that are phasing-in/out, items that are on promotion, items that are driving the utilization of capacities, and regular items. All these categories require a different way of controlling the operations. Most ASO systems currently applied are primarily developed for regular items. In this chapter, we describe how these ASO systems can be improved to also support other products. Although the findings are based on observations at Dutch retailers, discussions with retailers in other countries indicate that most results also apply elsewhere.

A final remark can be made on the importance of labor costs in retail chains, and its impact on the focus of Retail Logistics. In many retail chains, we noted that labor costs by far outweigh the inventory holding costs at the operational level (i.e. if the size of the store, the product assortment and the planograms are fixed). This implies that a major focus of top management in retail chains should be on how to improve labor efficiency. Little scientific research has been done in this area, and so more research is needed to get a better understanding of the factors determining labor efficiency in stores.

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A Dynamic Real-Time Vehicle Routing System for Distribution Operations

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1 Introduction

Urban freight transportation usually represents the most important element in logistics costs for most firms (Ballou, 1999). This is mainly due to the probabilistic factors that urban freight movement depends on, such as high levels of traffic congestion, negative environmental conditions (i.e. rain), tight delivery time windows, vehicle breakdowns, unexpected events (i.e. flea markets, road works), and so on. In addition, operational costs are ever-increasing due to the fact that freight carriers are expected to provide higher levels of service with lower margins, in order to meet the contemporary needs (i.e. smaller and variable productions, rapid market changes, and shorter lead times) of the entire supply chain network, and gain competitive advantage.

In order to optimize urban distributions, freight carriers examine their processes in a manner able to minimize their operational costs and, at the same time, maximize customer fulfillment. Terrestrial wireless communication systems such as General Packet Radio Services (GPRS) in conjunction with satellite constellations, such as Global Positioning System (GPS), can be integrated with Vehicle Routing Systems (VRS) and Geographic Information Systems (GIS) in order to provide real-time vehicle management. These services should be designed to address the case in which the execution of delivery cannot follow the prescribed plan, due to an unforeseen event.

This latter area is the focus of this paper, which investigates how technological advances in the fields of mobile and wireless computing can be employed towards an integrated architecture for mobile-enabled *real-time distribution management* systems. The paper reviews selected bibliography in Vehicle Routing in the light of recent technological developments,

and proposes a generic architecture for mobile real-time decision support systems for urban distribution. The structure of the paper is as follows: Section 2 examines the characteristics of urban distribution, while Section 3 describes vehicle routing parameters. Section 4 critically examines relevant research in Vehicle Routing Systems (VRS). Section 5 raises the need for *real-time VRS* incorporating mobile and wireless technologies and proposes a generic system architecture. Section 6 concludes with a discussion on future research directions towards the development and implementation of the proposed architecture.

2 Urban Freight Movement

One may distinguish at least two ways for distributing goods in an urban freight movement scenario: *standard deliveries* and *ex-van sales*. While both cases use a typical delivery network with *N* warehouses that deliver to *M* customers through a fleet of *K* vehicles, they differ in the way they handle demand. Standard deliveries are based on a known demand (usually driven by pre-placed customer orders), while ex-van sales operate in an unknown demand environment, where orders are being placed during the truck's visit to the customer site. Table 1 summarizes the main attributes of the two modes of urban deliveries.

Table 1. Characteristics of Standard Deliveries vs. Ex-Van Sales in Urban Distribution

Standard Deliveries	*Ex-Van Sales*
Fixed Geographical Layout	
Fixed Distribution Center Capacity	
Fixed Truck Capacity and Fleet	
Known demand per sales point	Unknown demand per sales point
Fleet delivers based on orders	Orders are not known in advance (only sales area is)
Fixed schedules and delivery time windows	More relaxed schedules
Truck routes determined *a priori* based on demand, network traffic, and other parameters in a near-optimal way	Distribution of work per truck is based on past area sales and business agreements with the drivers

The performance of either urban distribution model may deteriorate significantly due to a number of factors (Min et al., 1998). No matter how well the initial delivery plan has been designed, a number of unforeseen events inevitably occur during the distribution execution stage, thereby resulting in a need to make real-time adjustments, such as truck re-routing and delivery rescheduling (Brown et al., 1987; Rego and Roucairol, 1995; Savelsbergh and Sol, 1998), in order to adapt to the new conditions and achieve the objectives of the initial plan as closely as possible. In the case of standard deliveries, such events may include traffic congestion, ramp overload at points of delivery, truck breakdowns, unforeseen reverse logistics requests (for example, goods returns), and others (Ghiani et al., 2003). This situation may become even more complex in the case of ex-van sales, where inefficiencies usually stem from the inherent demand/route uncertainty of the model, raising complex requirements for real-time decision-making. For instance, if a vehicle has disposed of its entire inventory in the first few points of sales due to unexpectedly high demand, it may be beneficial for another vehicle (carrying excess inventory) to be re-routed in order to accommodate the increased sales needs in the first vehicle's area. Other issues in ex-van sales involve requirements that arise for real-time connectivity with back-end company systems, in order to support processes such customer credit control, invoicing, and so on.

From the above, it becomes clear that, while an efficient initial routing plan is necessary, it is by no means sufficient to minimize risk in high performance distribution systems. Initial routing plans need to be complemented by the ability to make and implement sophisticated decisions in real –time, in order to respond effectively to unforeseen events. We contend that this requirement may be facilitated by innovative technology-augmented approaches combining inter-vehicle wireless communication, back-end wireless connectivity with the distribution center, and real-time decision support.

3 Vehicle Routing Parameters

Many problems in the area of goods transportation by vehicle fleets can be modeled, to a certain extend, within the VRP framework (Figure 1). The focus of the typical VRP is the design of routes for delivery vehicles that operate from a single depot, and supply a set of customers at known locations, with known demand. Routes for the vehicles are usually designed to minimize the total distance traveled (or a related cost function). Bowers et al (1996) present the formulation of the typical VRP.

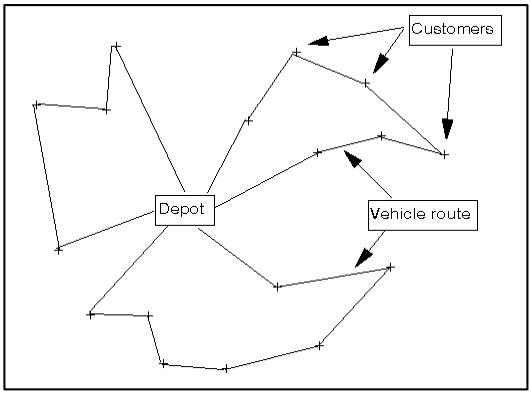

Fig. 1: Schematic representation of the typical Vehicle Routing Problem

In an effort to model and address important practical issues, the fundamental VRP has been extended in a number of aspects. Indeed, one can distinguish no less than seven topics of critical practical importance that raise considerable challenges in VRP-related research, and are all closely related to the real-time vehicle management problem.

***Number of Stages*:** While the *single-stage VRP (delivery only)* is primarily concerned with the establishment of outbound delivery routes, the *double-stage VRP* considers both *delivery & pickup,* i.e. outbound and inbound distribution. The latter is a salient feature of real-time distribution, since reverse logistics may necessitate adjustments to the original schedule, depending on the truck load and its capacity. For a treatment of the two-stage VRP, see Savelsbergh (1995) and Yang et al. (2000).

***Deterministic vs. Stochastic Supply/Demand*:** The *Deterministic VRP* assumes that demand/supply is known *a priori*, while the *Stochastic VRP* encompasses uncertainty in demand and/or supply levels (Min et al., 1998). As discussed above, demand uncertainty is a key characteristic of ex van sales (see Section 2).

***Fleet Size*:** We can differentiate between cases of *Single Vehicle* and *Multiple Vehicles*. As the number of vehicles in the delivery fleet is increased, the problem size and the computational complexity increase accordingly. It is clear that the multiple vehicle case is appropriate in the real-time vehicle management problem, since many contingency measures involve the cooperation between vehicles through appropriate inter-vehicle communication infrastructure.

***Vehicle capacity*:** There exist formulations for both the *Capacitated VRP* and the *Uncapacitated VRP,* depending on whether vehicle capacities are considered. The Capacitated VRP (CVRP), as presented for example in Toth and Vigo (2002), is perhaps amongst the most widely researched variations of the problem. Capacity considerations are important in the case examined here, especially in view of reverse logistics, in which the capability of the vehicle to respond to the customer need depends on its available capacity.

***Planning horizon*:** The *Static VRP* takes into consideration a single planning period (for example, solving the distribution problem for next day's deliveries), while the *Dynamic VRP* considers optimal solutions in multiple periods. In this case, the initial schedule can be adjusted, according to the current needs for distribution (Laporte, 1988).

***Time Windows*:** A classical variation of the VRP refers to the consideration of time windows, outside which deliveries cannot be accepted. Time windows can either be 'hard', when they cannot be violated, or 'soft', in which case violations are accepted but penalized. A recent analysis of the VRP with soft time windows has been provided by Ioannou et al. (2003). Time windows present one of the most common causes for the need of real-time incident management.

***Objectives*:** There exist *Single-Objective* or *Multiple-Objective* formulations of the VRP. The most common VRP objective is to minimize the total cost of deliveries. However, additional objectives might be considered, such as minimizing number of depots, or maximizing customer satisfaction (Renauld et al., 2000; Fisher, 1994).

4 Vehicle Routing Systems (VRS)

By taking into account the aforementioned vehicle routing parameters, significant research is ongoing in dynamic planning, especially dynamic re-scheduling and re-routing of vehicles, the relevance of which has increased due to the emergence of technologies enabling real-time, high-bandwidth information exchange between fleet vehicles and/or between a vehicle and its headquarters. Real-time vehicle management strongly depends on significant information exchange supported by appropriate information system infrastructure. Information systems related to the VRP, Vehicle Routing Systems (VRS), are reviewed below.

A number of Vehicle Routing Systems (VRS) have been developed by the logistics community since the 1980's. These systems were essentially Decision Support Systems (DSS) (Belardo et al., 1985; Evans et al., 1985),

and included typical DSS elements; i.e. a database, an algorithmic engine, and a user-interface. During the same period, the evolution of information technology provided the opportunity to combine vehicle routing DSS with geographical data, in an image form, in order to enhance user support.

Brown and Graves (1981) have developed a system for real-time dispatch of petroleum tank trucks, whereas Powell (1986) has presented a stochastic model of the dynamic vehicle allocation problem, as well as a system for real-time optimization for truckload motor carriers (Powell, 1990). Brown et al., (1987) have presented a real-time wide area dispatching system for Mobil tank trucks, and Ritchie and Prosser (1990) have developed a real-time expert system approach to freeway incident management.

During the 1990s, the emergence of Geographic Information Systems (GIS) permitted the display and manipulation of spatial information, and, thus, supported the realization of a more comprehensive model of the road network, thus, allowing more realistic modeling of path constraints (Keenan, 1997).

Tarantilis and Kiranoudis (2002) present a Spatial DSS to coordinate and disseminate tasks and related information for solving the vehicle routing problem using a metaheuristic method. Its architecture integrates a GIS system, a relational database management system (RDBMS), and special software tools. Zografos et al. (2002) developed a DSS to address Incident Response Logistics (IRL). The system provides functionalities including districting, dispatching of response units, routing of response units, and on-scene management. Gayialis and Tatsiopoulos (2003) developed a DSS that combines a supply chain management application with a GIS system and an ERP system to support planning and management of oil delivery trucks. Tarantilis *et al.* (2003) discuss a DSS that employs a metaheuristic algorithm for solving the open vehicle routing problem (OVRP), i.e. finding a set of routes to be used by delivery vehicles that do not return to the distribution centre. Matsatsinis (2003) presented the design of a DSS for the dynamic routing of a ready-mix fleet. Last but not least, Bertsimas and Van Ryzin (1991) presented a stochastic and dynamic vehicle routing problem in the Euclidean plane, and Savelsbergh and Sol (1998) discuss a system for dynamic routing of independent vehicles.

These systems present different approaches for addressing specific instances of real-time vehicle routing. However, they lack an analysis of the technological infrastructure needed to support real-time inter-vehicle and vehicle/headquarters communication, which is necessary to enable real-time information exchange and decision-making. Such an analysis yields important findings regarding the type of algorithmic approaches that can be realistically implemented in a cost-effective fashion to support real-time

vehicle routing, as well as regarding the technologies that can support these algorithmic approaches. In the next section, we present the results of such an analysis, synthesized into a generic architecture for real-time Vehicle Routing Systems.

5 A Generic Architecture for Dynamic Real-Time VRS

5.1 Dynamic Real-Time Vehicle Management Model

Most solution approaches to the VRP are in practice implemented in a centralized computer resource (normally at headquarters), producing a daily plan to be provided to the vehicles before the beginning of the distribution execution. Some of these approaches have been implemented in commercial systems that are successfully used by numerous transportation, logistics, and manufacturing companies over the last twenty years.

These systems have not, however, been designed to address the case in which the execution of delivery cannot follow the prescribed plan due to some unforeseen event. When there is a need for real-time intervention, it may be necessary to re-compute the plan using new input data. If a typical VRP approach is used for re-planning (i.e. re-planning the *whole* schedule from scratch), many vehicle schedules may be affected, thus causing significant performance inefficiencies (high overhead, nervousness, errors and high costs).

Thus, re-planning based on classical VRP solution methods may not be a realistic option. In the absence of algorithms capable of 'isolating' the part of the VRP affected by the unexpected event in order to minimize the disturbance to the overall schedule, interventions are typically performed manually (for example, through voice communication between drivers and the logistics manager), and the quality of decisions taken is naturally affected.

The need to enhance existing methods, or develop novel approaches, becomes clearer in view of recent advancements in mobile and positioning technologies. Using such technologies, information about unforeseen events may be transmitted when they occur directly from the affected truck(s) through a mobile network to headquarters and/or other parts of the fleet. Given an efficient re-planning algorithm, appropriate and implementable plan modifications may be transmitted back to the fleet in a timely fashion to respond effectively to the new system state.

A real-time vehicle management model is schematically depicted in Figure 2, using control system formalism. The model includes the following:

a) Control & Detection of the system's state: This concerns the selection of the parameters to be monitored, such as truck position, truck speed, truck inventory, and so on. These parameters need to be regularly monitored, as they will trigger intervention if needed. It is noted that interventions may lead to system "nervousness"; thus, the cost of intervention should be balanced against expected benefits.

b) Projection: This concerns the revised distribution plan that will be generated by the system, when it s observed that a vehicle is out of schedule. Typical parameters that cause significant disturbances to the original routing schedule are traffic jams, road works and negative environmental conditions.

c) Decision-making and execution: The selection of the problem objectives has significant effects on the decision-making and execution mechanisms employed. Objectives to be considered may include: minimize the deviation from the original plan, minimize the cost of non-conformance, minimize risk, and others.

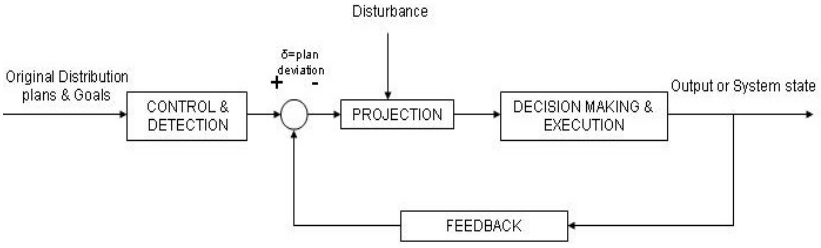

Fig. 2: Systemic representation of a real-time vehicle management system

Important decision-making issues include modeling of the real-time rerouting problem, and development of appropriate solution methods. In this case, problem complexity and computational time play a significant role. The reduction of complexity appears to be a necessary condition in providing timely, implementable solutions. A classic way to reduce complexity is by using a hierarchical approach, whereby, a complex monolithic problem is decomposed or disaggregated to multiple, simpler problems that can be solved independently. The solutions of these lower-level problems are combined to yield the solution of the global, higher-level, problem. By do-

ing so, one needs to consider the trade-off between optimality and computational efficiency.

5.2 System Implementation Issues

The model presented in Figure 2 can be realized through the use of mobile technologies, real-time decision-making algorithms (along the lines presented in the previous section) and back-office automated processing. In addition to providing the appropriate directions to the drivers of the fleet, the customer base may be kept informed in regard to changes in the initial schedule, therefore improving the company's service quality and customer relations.

The proposed system architecture is shown in Figure 3. It comprises three major sub-systems. The *back-end system* consists of a decision-making module to facilitate automated decision making and ERP connectivity. The *Wireless Communication sub-system* allows a two-way communication between the back-end and front-end systems. The *Front-end system* enables a) a robust user interface, and b) interaction between the software platform that is installed in the on-board truck computer and the company's back-end system.

Back-end sub-system

The back-end system is a decision support system that incorporates algorithms needed for real-time routing, scheduling and monitoring of the current state of the fleet, as well as a robust database containing both static (customers, geographical information of the road network, and so on) and dynamic (orders, quantities, time window information, and so on) data. The back-end system also provides ERP connectivity, which is especially useful in ex-van sales to provide information, such as customer sales history, customer credit, and other decision-critical data.

Wireless Communication sub-system

The wireless communication sub-system consists of two parts: a) The *mobile access terrestrial network*, which is responsible for the wireless interconnection of the back-end system with the front-end on-board devices, and b) the *positioning system*, which is responsible for vehicle tracking.

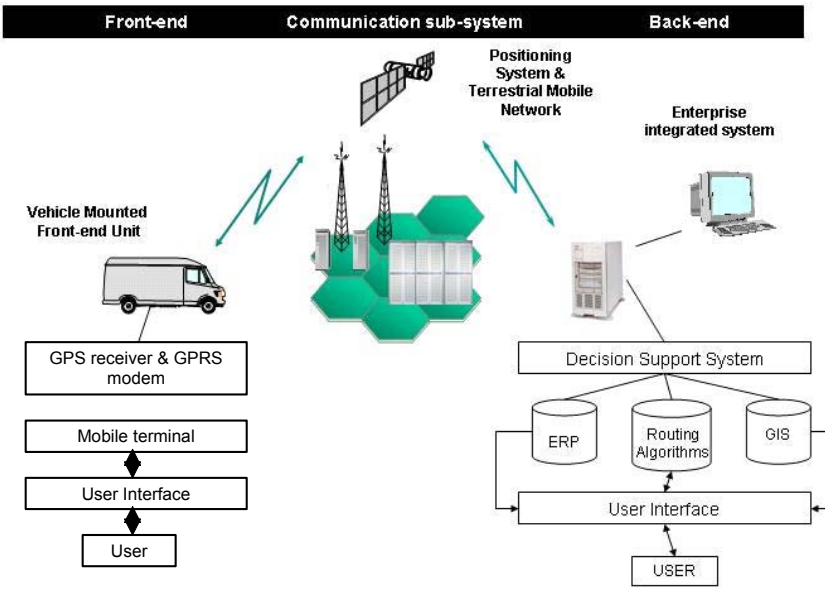

Fig. 3: Proposed system architecture for dynamic real-time vehicle management

The Mobile Access Terrestrial Network can be based on any of a number of existing or emerging mobile technologies (illustrated in Table 2). In examining the options available to support an integrated distribution system, bandwidth is perhaps the most important issue. The bandwidth requirements depend on the computational model chosen. If vehicle onboard devices support much of the computations, then the demand for bandwidth is different than in the case in which much of the computation is performed at the headquarters. In either case, however, the demand for bandwidth is greater when compared to existing applications, such as fleet tracking, graphical representation of real-time information in digital maps, and voice communication.

GPRS, TETRA, and UMTS can provide always-on, packet-switched connectivity and high-speed data rates. GSM is a mature technology. However, it cannot support high-data transmission effectively. GPRS combines high data rates, always-on connectivity, mature technology, and has also been used in fleet management systems. As far as TETRA is concerned, it is worth mentioning that it provides much better security than GPRS, as well as supporting point-to-multipoint voice broadcasting.

UMTS is an emerging standard, and its use cannot be assessed prior to thorough validation testing.

Table 2. Mobile network access technologies

0Type of mobile network	**Availability**	**Maximum Data rates**	**Data Service Provision**
Global System for Mobile Communications (GSM)	Yes	9,6Kbps	Circuit-switched
General Packet Radio Service (GPRS)	Yes	144Kbps	Packet-switched
Terrestrial Trunked Radio (TETRA)	Limited	36Kbps	Packet-switched
Universal Mobile Telecom-munications System (UMTS)	Limited	2Mbits	Packet-switched

As far as the Positioning System is concerned, positional accuracy of less than 100m is deemed acceptable for urban distribution (accuracy requirements can, of course, be relaxed in non-urban settings). An analysis of the technologies that can be used for location identification goes beyond the scope of this paper (a complete taxonomy of such technologies is provided in Zeimpekis et al. 2003). However, Table 3 illustrates the characteristics of some of the most widely used technologies today. GPS appears to be the most preferable solution, since it is a globally available, free-of-charge system.

Table 3. Accuracy of positioning methods

Network	**Accuracy**
Terrestrial beacon	Up to 50m
Global Positioning System (GPS)	100m
Differential GPS	5-50m
Low Earth Orbit (LEO) Satellites	1Km

Front-end system (Access media)

The front–end system generally consists of a mobile device, to which all necessary information is sent from the headquarters. The selection of the front-end device is important both from a user interface and from a computational performance perspective.

Typical mobile devices that can be used on-board include mobile phones, personal digital assistants (PDAs), and Tablet PCs. In their present state, mobile phones do not appear capable of coping with the requirements of the applications under consideration. By contrast, PDAs and Tablet PCs are already used for specific distribution applications, such as back-end ERP connectivity. These devices include high-resolution displays, wireless networking capabilities, and integrated support for peripherals (such as barcode readers).

6 Conclusions and Research Directions

Real-time vehicle management is important in supporting supply chain execution systems, and minimizing the related logistics risks. It has been demonstrated that a good, near-optimal, distribution plan is necessary but not sufficient for high performance distribution. This needs to be complemented by the ability to make and implement sophisticated decisions in real –time, in order to respond effectively to unforeseen events. The emergence of technologies and information systems allowing for seamless mobile and wireless connectivity between delivery vehicles and distribution facilities is paving the way for innovative approaches in addressing this requirement.

In order to develop robust, practical approaches to the real-time vehicle management problem, research efforts should focus on three fronts: systems design, decision support methods, and system implementation.

In the first area, significant issues to be tackled include the definition of the system's objectives (minimize cost, risk and/or deviation from the original plan), the observability of the system's state, balance of intervention costs vs. expected benefits, the extent of interventions (local vs. global), and other parameters. System designs cannot be generalized beyond the extent achieved in this paper due to their heavy dependence on the characteristics of the problem addressed, and the algorithmic approach chosen for intervention. Therefore, future research can assess alternative design specifications against real-life case studies of real-time vehicle routing problems.

In the second area, a review of the vast existing literature on the vehicle routing problem has indicated that some research is relevant and can be used as a basis for the development of appropriate enhancements and/or novel decision support approaches in real-time vehicle re-planning. In this case, problem complexity and computational time play a significant role in system effectiveness.

In the implementation area, it appears that there exist mature technologies to sufficiently address the requirements of the real-time vehicle management system. In terms of the communication subsystem, GPRS and TETRA are appropriate mobile access networks, while GPS technologies meet all the related positioning requirements. For the front-end system, PDAs and Tablet PCs have significant potential, since both their interface capability and computational power support efficient user interaction and the local computational system requirements, respectively.

All three fronts discussed above present interesting challenges with significant implications for both VRP-related research and the technology that will support effective logistics execution.

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Bargaining and Alliances in Supply Chains

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1 Introduction

Negotiation is a common and important activity in many organizations. Within an organization, pay scales, work schedules, budgets, etc. are often negotiated between various parties. From an inter-organizational view, negotiation is possibly the most common method of drawing up contractual terms, settling disagreements, etc. between supply chain partners. The number of seminars and workshops that are designed to improve the negotiation skills of top-level management is ever on the increase. Indeed, considerable energy has been spent by academics in characterizing the type and importance of negotiations between firms in various sectors. Some examples include Bonaccorsi et. al. (2000) who claim that in medical supplies procurement, negotiation is often the norm especially when quality is uncertain. Bajari et. al. (2002) argue that in the construction industry 43% of all projects are awarded using negotiation while the rest use some form of auction. The Taiwanese semi conductor industry association (TSIA, www.tsia.org) reports that over a third of all contractual terms between its members and OEM's are negotiated. Helmberger and Hoos (1965) provide a seminal analysis of negotiations in fruit and vegetable markets. Iskow and Sexton (1992), Worley et al. (2000), etc. are other examples of recent research that largely describe existing bargaining institutions and contracting in commodity sectors. Other examples include timber procurement, the automobile industry and retail. Thus, adopting a negotiation framework to examine profit allocations among supply chain partners seems very natural.

In this article we concentrate on the retail industry, specifically we provide a framework to analyze the negotiation process relevant to procurement contracts and provide some important results. The current Operations Management literature presents, discusses and analyses several different procurement contracts. Most of this work focuses on two important questions: The possibility of coordinating the channel, and the mechanisms that coordinate the channel. For a good review of this literature, see Cachon, (2002). A vast portion of the contracting literature establishes that it is indeed possible to coordinate the channel by explicitly presenting mechanisms that achieve this objective. Moreover, many of these studies demonstrate that there are infinitely many ways to coordinate the channel. While all these mechanisms coordinate the channel, they differ in their allocations of the channel profit (pie) to the various players in the channel. Clearly, in any supply chain, every firm/player is individually rational and is interested in maximizing his/her share of the profit. This naturally results in the different players negotiating to get as large a share of the pie as possible. The existing contracting literature in supply chain management ignores this important issue and assumes that the negotiation process is exogenous to their analysis.

To illustrate this point, we mention just few contracts: (1) The "Buy-Back" contract. When a "Buy Back" contract is used, the supplier is willing to buy back, at a negotiated price, all or a part of the excess inventory that the retailer did not sell during the season. Assuming such a contract, the retailer and the supplier will negotiate the wholesale price, the buy-back price and the quantity that might be bought back at the end of the season, and of course the initial quantity purchased by the retailer. The Vendor Managed Inventory contract can be viewed as a special case of the Buy-Back contract. In this case, the supplier basically buys back the entire excess inventory at its full price. Buy-Back contracts are common in the book and toy industry. VMI system is a common practice in many industries and is almost the norm in the food industry. (2) Another type of contract is the Revenue-Sharing contract in which the supplier and the retailer agree to share the retailer's revenue in a certain way. Here, the two parties negotiate and agree upon the wholesale price of the product and the fraction of the revenue that each party will get. Such a contract was common in the video renting industry. These are only two examples of several kinds of procurement contracts that are widely used in the retail industry and were extensively studied in the Operations management literature. As mentioned above, the objective of researching such contracts is to study ways and suggest mechanisms to better coordinate the entire channel, or in other words, to maximize the sum of the suppliers' and the retailers' profits, and, at the same time, to ensure that all participants benefit from such

contracts. It was demonstrated that given the above two contracts, it is possible to devise mechanisms that actually coordinate the channel, and improve the profit of all the participants. For example, using the Buy-Back contracts it was demonstrated that it is possible to find buy-back and wholesale prices such that it is in the best interest of all players to coordinate the channel. Moreover, it was shown that there are infinitely many ways to coordinate the channel (infinite number of pairs of buy-back and wholesale prices that coordinate the channel). While all these pairs coordinate the channel they differ in the way they allocate the profits to the different participants.

In these studies, very little attention, if any at all, has been paid to the negotiation process itself. While the channel profit is maximized, it is not clear what share of the profit each of the players obtains. In addition, the negotiation process may affect the structure of the supply chain, the variety of products that are offered by each of the players, the structure of the alliances that are formed, and the existence of intermediaries that provide efficiency in the negotiation process. In particular, this crucial issue of the effect of the negotiation process on the very structure of the supply chain is completely ignored in the extant literature. Studying the negotiation process explicitly, we show that the widely believed notion that by forming a group, individuals increase their negotiation power is not always valid. Thus, it is not always true that suppliers should join forces and form a coalition to increase their negotiation power. Similarly, we also show that it is not always true that a supplier with a large variety of products can extract larger profits as compared to several suppliers each providing a small variety of products.

2 The Problem

In this article, we consider a single retailer that sells N different products packaged in one basket. For example, the retailer may sell a high-end gift basket with an assortment of several cheeses, jams and meats in a single basket. The retailer purchases a single product from each of the N different suppliers, packages them together and then retails them for a certain value. Clearly the retailer negotiates for the best terms (i.e. cost) with each of the suppliers. We assume that the retailer faces random demand for the final product (the gift basket). We also assume symmetric information, that is, all players have the same information with respect to costs, profits and demand.

This example merely provides a motivation to our problem. Indeed, though gift baskets are quite common, the situation can be easily abstracted to describe scenarios where a retailer (or a service provider) may bundle several products (services) purchased from various firms and provide a packaged bundle at a high premium.

3 The Bargaining Framework

The actual manner of negotiations between agents in a supply chain can be quite complex. We do not presume to model these exact processes or their specific outcomes. Often, we take a diluted view of reality by making several simplifying assumptions. We use as a building block the Nash bargaining (NB) concept. Nash engaged in an axiomatic derivation of the bargaining solution. The solution refers to the resulting payoff allocation that each of the participants unanimously agrees upon. It is not our intention to provide a detailed discussion of the axioms and the Nash Bargaining solution concept. The interested reader can find a very good discussion of these issues in Roth (1979). Nash has shown that there is a unique allocation that satisfies all the axioms. The Nash Bargaining solution ensures that the unique allocation (a_1,a_2) is the outcome of maximizing the following expression:

$$(u_1(a_1) - d_1)\ (u_2(a_2) - d_2) \quad (1)$$

where u_1 (u_2) is the utility of the first (second) player, d_1 and d_2 are the so-called disagreement points of the two players. The players will not be willing to accept less utility than their disagreement points. Note that if the players are risk neutral then:

$$a_1 - d_1 = \ a_2 - d_2 = \frac{\pi - d_1 - d_2}{2} \quad (2)$$

where π is the profit (pie) to be allocated. The essence of this observation is that risk neutral players get the same effective profits (difference between allocation and disagreement point). This raises the important issue of how to capture negotiation power when players are risk neutral. We will discuss the issue of negotiation power shortly.

The axiomatic approach, though simple, can be used as a building block to discuss more complex bargaining problems. However, this approach

fails to describe any actual negotiation process - for instance, that of players making offers and counter-offers. This leads one to wonder whether the Nash bargaining solution, although mathematically elegant and simple, fails to accurately model real life negotiation scenarios. Fortunately, Rubinstein (1982) has proved that non-cooperative models in which players make alternating offers, when parameters are assigned appropriate values, yield results identical to the Nash bargaining solution concept. This seminal result justifies our approach as we resort to the NB concept, and greatly benefit from its inherent simplicity.

As mentioned above, the Generalized Nash Bargaining solution concept provides us with the building block for our model. Following Nagarajan and Bassok (2003), we extend the negotiations between the retailer and a supplier to negotiations between a single assembler and N suppliers. Since the retailer puts together a product that uses services or sub-products from each of the N suppliers, the individual interactions (viz. negotiations) need to be captured. In order to do so, we adopt a sequential framework in which the retailer negotiates with each of the suppliers separately, one after the other. Despite the apparent length and cumbersomeness of this process, several examples indicate that sequential negotiation is quite prevalent. A recent article (WSJ, FEB. 28, 2003) describes how state health officials meet with drug companies (GlaxoSmithKline, Merck & Co, Pfizer etc.) sequentially to negotiate the prices of drugs. Another article (WSJ, Mar, 10, 2003) describes the sequential negotiation approach used by Iberia Airlines in negotiating with Airbus and Boeing when shopping for jetliners. Unions in the automobile industry and the construction industry routinely engage in pattern bargaining, which is essentially a sequential approach. These examples may not exactly fit with the model in this article. However, they do demonstrate that sequential negotiations are quite commonplace. Furthermore, in our framework, it may make little sense to consider a simultaneous negotiation process, for the number of suppliers could be large and their roles are complementary. Thus, it is unlikely that a simultaneous negotiation between all players is a natural choice. Thus, the retailer first negotiates with supplier 1, and then with supplier 2, etc., and finally with supplier N.

This type of negotiation process raises some very important questions: Is the negotiation sequence important? If it is important, how would the retailer prefer to sequence the negotiations with the suppliers? How would the suppliers prefer to sequence the negotiations? Indeed, what would be the resulting stable sequence? Would they form a coalition to increase their negotiation power? We model the interactions between the suppliers and the retailer by a three-stage game.

4 Negotiation Power

At this juncture, it may be pertinent to briefly explain how we model negotiation power between the agents. The Nash bargaining model, when originally presented, found a way of allocating a pie, given the risk preference of the two players negotiating on its allocations. The allocations depended on their preferences and a disagreement outcome that each player brought to the table. This disagreement outcome has various interpretations. A common approach is to assign them values such that each player will walk away from a negotiation whose outcome promises him/her less than the disagreement value. We interpret this value as the costs that a player may accrue in this supply chain. For any supplier, this could be manufacturing and production-related costs, for the retailer this includes the costs involved in putting together the gift basket, etc. As mentioned above, when the players are risk neutral, the Nash bargaining solution consistently assigns the same negotiation power to all players. While we choose to assume that the different players are risk neutral, we would like to assume that they don't have the same negotiation power. We can capture different negotiation power by introducing the notion of commitments.

It is not uncommon to see players or firms in several bargaining situations take actions prior to the actual negotiation process that may partially commit them or strategically force them to a certain negotiating position. This tactic, though very common in the political arena, is not alien to business situations. Cutcher-Gershenfeld et al. (1995) point out that in negotiations involving industrial relations, commitments are very common. Other instances include retailers spending money advertising future price promotion schemes before negotiating wholesale prices with suppliers, companies having stock holder meetings and making strategic announcements before entering negotiations with another firm, etc. Indeed, a very good illustration from Schelling (1960) is as follows: "It has not been uncommon for union officials to stir up excitement and determination on the part of membership during or prior to a wage negotiation. If the union is going to insist on $2 and expects the management to counter with $1.6, an effort is made to persuade the membership not only that the management could pay $2 but even perhaps that the negotiators are incompetent if they fail to obtain close to $2. The purpose… is to make clear to the management that the negotiators could not accept less than $2 even if they wished to because they no longer control the members and could lose their positions if they tried to. In other words, the negotiators reduce the scope of their own authority and confront the management with the threat of a strike that the union cannot avert, even though it was the union's own action that elimi-

nated its power to prevent strike." Clearly, it may happen that a player (the union) will have to back off from a previously made commitment at a revoking cost to the player.

Our approach follows the work of Muthoo (1996). Rather than actually describing the process of making a commitment, it is assumed that the suppliers and the retailer announce (by choosing) their commitments to receiving at least a certain allocation of the pie. This announced allocation is more than their disagreement outcome. Indeed, since these commitments are made independently and are announced simultaneously, it is quite possible that a feasible allocation of the pie is not feasible. Faced with such an alternative, players revoke their commitments. Revoking partial commitments is costly. This cost (modeled proportional to the amount revoked) symbolizes the reputation that a firm brings to the table for being a tough negotiator. Thus, a high cost of revoking commitments implies a higher reputation for being tough. The process of making early commitments and than revoking them at a cost to achieve a feasible solution has a unique Nash equilibrium. In this equilibrium, the commitments made yield the final allocation of the pie. Indeed, as expected, the player with the higher revoking cost receives a greater share of the pie. It can be shown that using this approach the negotiation power can be captured in a generalized Nash Bargaining concept. Using this concept, the allocation to each player is obtained by maximizing the following equation:

$$(a_1 - d_1)^{\gamma_1} (a_2 - d_2)^{1-\gamma_1}$$

where γ_1 captures the negotiation power of player 1 (related to his/her revoking cost) and $1-\gamma_1$ is the negotiation power of the second player.

The attractiveness of this approach is two-fold. First, the use of commitment tactics allows us to preserve risk neutrality and obtain structural and constructive results. Second, when players with equal revoking costs form a coalition, it is reasonable to assume that the effective revoking cost of the coalition is merely the average of the individual costs. This allows for modeling the negotiation power of a coalition.

4.1 The First Stage in the Negotiation Process

At the first stage the retailer who faces random demand must decide on how many baskets to stock in expectation of the demand. Notice that, at this stage, making the stocking decision seems to be quite difficult. The reason is that the retailer does not yet know the wholesale price he will pay for each of the products, and thus he/she can't estimate the cost of the bas-

ket. These prices will be determined only at a later stage, when the negotiation process is concluded. On the other hand, the retailer can easily determine the purchasing quantity that will coordinate the channel (the sum of profits of the retailer and the supplier). We will show shortly that it is in the best interest of the retailer to purchase this channel-coordinated quantity.

Assuming that the retailer purchases the channel-coordinated quantity, then the expected profit of the channel is known to all players. Now the retailer negotiates with each of the suppliers. The result of the negotiation process is the price of the product that a supplier sells to the retailer. Assuming that the retailer purchases the channel-coordinating quantity, determining the price of the product is equivalent to determining the share of the profit of the supplier. Thus, from now on, we will say that the retailer negotiates with the suppliers on the share of the profits that each of them will obtain. Clearly, the share of the profit that a party obtains depends on the party's negotiation power. The generalized Nash bargaining solution indicates that the effective profit of the retailer is: γ_R of the effective expected profit (the pie):

$$(a_1 - d_1) = \gamma_R(\pi - d_R - d_S)$$

while the supplier gets γ_S of the pie. Recall that the retailer negotiates with the suppliers in a sequential manner. Thus, the retailer share of the profit after negotiating with supplier *i*, will be allocated further between the retailer and the N - i suppliers. For example, suppose that the channel profit (pie) is equal to \$100 and the $\gamma_R = 0.9$, the negotiation power of the first supplier is $\gamma_{S,1} = 0.1$. The first supplier gets \$10 and the retailer gets \$90, which will become the pie to be negotiated between the retailer and the next N-1 suppliers. At this juncture, we are able to determine whether and how the negotiation sequence matters. We are able to show that the retailer is indifferent to the negotiation sequence. On the other hand, we demonstrate that the suppliers would like to negotiate as early in the sequence as possible.

4.2 The Second Stage in the Negotiation Process

The preference of the suppliers to negotiate as early as possible leads us to the second stage of the negotiation process. Since the suppliers prefer an earlier position in the sequence, they will try to convince the retailer to ne-

gotiate with them as early as possible. They can achieve a better negotiation position by offering the retailer a lower price for their product. This is equivalent to them accepting a smaller share of the pie, meaning that they are willing to transfer a share of their allocation back to the retailer. Thus, the suppliers will actually compete with each other for a better negotiation position. We show that when the suppliers are equally powerful, there is a unique equivalence class of Nash equilibria for this game. In any equilibrium solution in this class, each of the N suppliers receives exactly the same share of effective profits as the supplier who negotiates last. Thus, naturally, the retailer benefits from the destructive competition among the N suppliers.

In all of the above discussion, the total size of the profit pie does not qualitatively affect the results. Indeed, we show that the allocations of the different players in the equilibrium, increases proportionally with the size of the profit pie. Thus, it is clear that the retailer will choose the pie that maximizes his own profit. This results in him/her purchasing the channel-coordinating quantity from each of the N suppliers. This property remains unaffected in the subsequent stages of the game, when the suppliers form alliances among themselves.

4.3 The Third Stage in the Negotiation Process

At the final stage of the negotiation process, the suppliers may join forces and form coalitions and sub-coalitions to increase their negotiation power and share of profits. This raises the important and interesting question of how to model the negotiation power of a coalition of players. Since we assume that all suppliers have the same revoking cost, it seems natural to assume that the coalition also has the same revoking cost, and thus the same negotiation power as its suppliers.

When modeling and analyzing the process of coalition formation, several questions present themselves. One needs to find a model that is mathematically elegant and, at the same time, descriptive in that it captures the coalition formation process accurately. We borrow from the realm of cooperative games to model and understand these phenomena. Till recently, cooperative game theory essentially modeled the formations using a static framework. This inhibited the description in at least two ways: First, it assumed that the value that a group of players can achieve by forming a coalition is independent of the actions of those not in this group. In the context of the model in this article, the pay-offs accrued by a group are dependent on the actions of the non-members. Thus, if suppliers 1 & 2 decide to form an alliance their allocations are affected by the coalitions

formed by players 3 through N. Second, it predicted the stability (instability) of a status quo outcome based on whether a single defection by any group from the status quo would occur. This imposed the restriction that players are myopic, and cannot contemplate the possibilities of future defections and coalition formations.

Two recent papers by Chwe (1994) and Konishi and Ray (2000), attempt to address this issue. Following Chwe (1994), we use the notion of the largest consistent set (LCS) to analyze the stable supplier alliances. The LCS is best described as the set of possibly stable farsighted outcomes. Using the commitment approach, we vary the negotiation power of the suppliers and the retailer. Since we assume that suppliers are equally powerful, we will present our results as a function of the retailer's negotiation power. Thus, given a certain profile of the retailer's power (and consequently the individual supplier's negotiation power), we can predict the evolution of supplier coalitions and the stable outcomes, with the assumption that players are indeed farsighted.

Using this framework, we are able to show the following: When the retailer is very weak, the suppliers gang up on him by forming a grand coalition of suppliers. Indeed, we show that this is the unique structure of the supply chain. When the retailer becomes increasingly powerful, we show that the suppliers start splintering from the grand coalition, and several smaller coalitions start appearing as stable outcomes. Indeed, when the retailer is extremely powerful and possesses very high negotiation power, then the suppliers are better off by negotiating with the retailer individually. In fact, this is the unique stable supply chain structure. In each of these scenarios, we calculate the allocation of the supply chain profit that each coalition and the retailer have received.

Before concluding, we need to reflect on the comments made in this article. When speaking of negotiation power, we mentioned one aspect. The aspect that we elaborated extensively in this article is an artifact of the economic model that is used to capture the bargaining process. Our choice of the Nash Bargaining implied that the ability to make credible commitments (as demonstrated) affect the individual negotiation power of the players. This aspect captures that part of negotiation power that may be absolute and unique to a player. The second aspect that we never explicitly alluded to was extraneous to the choice of the model. Having completed our analysis of the supply chain, we are now in a position to expound this feature. Recall that we assumed that all players are risk neutral and the suppliers have identical revoking costs. The retailer, at the first stage, chooses a sequential negotiation process. The outcome dictated that he/she received a rather small portion of the profits. Indeed, at this stage, the retailer preferred to have as few suppliers as possible. However, this imme-

diately gave rise to a situation where the suppliers competed for positions in the negotiation sequence. Competition among the suppliers immediately increased the bargaining position of the retailer. This, though an artifact of the model, is quite natural. Indeed, the fact that the suppliers were in competition reversed the retailer's preference for the number of suppliers. The determinants of negotiation power in a supply chain are manifold. Clearly, competition is one of them, and we demonstrated its impact on our supply chain. The ability to form alliances is another. The final section of our article precisely addressed this aspect. The suppliers retaliate by forming coalitions. Note that we did not empower the negotiation power of the coalition extraneously. We assumed that the effective revoking cost of the coalition is exactly the average and, thus, equal to the revoking cost of any individual supplier. However, by forming coalitions, the suppliers affected the structure of the supply chain. They traded off the benefits of competing for a position in the negotiation sequence with the number of times they would negotiate with the assembler. Once again, this changed the negotiation power of the suppliers as well as the retailer.

One can ask if such coalitional structures are seen in practice. Is our example of the retailer selling gift baskets relevant? The retailers selling high-end gift baskets do not negotiate with individual suppliers who manufacture the products that are part of the basket. They rather negotiate with distributors who sell them pre-packaged assortments. Companies such as Cisco Systems do not purchase components from individual suppliers, but rather trade with sellers of kits of components (ex. Solectron). A supplier of a kit of components can be thought of as a virtual coalition. In another example, TSIA reports that it provides a platform for smaller suppliers to come together and negotiate trade terms with manufacturers from overseas. These platforms usually involve a coalition of semi conductor component manufacturers who trade with a buyer. We are in no way suggesting that outsourcing or the existence of virtual coalitions can be fully explained through our model. The reasons may be manifold.

Another aspect of our results addresses the trend in several supply chains, towards manufacturers and retailers preferring to have fewer suppliers. Well, how few is fewer? Our model suggests that due to the effects of transaction costs and negotiation power, it may not always be advisable to just have one supplier or at the other extreme, a whole lot of them.

We are not in any way suggesting that the model and the results thereof are complete or general. Indeed, the issues at hand are much more complex, and our model pertains to a supply chain with a very specific structure. We believe that future research should focus on modeling negotiating power as a function of risk aversion, competition among suppliers manufacturing similar components, etc. It will also be interesting to model and

understand negotiation situations in which the different parties posses asymmetric information. An issue of interest is to model negotiation power exogenously as a function of the position in the sequence. Indeed, one could argue that a supplier who comes last in the sequence may have more negotiation power, as his/her ability to veto may be quite costly to the assembler. This can be accommodated in our framework by letting the cost of revoking commitments be a function of the position. Indeed, the question of an equilibrium set of payments (position) is to be reckoned with. This is an important and interesting extension. Our results on coalition structure are sensitive to the definition of stability that we use. A broader notion of stability and the examination of the results thereof are important topics for future research.

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Last-Mile Supply Chain Integration: Easy Connection and Information Exchange between Suppliers and Retailers

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1 The Past: Developing the Need

Many contemporary Small-Medium Enterprises (SMEs) have been investing in IT solutions over the past few years in order to automate and streamline their internal business processes, following the trend of larger, national and multi-national organizations. Even though these enterprises have been successful (in one way or another) in maintaining inventories, semi-automating their ordering systems and customer management, they still lack the ability to leverage the real power of interconnectivity and *external* automation with their business partners.

Indicatively, some of the issues that concern businesses – regarding the external automation of their processes – are summarized below:

1. Minimize costs of receiving/sending/processing thousands of business messages monthly (like manual data-entry, administrative tasks, etc.).
2. Automatically update inventories, in order to minimize manual inventory measurements.
3. Have accurate information for category management.
4. Reduce lead times (order-delivery, introduction of new products, promotions, payments, etc.).
5. Have real-time information on their business associations (like buyers, suppliers, logistics, distributors, representatives, etc.).
6. Receive and process real sales data (from POS, etc.).

Both Suppliers and Retailers have had a clear view that the business process automation could eventually result into faster lead times, less cost and price reductions. And even though some of them (the larger ones -

mostly multinationals) have planned to strategically tackle these issues by adopting (mainly) EDI technologies, it was not clear how the smaller ones could follow on– especially due to the high costs involved (new investments in costly IT solutions, replacement of existing infrastructure, exclusive connections to proprietary VANs, large administrative cost, lack of appropriate personnel skills, long-running implementations, etc.). This resulted into a "two-speed" marketplace with serious problems. EDI has only been used by the "elite" to allow business communication "between the members of the team", while – on the other hand – those members still need to do business traditionally with the bulk of smaller suppliers that only have faxes and telephones.

Talking specifically about the Greek market and after ten (10) years of EDI presence in Greece, this technology did not have the initially awaited results. Its penetration is minimal, which is due to many reasons:

- The total implementation and maintenance cost is prohibitive for the majority of Greek enterprises (like 99,7% SMEs).
- Dedicated IT personnel, is required for maintaining the systems.
- EDI-aware software is required, which can be a tremendous problem for enterprises that want to use it, without having to replace their complete internal infrastructure and re-educating their personnel.
- A lot of customization is required for EDI to actually work: using a common standard is not always the key to success, since separate customization, data analysis and – sometimes – development is required. EDI enforces standards that, sometimes, not everyone can follow.
- Traditionally EDI and the existing transaction networks do not support intelligent mapping from one business document (catalog, order, invoice, etc) to another but - rather - a simplified business logic without embedding business rules (like minimum order quantity, promotional product codes mapping, etc.) when exchanging data.
- Assuming an enterprise is already using EDI, adding a new business partner requires additional work. As a result, multiple (N*N) connections are still required, resulting into overall system complexity and advanced risk of malfunction.

2 A Market Approach

SMEs play a major role in the European Union's business economy, accounting for approximately two-thirds of employment and 60% of value added in the EU.

If we were to discuss about the Retail sector, we would find out that it is characterized by intense competition at a pan-European level, especially for SMEs. Nowadays, SMEs have to face major problems, such as: sales decrease, mistakes and problems from inefficient collaboration with their business partners, cost rises due to the incomplete fulfilment of orders, decrease of profit margins and, overall, complexity of commercial transactions.

Specifically for the Greek market, SMEs account for almost 99.7% of the total Greek companies. Even though EDI has existed in Greece for almost 10 years, the number of enterprises using the relevant services is only about 35. According to a survey we conducted, especially for the Retail Sector, we find that there is an enormous market that is not currently being served (Table 1).

Table 1. Supermarkets/Grocery Retail Market not being served

	Suppliers	**EDI**	**Internet Based**[4]	**Not served**	**% not served**
1. Pure Grocery	405	13	20	372	91,85%
2. Fresh Assisted Sales	424	3	3	418	98,58%
3. Fresh Self Service	175	8	3	164	93,71%
4. Bazaar	274	5	25	244	89,05%
5. Electric Appliance	112	4	0	108	96,43%
6. Textile	89	0	0	89	100,00%
Total	1479	33	51	1395	94,32%

EDI: number of suppliers using traditional EDI solutions (mostly large enterprises already having an investment in EDI).

Internet-based: New electronic connections that use the Internet as the communication channel for business document exchange among partners

Not served: Supermarket Suppliers in Greece – (EDI plus Internet-based)

It is clear that both at a European level and locally (in Greece), there is a tremendous number of SMEs that would like to automate their business exchanges but *lack the enablement service*.

[4] Refers to Internet-based business document exchange services.

3 The Present: Realizing the Shift

Currently, worldwide new transactional networks are emerging, providing alternatives to EDI solutions by enabling enterprises to interconnect over the public Internet. However, the majority of these networks do not provide any value-added services (which are required especially by Suppliers). For example, most of these networks provide forms-based EDI (or Web-EDI) or plain EDI exchange over the Internet; the former is a limited solution, since the receiver still needs to do manual data-entry; the latter simply avoids the networking cost (of the private VAN), but still requires a lot of investment in EDI-aware software at each end. WebEDI is like "web fax", meaning that it is not actually a flexible solution, since it benefits only the retailers (or – in general – "information senders" that have already invested in EDI) without really taking into account the *service* it provides to the suppliers (or – in general – to "information receivers").

Both these approaches lack one important factor: they lack *intelligence* between the ends: in an ideal world, where both Suppliers and Retailers would share the correct information, there would not be any need for intelligence at the Service Provider level. However, since this is not the case, Application Providers can apply *intelligent business rules* (like product mapping control, information checking, i.e. minimum order quantity, packaging issues, etc.) in order to provide true end-to-end integration between Suppliers and Retailers.

These intelligent business rules apply regardless of the *format* required by each end: for example, in the EDI world everyone had to understand the specific EDI version per message type (like EDIFACT ORDER D96A); in case a peer (Supplier or Retailer) decided to upgrade to a new format (like ORDER D97A), then *n* peers will also have to upgrade their systems to support the new standard. This *lack of flexibility* has started affecting existing EDI customers, who want to be more focused on their business than on the supported EDI formats. As such, the new business exchange services require that *communication is irrelevant to the language of the exchanged information*, since there could be an in-between translator that can speak the respective "languages". For example, a successful contemporary scenario would call for an organization standardizing on a format of their choice (like – let's say – some XML-based format) but being able to exchange business information with *any* business partner, regardless of the standard format each partner uses (like EDI, XML, ASCII, Excel, Access, etc.). The success of such a scenario depends on the capabilities of the Provider to bridge the chasm of communication ("language") among the partners.

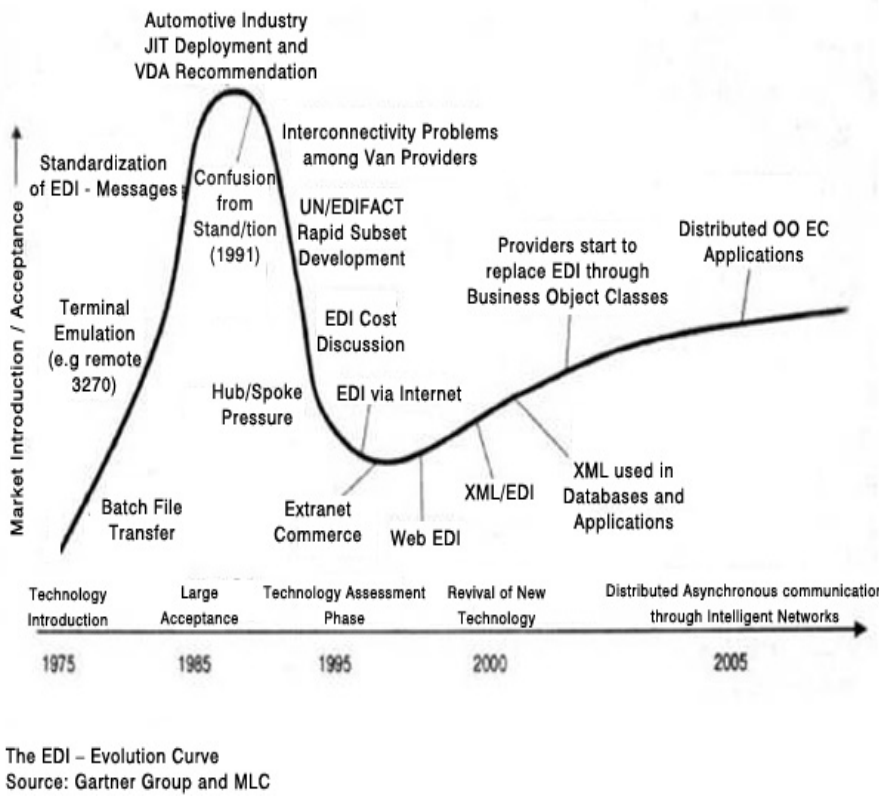

Fig. 1: Replacement of EDI

As depicted in Figure 1, after the EDI blow and deflation, there has been a steady – though low – uptake of evolving electronic exchange services that take advantage of relatively new technologies like the World Wide Web, XML and Distributed programming. The development of intelligent thin clients that can operate in accordance to a central service is the next step, where enterprises outsource the difficult tasks of internally maintaining one-to-one electronic relationships.

Moving towards distributed applications that leverage all the new IT developments, EDI is gradually replaced as a standard for electronic document exchange, and the market opens up to new intelligent transaction networks that are flexible enough to operate on multiple document standards and formats with a focus on XML. This is also the paradigm of Internet-based business document exchange services.

4 The New Trading Exchange Paradigm

The new Internet-based trading hubs (IBTHs) combine the benefits of EDI (structured data formats) and WebEDI (Internet-based delivery) and extend these by adding intelligent transportation, transformation, tracking and notification services, in order to provide a complete, easy-to-use and flexible integration platform that is attractive to both large and smaller enterprises. Such sophisticated Internet-based trading hubs can be the basis for extra value-added services, like CRP (Continuous Replenishment), VMI (Vendor-Managed Inventory), etc.

This section provides insight into the services provided by contemporary IBTHs in terms of the issues discussed in the previous sections, and is based on our research both in the local (Greek) and the international (European and North American) markets.

4.1 Concept Overview

IBTHs provide intelligent integration services among business partners, across the entire Supply Chain, services that can apply to multiple business sectors like Retail, Pharmaceutical, Automotive, etc. They (should be able to) allow for easy and secure business documents exchange between multiple business partners, disparate data formats and heterogeneous systems, providing simple yet powerful business document integration between enterprise applications.

Common services provided by IBTHs are:

1. Enterprise Connectivity Services
2. Other Enterprise Services, such as business connectivity among special business partners also known as local distributors or representatives

The major goal of IBTHs is to establish electronic data exchange networks for secure and reliable business document exchange among business partners that are simple to use and require a minimum initial investment. From an IT perspective, such services provide a set of transportation and transformation services at a central processing "hub", as well as a set of client tools at each participating business partner ("spoke"), providing simple, yet powerful application integration between enterprise applications. The services in question realize a fundamental transformation in the way businesses transact in order to:

- allow businesses to achieve better control over their business processes, in a managed, automated way, find inefficiencies in the existing proc-

esses and eliminate them, gain cost reductions through an inexpensive channel, augment personnel productivity;

- allow businesses to maintain high quality information stored in the internal systems.

The concept of IBTHs is based on the following functionality layers (Figure 2):

1. Light, distributed, service-oriented (SO), Web Services-enabled application: this thin client is able to handle communication (including transportation, transaction monitoring, security, polling, etc.) both with the Central Service (Hub) and the internal ERP/application.
2. Central Mapping Repository (CMP): working at the Hub level, it is the application that can handle (store, extract, process, map, etc.) disparate data formats, map fields among different specifications, and generate outgoing files regardless of content.
3. Intelligent Business Rules (IBR): this is the application add-on that can dynamically process incoming data, maintain and apply business rules (in terms of "condition-action" relationships) on incoming and outgoing data.
4. Inter-organizational, Process-oriented Workflow (IPW): the application that manages the logical series of steps that need to be taken for a specific one-to-one business relationship.
5. Advanced Notification Services (ANS): the application that communicates the outcome of specific steps that relate to the overall process workflow back to the original stakeholders.
6. Real-time Monitoring (RTM): a (mostly internal) service that allows instant insight into the overall data processing, including status tracking, performance monitoring, etc.

Concerning their *main features*, these secure network services:

1. are turn-key solutions (no additional investments – like IT personnel, new hardware/software, etc. – are required)
2. are based upon standard Internet technologies, so that they are capable of integrating with any type of back office systems.
3. work with standards but do not impose them.
4. are based on the use of the latest security and trust technologies, in order to provide the best possible security, confidentiality and trustworthiness for the commercial transactions exchanged through them.
5. have interoperability as their main tenet, so that they can cooperate with all existing and future commercial applications that are based on standard industry technologies.
6. provide easy end-to-end integration.

7. function as the base solutions required to move towards a full business supply chain integration solution.
8. can be rapidly (in some cases in just 3-5 days) deployed in most standard SME cases
9. can be used with *any internet connection* (even dial-up) and *any entry-level PC*

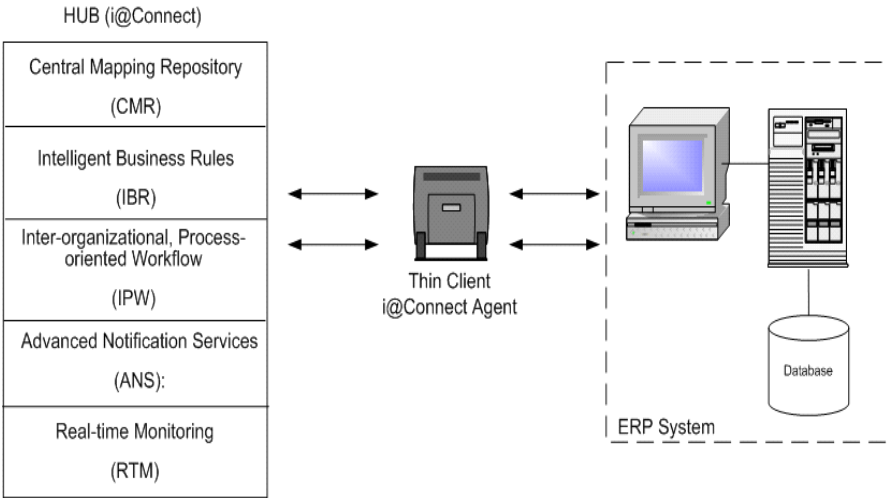

Fig. 2: IBTH Indicative Service concept

IBTHs are important since:

1. they provide rapid Return On Investment (ROI) - even from the first few months of usage - and tremendous cost reductions (by cutting down fixed administration costs or other related costs, e.g. data-entry).
2. their cost is affordable to everyone, even to SMEs.
3. they can directly connect with enterprises that have already invested in EDI.
4. they massively simplify and improve the N*N model, by providing virtual 1*1 connections for all participating partners. In this way, an enterprise that has joined such a service needs not modify *anything* in order to work with other business partners (that have joined the service as well). The IBTH will make sure that information is going to be provided to each participating enterprise in an understandable format.

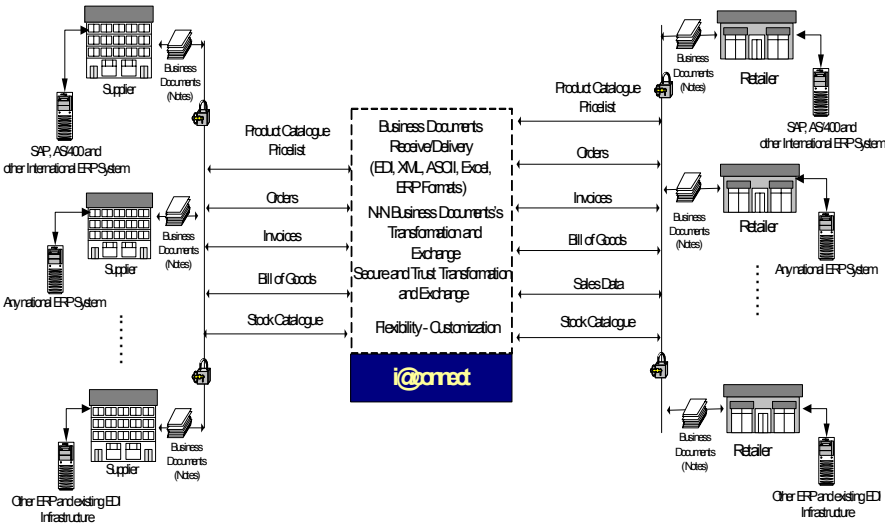

Fig. 3: IBTH Indicative Business Document Exchange

An indicative IBTH Business Document Exchange application is depicted in Figure 3.

5 Using the Internet-based Trading Hubs

5.1 Business Scenarios

IBTH services can apply to multiple business scenarios, in order to streamline the dynamic data-exchange operations among business partners. Some usage scenarios are presented below:

- *Large buyer with its suppliers*: leading buyers (such as large supermarkets) can leverage such services in order to electronically: send orders to their suppliers, receive order proposals from their suppliers, receive delivery notes and invoices, send stock and sales information to their suppliers, receive product and price catalogs from their suppliers, etc. Apart from transporting this data, there is a large workload of data transformation involved (e.g. product code mappings between Supplier and Buyer SKU in case unique barcodes are not in place, etc.).
- *Supplier with its partners*: large suppliers can leverage such services in order to electronically exchange information with some or all of their partners. Here, partners are defined as “special business partners”,

meaning that they can be representatives, 3PL – distributors, resellers, etc. All these partners participate in the supply chain and exchange a large number of business documents (orders, delivery notes, invoices, etc.). All these documents can be electronically handled, so that the business partners can have instant access to information and shorter cycle times.

- *Supply Chain Integration scenario*: supply chain management solutions often lack the integration part of the solution. This may be due to several reasons, one of the most important being the fact that different partners most probably use different internal automation systems, including multiple file formats, etc. That is, even though large investments have been made in streamlining business processes, performing data alignment, etc. still, the partners need to communicate in a way that hides the existing internal complexity and differentiation. As such, there is a specific need for value-added services that will overcome these differences, and provide end-to-end connectivity solutions throughout the supply chain and the partners that participate in specific business networks.
- *Hub-to-Hub scenario*: this scenario includes the provision of integration and connectivity between disparate "business hubs" that are not flexible enough to allow interoperability with others. The described service can act as a broker between these hubs, bringing together business partners that have already invested in other solutions. A concrete example is the EDI VAN users who – despite successfully sending and receiving business documents – they cannot do the same with partners that do not use EDI. As such, the described service can act as the "glue" that will bring the two – or more – service hubs together in a unified and manageable way.

From the above scenarios, it is clear that the business model includes all the actors participating in the Supply Chain. More specifically, these are:

- Buyers
- Suppliers
- Special Business Partners (representatives, distributors, resellers, logistics companies, etc.)

It is very important to understand that each actor can have twofold roles, depending on the "view" of the Supply Chain. For example, an organization can be a supplier for its buyers, and also act as a buyer for its own suppliers. A representative might act as a supplier for its buyers and also be a buyer for its supplier (the company it represents). The main idea behind the IBTH services is that -irrespective of the business model and the actor interactions - they can support the dynamically changing business environment, allowing instant interoperability among business partners.

5.2 Qualitative Business Benefits

An IBTH service provides a set of business benefits to the participating companies:

- Improving and automating the exchange of business documents used for:
  1. trading and commerce (orders, invoices, dispatch notices)
  2. key inter-organizational retail to supplier process (CRP, VMI, etc.), like inventory report (central warehouse and store level), point of sales data, etc.
- Minimizing or even eliminating administration costs (like data entry, order checking, etc.)
- Eliminating error-prone processes (like manual data entry)
- On-time exchange and update of orders, invoices (consequently inventory levels), etc.
- With one connection (i.e. one business document mapping), offering a company access to the entire market
- Improving trading processes

In more detail, some additional business and financial benefits are:

1. *Telecommunication Costs Reduction:* less phone calls (sometimes long distance) for voice and fax communications
2. *Paperwork and Employee Workload Reduction:* through the automation of the order-taking procedures, less administration workload will be needed at the sales departments.
3. *Negotiation power:* automated business document exchange can be used as a negotiations handle, especially in markets (such as Retail) with low profit margins.
4. *Customer reach:* the services provided to business partners will be enhanced (e.g. reduced overall order-taking time, almost zero data inconsistencies, faster response to customers, better overall control of the business operations), affecting the reach of users and the corporations that want to do business with them.
5. *Opportunity cost gains:* more business partners could be serviced at the same time i.e. faster service for the same (or even less) cost.
6. *Return on investment:* due to a subscription-based licensing model (review Table 2 below), the users will have rapid returns on their investment, since their total spending for communicating and administering document exchange will be reduced by at least 86% from the first month of the service participation.
7. *Additional cost savings*, like balanced (reduced) inventory levels, less out-of-stock situations, etc.

8. *Once-and-for-all integration:* as long as an organization participates in the service, there is no additional work and cost involved in exchanging documents with any other organization that is already connected to the service or will connect in the future. This is guaranteed, since, by using the service, the communication from a 1-to-many (one entity communicating with multiple entities) model is remodelled to a 1-to-1 model (one entity only communicating with the service provider, who takes care of all the communication with any number of entities, on behalf of the first entity).
9. *Security and trustworthiness,* since the service in question makes use of the latest security mechanisms so that companies can securely do business online.

Regarding the *daily operations* of their business, through the adoption of the service, users can:

- Extend their enterprise and business operations, in a secure and automated way, to their business partners, current and future.
- Tightly connect and interoperate with their best partners.
- Gain advantages over stagnant industry competitors, through the significant cost reductions gained, the faster responsiveness to business actions, and the higher quality of corporate information (e.g. sales information).
- Automate their business processes towards the outside, which means enabling the specification of document processing flows not only within the borders of an organization, but also throughout the "supply chain" with the organization's business partners.
- Gain better control over their business processes in a managed, automated way (like ability to know when an order has been received, dispatched, etc.).
- Find inefficiencies in the existing processes and eliminate them.
- Gain cost reductions through an inexpensive channel (in most cases, they already use the Internet as consumers, not in the business sense of the term)
- Be prepared to rapidly react to business changes.
- Leverage opportunities for expansion and growth, through the openness of their internal system applications.
- Increase personnel productivity and overall business productivity.
- Preserve a high quality of information stored in the internal systems.
- Achieve better and immediate forecasting of demand due to faster and more reliable automated order-taking procedures.

5.3 Quantitative Business Benefits

We separate the quantitative business benefits in two main categories:

- Benefits for the suppliers
- Benefits for the buyers

Supplier-Specific Quantifiable Benefits

Looking at the administration costs only, significant savings for each user can be achieved (Figure 4) depending on the connected partners and documents exchanged (orders, invoices, etc.). We assume that data entry for each document, like order, invoice, etc. has an average cost of 2-3 € in Greece.

If we only take into account the business document exchange processes of "Send PO to Vendor", "PO Confirmation" and "Match Invoice, Receipt, etc.", we will find out that we still have a significant cost which can be vertically diminished by automating the exchange.

According to relevant research, electronic business document handling provides significant cost reductions, ranging from over 75% to almost 95%.

Buyer-Specific Quantifiable Benefits

Additionally to the above-mentioned benefits, buyers can gain huge cost reductions by adopting IBTH services. Traditionally, buyers (and especially large ones) have a lot of personnel for doing the data-entry, due to the piles of paper-based business documents (e.g. invoices) they receive.

Example: One example is a large supermarket chain in Greece, which employs about sixty (60) people to do invoice data-entry and control. Using an average of 18.000 (per person per year, including public insurance, consumables, employee benefits, etc.) means that the chain has to spend *around 1.100.000 € for manual data-entry* on a yearly basis. Through the IBTH approach the bulk of these operations can be performed automatically. If only 80% of the process is automated (i.e. the chain could now only use about 10 persons), by doing simple calculations, it is obvious that *the chain could gain about 900.000 yearly – a cost reduction of 83.3%* just by using the service!

Process Step	Manual/EDI (Minutes)	eProcurement (Minutes)
Product Selection	20	3
Availability/Price Check	10	1
Requisition Creation	11	2
Requisition Approval	21	3
PO Generation	11	0
PO Approval	3	0
Send PO to Vendor	14	0
PO Confirmation	4	0
Status Check	11	1
Receive Shipment	12	2
Match Invoice, Receipt, etc.	8	5
Process Exceptions	8	3
Payment Approval	4	3
Payment Generation	8	5
Process Returns	5	3
Total Minutes/Purchasing Cycle	150	31
Cost/Cycle Time (Avg. $0.50/minute)	$75	$15.50
Per Purchase Savings	NEARLY $60!	

Source: NAPM

Fig. 4: Savings achieved through improved purchasing cycles

Additionally, huge indirect savings can be achieved when automating invoice entry by:

- *reducing physical inventory procedures,* due to the fact that through the automatic processing and control of buy & sales information they can have instant knowledge of their stock
- *accurate stock* and delivery information
- *real-time control* of spending
- control of supplier *service levels*

6 Related Technologies

The development of an IBTH solution should be based on the following tenets:

- End-to-End Security and Trust
- Service-oriented approach (no local resources required, clients just consume a service)
- Support for heterogeneity
- Use of public networks (the Internet)
- Flexibility
- Use of the latest IT technologies

Service-Oriented Architecture (SOA)

The SOA paradigm radically improves the efficiencies of creating, modifying, extending, and repurposing solutions for enterprise application integration, process automation, and trading partner interchanges. SOA redefines the concept of an application, from being an opaque procedural implementation mechanism, to that of an orchestrated sequence of messaging, transformation, routing, and processing events. With SOA, XML technologies allow applications to declare and expose both the message contents and the functional components that operate on the messages. XML-based development and deployment platforms that facilitate the SOA paradigm are highly compelling, because they simultaneously reduce development and life-cycle overheads substantially, and enable an unprecedented extensibility and reusability of components and entire applications.

Enterprise Application Integration

Enterprise Application Integration (EAI) software provides the infrastructure to connect an organization's internal applications. The ultimate goal is to have an organization's disparate internal applications appear and act as one single unified application.

XML / XML Web Services

Extensible Markup Language (XML) is the universal format for data on the Web. XML allows easily developing, describing and delivering rich, structured data from any application in a standard, consistent way.

XML Web services are the fundamental building blocks in the move towards distributed computing on the Internet, becoming the platform for application integration. XML Web services are built on XML, SOAP, WSDL and UDDI specifications.

Security and Encryption
Security is obviously a primary concern, especially in business / trade scenarios. Messages need to be protected against data theft and tampering; people and systems need to be reliably authenticated; services must be hardened against intrusion and denial of service attacks.

Hub – Spoke Architecture
In a Hub-and-Spoke Architecture, the Hub is the central building block that handles all communication among the connected business applications, known as spokes (application clients). Each spoke can be a message sender, or a receiver, or both.

In a business exchange network, each spoke possesses additional functionality such as:

- message persistence
- transaction support
- security

7 The Future: Expand and Extend

Easy and flexible connectivity will remain one of the most important factors in implementing supply chain integration, thus providing the backbone for advanced supply chain management implementations.

We believe that the next steps in supplier connectivity are:

1. *Connectivity becomes a commodity*: as more and more enterprises realize the need to do business online (including exchange of business documents), and more solution offerings appear in the marketplace, connectivity services are going to be a must in modern business.
2. *Trading exchange services evolve to intelligent, inter-organizational process-execution hubs*: these services include VMI (Vendor Managed Inventory), CRP (Continuous Replenishment Programme), CPFR (Collaborate Planning Forecasting and Replenishment) and others.
3. *Network of Networks*: similar to the evolution of the Internet, we believe that, gradually, business networks are going to be standardized into a distributed inter-network, so that communication and exchange are easier among trading partners. Local Providers are going to play a significant role in this development.

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PART 2

MULTICHANNEL RETAILING: RELATIONSHIPS, INTEGRATION AND ELECTRONIC TRANSFORMATION

Multichannel Retailing and Brand Policies

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1 Introduction

Consumers buy the same goods or categories of goods from several store formats. They take advantage of a multichannel environment that allows them to select store formats on the basis of their characteristics, the categories they want to purchase, and the occasion more suitable to do it. This is a well-recognized pattern, but also one not studied enough. Considering the wide ranging implications of multichannel patronage, both with respect to retailers' marketing policies and to those of manufacturers, it is surprising to find just a few studies devoted to this issue. The recent study by Inman et al. (2004) is the only one exploring multichannel buying behavior from a broad perspective. Other authors explore the choice between specific alternatives: between physical and virtual channels (Zettelmeyer 2000; Nicholson et al. 2002); between high/low price formats (Lal and Rao 1997; Bell and Lattin 1998); between traditional retail outlets and alternative non-store channels (Williams 2002); or focus on the reasons leading consumers to select a particular channel (e.g.: Korgaonkar 1981, on catalog showrooms; Van Kenhove et al. 1999, on do-it-yourself stores). The remaining vast literature deals with store selections, either considering stores pertaining to the same channel or without differentiating the approach when trying to explain switches among similar stores and stores of different channels. The aim of this article is to highlight the importance of conceptualizing the issue of multichannel retailing, indicating a number of implications for manufacturer-retailer relationships that impinge upon strategic questions.

The paper is organized as follows. The next section is devoted to defining multichannel retailing. Since differences in service across store formats are recognized but seldom explored in some detail, an attempt is made to define store formats in terms of the different mix of service attributes that they offer. In the subsequent section, attention is turned on purchasing behaviour in a multichannel environment. The results of a survey on consumer channel patronage are used to explore the impact of buyer characteristics on the choice of channel and on purchasing patterns across product categories. The implications of multichannel retailing for the marketing policies of manufacturers and their relationships with retailers are dealt with in the last section. The main focus is on brand strategies and the possibility to reframe them in view of the opportunities offered by a multichannel environment.

Though multichannel retailing is of general relevance, involving all types of goods and retail sectors, the point of reference of the article is the fast moving consumer good (FMCG) market and the related retail formats and product categories.

2 Store Formats, Retail Innovation and the Attributes of Retail Service

The term multichannel retailing has become widely used with the advent of electronic shopping. To most, the first meaning of multichannel retailing is probably the strategy by which a retailer offers goods, both through a physical network of stores and the internet, the so called <bricks and clicks> approach (e.g., Nicholson et al. 2002). However, this is a narrow definition, a special situation that can be extended in two ways. Firstly, it could encompass all channels used by a retailer, both physical (different store formats) and virtual (TV, the internet, catalogues). Secondly, it could be generalized with respect to the retail environment and the choice of channels open to consumers, without making reference to a specific retail firm (this is the approach taken by Stone et al. 2002). The growing importance of retail companies managing different store formats, physical and virtual, is a consequence of the existence of differentiated retail products, offering to consumers alternative ways of fulfilling their procurement needs. Thus, the term multichannel retailing will be defined as a retail environment that allows consumers to purchase the same good or category of goods in different store formats providing differentiated services.

Different channels can be looked at as the result of product innovation in retailing, which consists in offering to consumers new or improved

ways to purchase the goods they need. A fundamental achievement of modern retailing has been the realization that the demand of retail services has a degree of autonomy with respect to the demand of goods. Different mix of retail services can satisfy the demand of the same good or category of goods, and the proliferation of store formats is the result of this attempt to innovate. If one looks back at the traditional structure of retailing, it becomes clear that retail innovation has had far reaching implications. For a long time the mix of retail services was the same or very similar, and what distinguished one store from another was the kind of merchandises they carried. Today, the opposite happens: the same kind of merchandise is offered by several channels. The traditional retail specializations, based on narrowly defined product categories, have given way to specializations centered on the type of retail service provided. Given the purchasing pattern served, then the assortment is built up including all the goods (and services) that are coherent with that pattern and can be bought in the same shop expedition. In terms of producer-distributor relationships, which is the main focus, this implies an important change, as retailers are asking for products and supply conditions tailored to the distributive format they operate. Even within the same product category, goods and supply conditions relevant for, say, convenience stores, supermarkets, or hypermarkets are not the same. Later on this point will be dealt with in more detail; here, it is enough to note that it poses new problems for brand manufacturers, since it may go against the often unquestioned tenet that their products should be available, in exactly the same version, in all stores that stock the relevant product category.

In the FMCG market, changes in the retail industry have developed in parallel with changes in the demand of retail services by consumers that has led to a generalized decrease in the level of service provided (Schwartzman 1971). To understand these changes, it is useful to refer to the so-called household production model (Betancourt and Gautschi 1990, 1991, for a formal application of the model to retailing). Consumers can be seen as small firms that need to acquire the inputs needed to perform the activities that generate utility, at the lowest cost. The cost incurred in purchasing these inputs is the sum of their price plus the opportunity cost of the resources needed to move to and from stores, and to stock goods at home. Consumers have to optimize the trade-off between the cost of moving more or less often to stores and the cost of keeping a lower or higher stock of goods. Since this is a trade-off between labor and capital costs, consumers have to decide about the labor/capital intensity of their purchasing activities. The increased participation of women in the labor market and the higher relative cost of labor in the developed economies have started a trend towards more capital intensive shopping habits (Pashigian

and Bowen 1994). Reorganizing the way they acquire the inputs for their activities, consumers have therefore shifted part of the cost carried by retailers to themselves: stock holding and, on average, a higher distance covered to reach stores. They have done it because factor costs have changed and, with them, the trade-off between stock holding costs and frequency of shopping.

Like in most other industries, the industrialization of retailing started with one successful and undifferentiated product, the supermarket, on which to build up economies of scale. Viewed in this perspective, the supermarket can be looked at as the <Ford model T> of retailing. It rapidly conquered market shares from traditional grocery stores on the basis of lower prices, and became the dominant format for groceries (see Tedlow 1990 and his reconstruction of the A&P case). But once traditional retailers were displaced by large stores controlled by large companies, competition moved within these latter. Structural cost advantages were not available any more, and retailers had to compete proposing undifferentiated stores, stocking identical goods, namely well known brands. Retailers found themselves producing commodity-like services: they were offering the same goods with the same service, and the only way to compete was to compete on price. And since the prices are those of branded products, the margins on them are reduced and relationships with suppliers worsen (Albion 1983; Steiner 1984; Pellegrini 1989). When this happened, retailers started to look for ways to differentiate, innovating in two main directions. The first consists in attempts to provide different mixes of retail services, i.e. new distributive formats. The second is the search for distinctive features within the same distributive format, which leads, in particular, to the development of store brands (Thil and Baroux 1983), an issue outside the scope of this paper.

Innovation followed different paths in different countries, but it has spread across borders, and today a variety of retail products coexists everywhere, though with different volume shares in the many categories they sell: supermarket, superstore, hypermarket, convenience store, hard and soft discount, supercentre, wholesale club, e-commerce. The emergence of a multichannel environment also led retailers to manage different store formats, so as to take advantage of a freely usable innovation (it is not possible to protect retail innovation through patents) and exploit new market opportunities.

The process of retail innovation is a poorly researched issue, but is the first step in understanding multichannel retailing and its implications. The most successful descriptive model of retail innovation in the grocery market involving new formats, the so called <wheel of retailing>, posits that new formats displace old ones, offering the same categories with a lower

service and at a lower price (Hollander 1960; Brown 1988). In fact, they coexist and appeal to different consumer segments and/or are used by the same consumer in different occasions. Besides, not all new formats have a low cost positioning.

One can look at the process of innovation/differentiation in retailing in the same way it is done for other products and services. Products and services of a given category are offered in variants that provide the same basic attributes in different quantities and/or proportions. The application of this approach to retailing is summarized in Table 1.

Table 1. The attributes of retail service

Attribute	Value to consumers
Logistic attributes	
Proximity	Lowers costs to move to where products are physically held
assortment: broadness	Allows concentration of purchases: one-stop shopping
opening time	Use of time with a lower opportunity cost to shop
waiting time	Less time needed to obtain goods
Information attributes	
pre-selection	A targeted selection of goods reduces consumer search costs
assortment: depth	Inspection of alternative products is possible at the same store
direct information	Saves on cost to acquire alternative information
Other attributes	
comfort	Lowers the subjective cost of time spent on shopping; makes shopping a form of entertainment
Post sale services	Easy access to repairs, spare parts and consumables
↓ price	The production of attributes raises retail costs and prices

The attributes of retail services help consumers save both logistic costs and search costs. Attributes are related to the following two main functions of retailing: to provide utility of time and place, and also information about the goods available and their features. The service offered by a given store format can be thought of as a combination of elementary attributes and its price (the retail margin), as a function of the amount of attributes pro-

duced. The production of attributes raises retail costs and, through higher margins, selling prices.

Logistic attributes are associated with four main features of the retail service:

- *Proximity*; it is a function of the accessibility of a given store in terms of time and other resources needed to reach it;
- *Broadness of assortment*; as product categories available in a given store increase, consumers can concentrate their purchases and reduce their costs;
- *Opening time*; longer opening hours allow consumers to use time with a lower opportunity cost;
- *Waiting time*; faster service reduces the time needed to obtain products in a store or to have them delivered at home.

Information attributes can be summarized as follows:

- *Pre-selection*; retailers are experts searching the market to propose a selection of products for their target clients, in doing so reducing their search costs (Biglaiser 1993);
- *Depth of assortment*; clients can inspect alternative products in the same place, and reduce the cost of gathering the information they need;
- *Direct information*; clients can obtain direct information from attendants, again reducing the cost of evaluating different product variants.

There are two other important attributes to take into account, which can be framed as follows:

- *Comfort*; a more agreeable shopping experience lowers the subjective cost of time spent on doing it; if it is perceived as pleasure, shopping may become a form of entertainment;
- *Post sale services*; allow consumers to obtain all they need during a product lifetime (repairs, spare parts, consumables).

Depending on their characteristics, one would expect consumers to choose the format that minimizes their procurement costs. However, this is conditional on the occasions and motives leading them to visit a store, which may well depend on the product categories they are looking for (Inman et al. 2004). Resulting patterns of channel patronage involve several store formats used with different intensity. In the next section, some evidence is provided about these patterns.

3 Multichannel Retailing and Consumer Purchasing Behaviour

Like for most other goods and services, consumers buy more than one type of retail service, and this leads to complex purchasing patterns. Markets are not just defined by the supply of products, but also by the supply of retail services. Consumers have to decide which product to buy, and also from which channel to buy it. Besides, products are not offered by manufacturers only, but also by retailers with their private labels. With respect to any given product category, consumers have to choose among:

1. the types of product available (e.g. a low priced, commodity-like version; a functional good-value-for-money version; a designer, lifestyle oriented version);
2. the brands on offer;
3. the channels that carry them;
4. the stores of any given channel.

The act of purchasing, which is normally thought of as a choice among competing goods/brands, needs to be reconsidered as a set of decisions, which involve both products and retail services, both brands and store names. The relationships between these decisions, and especially their hierarchy, are central to a better comprehension of consumer behaviour. The issue of the hierarchy of these four choices will not be pursued here, maintaining the focus on the third, i.e. channel selection. The proportion of total consumer expenditure going to different store formats depends on three main sets of variables: households' characteristics (location, demographics, income, lifestyle, life-stage); the categories consumers want to purchase (high/low frequency; high/low involvement); the occasion more suitable to do it (a planned shopping expedition, a top-up in-between two planned expeditions, a purchase motivated by occasional convenience or bargain, immediate consumption).

The data reported in Table 2 offer some clues about the incidence of households' characteristics on the choice of store formats. They have been collected through a survey of channel patronage with respect to food purchases, involving a casual sample of 1000 consumers living in Lombardy. Half of the sample has been drawn from the Milan province, and the other half from the other provinces of Lombardy. 38.8% of the respondents regularly use a single channel, 50.5% two channels, 8.9% three channels, and 1.8% four channels. The average respondent uses 1.7 store formats. Among those using one channel, most rely on supermarkets (74%) and hypermarkets (21%), while only a minority on discount (2%) or traditional stores (3%). In Table 2, intensity of multichannel usage is defined as the

difference between the average number of store formats visited by the sample, and the number visited by a particular sub-group, expressed as a percentage. Relative intensity is defined in the same way, but with respect to the four channels considered in the survey, namely as the difference between the average number of respondents using a channel, and the usage of a particular sub-group, expressed as a percentage. Different patterns of channel usage emerge:

Table 2. Channel patronage and buyer characteristics

Respondents' characteristics		Intensity of multi-channel usage	Relative intensity of channel usage			
			Hyper-market	Super-market	Discount	Tradi-tional stores
Sex	Male	-3,6	18,8	-1,4	2,8	-23,6
	Female	0,7	-3,8	0,3	-0,7	4,7
Age	18 to 24	-3,5	-25,2	3,8	24,8	-9,6
	25 to 34	2,6	50,0	-5,8	-10,6	-10,5
	35 to 44	4,7	14,6	2,5	31,9	-5,9
	45 to 64	-0,6	-0,3	-2,0	2,1	0,6
	65 +	-3,1	-32,2	4,7	-27,7	10,2
Profes-sional status	Em-ployed	2,1	10,5	2,1	21,3	-9,0
	House-wife	-2,2	14,6	-6,0	-6,4	-5,5
	Retired	-1,7	-22,6	0,5	-25,5	15,0
	Other un-employed	7,5	8,9	9,3	49,6	-8,4
Educa-tion	Primary	-5,4	-31,8	-2,0	-15,6	9,0
	Secon-dary	-1,8	21,0	-4,8	12,8	-16,0
	High school	3,1	1,3	1,4	-1,4	8,4
	Univer-sity	-1,3	-14,6	5,9	-5,0	-3,5

Household members	1	-3,1	-26,8	-1,4	-6,4	10,5
	2	-7,1	-14,3	2,0	-20,6	-13,3
	3	2,6	5,1	3,5	7,8	-2,0
	4 +	8,6	30,3	-5,7	23,4	13,7
Place of residence	Milan	4,3	-28,7	14,9	-9,2	12,3
	Other cities	-4,3	28,7	-14,9	9,2	-12,3

Multichannel intensity is higher among people in the age bracket 35-44, among unemployed, other than housewives and pensioners, and among large families; respondents that use less store formats are male, have a low education and/or are part of small families;

The hypermarket is favored by males, by shoppers in the age bracket 25-34 and by large families, while it is less frequently visited by old people, by people with either very low or very high education and by singles;

Supermarkets are the reference channel for most respondents, with differences in the relative intensity of usage across sub-groups that are smaller than for all other store formats;

The patronage of discount stores shows marked differences with respect to respondents' characteristics; they appeal to unemployed, to people in the age brackets 35-44, to large households and also to young shoppers; instead, singles, pensioners and old people are much less likely to visit them;

Traditional stores are visited with more intensity by singles and pensioners, but also by large families, which have the highest level of multichannel usage; they are less likely to be visited by men and by families with two components, the group which shows the lowest intensity of multichannel usage.

The different patterns of channel patronage with respect to the place of residence are also interesting. People living in Milan, a large city, use more channels, and show a preference for supermarkets and traditional stores, while people living in the rest of the region prefer hypermarkets and discount stores (as the sample is divided into two identical sub-groups with respect to this variable, percentages are the same with opposite signs). Many other comments could be made about the table, but these are enough to confirm that patterns of channel usage do differ, and that channels may be used to segment consumers.

Table 3. Channel patronage and product categories

Product categories	Hyper-market	Super-market	Discount	Traditional stores
Fruit and vegetables	-8,8	-6,7	-18,2	107,6
Dairy products	0,9	4,3	18,2	-42,4
Meat	-1,4	1,0	-27,3	18,2
Bread	-11,1	0,3	12,1	19,7
Fresh fish	1,8	5,8	-87,9	-7,6
Frozen food	8,8	4,5	18,2	-71,2
Wine	-11,5	1,8	66,7	-22,7
Fresh pasta	17,5	-6,8	45,5	-10,6
Sweets and cakes	7,4	-5,9	0,0	27,3
Ready meals and delicatessen	-1,8	1,9	-30,3	-18,2

Channel usage also varies with respect to product categories. Table 3 reports data from the same survey concerning the relative intensity of purchases of food products in different channels. As before, this is expressed as the difference in percentage between the average usage of a channel across all product categories considered, and the usage with respect to each of them. The supermarket confirms its central positioning, with small differences across product categories; only for fruit and vegetables, (packaged) fresh pasta, and sweets and cakes, the intensity of usage is lower than average. Variations are more marked in the case of the hypermarket, where fruits and vegetables, bread and wine are below average, and fresh pasta is above it. Discount and traditional stores are the formats for which patterns of usage with respect to product categories differ most. Consumers visiting discount stores buy more dairy products, bread, frozen food and, particularly, wine and fresh pasta, while they are much less likely to purchase fresh fish (often unavailable), meat, fruit and vegetables and, as one would expect, ready meals and delicatessen. Traditional stores have their strong point in selling fruit and vegetables, meat, bread, and sweets and cakes, while they are less likely to be visited for buying dairy products, frozen food, wine and ready meals and delicatessen. Again, with respect to product categories, channels also matter, and have a strong influence on buying behavior.

There is a further issue that would be interesting to explore, and that is the influence of channels on the purchase of different types of brands. In a multichannel retail environment, the role of types of brands is unlikely to be the same across store formats. Different channels, which try to appeal to

different consumer segments and shopping motives, are likely to favor one or more types of brands depending on their marketing mix. If this happens, then market shares by types of brands also depend on market shares by channels: the substitution of retail formats leads to the substitution of the type of brands that are more strongly present in their assortment.

	National brands	Local brands	Private labels	Discount brands
Convenience store	Central	Integrative	Integrative	Marginal
Supermarket	Central	Integrative	Central	Integrative
Hypermarket	Central	Integrative	Integrative	Central
Hard discount	Marginal	Marginal	Marginal	Central

Fig. 1: Role of different types of brands across retail channels

The survey used until now does not allow us to explore this linkage, but combining types of brands and retail formats in a matrix, as it is done in Figure 1, can help to pinpoint some of its implications. It is not proposed as a general reading of the relationships between types of brands and types of stores. Given the different structure of retail systems across countries, and even within countries, this would be very difficult. However, a few comments concerning Figure 1 allow us to exemplify how alternative formats may impinge upon types of brands.

- *Convenience store*. They are tied to a small set of consumers living in the same area. Most consumers do not use them for their main purchases of groceries, but to top up their pantry in-between main shop expeditions. Otherwise, they can appeal to small households where price is not a priority. They also have constraints in offering depth of assortment due to space limitations. In these conditions, they have to be selective, and are likely to stock national brands, rather than private labels, and discount brands (the lowest price alternatives branded either by retailers or their suppliers), since the former are more likely to appeal to a larger set of customers.
- *Supermarket*. Private labels are normally important, at least as important as national brands. Supermarkets have to face price competition

from hypermarkets and discount stores, and private labels offer advantages to both retailers and consumers: with respect to national brands, a higher margin to the former and a lower price to the latter. Discount brands are present, but they are not actively promoted, since their low absolute margins do not contribute enough to cover the cost of a high service format.

- *Hypermarket*. Their assortments include all types of products. Given the volume of sales they have to achieve, drawing from a very large and heterogeneous population of customers, and the low frequency of shopping expeditions they can count on, they cannot target their offer to specific consumer segments. The presence of private labels is also limited by the competition from discount brands that hypermarkets have to stock to appeal to consumers who would otherwise move to discount stores. Positioned in-between national brands and discount brands, private labels are more difficult to develop and use in order to increase store loyalty than in supermarkets.
- *Discount stores*. Their mission is to offer goods at the lowest price, and discount brands dominate their assortments. These are the only products that allow cost reduction through the entire supply chain, from production to retailing. Though they may have to stock some powerful national brands, these have a marginal role in their assortments.

This tentative characterization of the role of types of brands in different channels makes clear that, whatever it may be, a structure exists, and has obvious implications for marketing policies and producer-distributor relationships. The tenet that national brands should be available in all stores that stock the relevant product category is no longer valid or even sensible; e.g., to force their listing into discount stores would involve the concession of sale conditions that other retailers may then ask to apply to their contracts, putting the positioning of the brand at risk. In general, producer-distributor relationships depend on the store formats involved and on the strategies followed by the retailer operating each of them. Relationships with a big supermarket chain strongly committed on developing its private labels are likely to differ from those that a national brand manufacturer has with a local chain less reliant on its own brands, or with a convenience store chain stocking mostly manufacturer brands.

In the past, when the number of retailers was very large, and retail formats much less well defined than today, both in terms of their marketing and their organizational procedures, it would have been impossible for manufacturers to establish specific relationships with all their clients. Today, after much concentration in retailing, it is possible (Dawson and Shaw 1989; Shaw et al. 1992; Bergen et al 1996): store formats may be used to

reach desired consumer segments more effectively, and to offer them differentiated products.

4 Multichannel Retailing and Brand Policies

Why should manufacturers explore the option of differentiating products with respect to store formats? A first answer, given in the previous section, is because channels attract different consumers, for different product categories in different occasions, and can be therefore used as a base for segmentation. A second is that differentiating products by store formats may help improve relationships with retailers. We shall first deal briefly with this second reason, and then return to the first, to see how brands can be used to differentiate across channels.

Suppliers influence inter-channel competition in two ways:

1. *Brands*. Store formats have different margins, but sell a core of identical goods/brands. Though they are sold together with a varying amount of service, they expose retailers to price competition. This effect is particularly evident with respect to well-known brands, those that are often called traffic makers or loss leaders. They make price differentials across channels (and rival stores within the same channel) more transparent, and increase retail competition: the more inelastic the demand of big brands, the more elastic becomes the demand of the store. Thus, in a competitive environment, retailers discount on these brands, and then try to obtain better sales conditions, worsening relationships with suppliers.
2. *Supply chain arrangements*. They have asymmetric influences on costs across store formats. Agreements on promotional expenditure, collaboration in the launch of new products, joint initiatives in advertising at a local level, readiness to stock more or less items within a product line, and all other similar matters will have quite different outcomes (Davies 1994). Moreover, physical distribution requires diverse standards. To achieve an efficient supply chain, the frequency of drops, drop sizes, number of items per box, and even packaging sizes should be different.

Manufacturers may consider their indirect influence on retail competition as a problem of retailers. However, what these latter do to reduce the overlapping of assortments and to obtain better sales conditions becomes the manufacturers' problem. In the absence of supplier cooperation, retailers increase efforts on private labels to make their assortment more distinctive (Narasimhan and Wilcox 1998). They can also reduce sales of prod-

ucts with lower margins, using the levers they control in the store: e.g., cutting shelf space and accepting a higher probability of stockout; allocating shelf space of low quality, and reducing impulse purchases; delisting product variants. Manufacturers do have strong incentives to help retailers reduce assortment overlapping, and brand policies are the most important tools to do it. Even more so, if, at least with respect to channels, these can also serve to improve segmentation.

Brand policies are often looked at as consisting of two radical alternatives: a manufacturer either sells its own brands, or produces those sold under the name of a retailer. Figure 2 helps transform these two alternatives into a continuous set of options. There are two main dimensions to consider, one entails product differentiation, the other brand differentiation. The main tenet in the FMCG market is that a product should be sold everywhere with the same brand. In the past, this meant offering a single object identified by a given brand. In time, goods have started to be offered in different packages under the same brand (e.g., with respect to size, number of items, convenience), to serve varying preferences and uses by consumers. Often, even different product specifications have been made available under the same brand, identifying the brand with a line of products.

In Figure 2, this trend towards a more complex brand syntax is extended to include brands that, through the addition of a symbol or a name, are made available to specific channels, namely a line brand defined with respect to a given store format. It is of course possible to conceive packages made specific to a particular channel without altering the brand name, as in the case of the so called <jumbo packs> available in warehouse clubs in the US. But the addition of brand specification, makes channel differentiation stronger, and lowers assortment overlapping. Depending on the product category involved, it can then cover the same set of products sold under the original brand, a set of channel-specific packages, or even a line with product specifications tailored to a channel. A further step in tailoring brand policies to channels could be the use of different brands to sell through different store formats. This is often done by manufacturers of personal care products, sold with different brands through large self-service stores, pharmacies and perfumeries. Though this adds to promotional costs, if volumes of sales are large enough, these can be compensated for by the advantages of avoiding the effects of inter-channel competition.

	Same brand everywhere	Line brand per channel	Channel brand	Private label
No differentiation	The brand identifies a single product	A symbol or name is added to the brand when sold in a given channel	Different brands are used for the same product in different channels	The supplier provides the same product sold under his/her brand
Differentiation in size/packaging	The brand identifies a single product packaged in different sizes to increase convenience	A symbol or name is added to the brand and provided with different packaging when sold in a given channel	Different brands and packaging are used when supplying different channels	The packaging of the product differs from the one used for the supplier's brand
Differentiation in product specifications	The brand identifies a line of products	A symbol or name is added to the brand and provided with different specifications when sold in a given channel	Different brands and product specifications are used when supplying different channels	Product specifications differ from those of the product sold under the supplier's brand

Fig. 2: Store formats and product/brand differentiation

These is a last and even more radical option, that is to grant the exclusive right to sell some product specifications, either defined in terms of packaging or product variant, to one retailer. It has been done, as in the case of Nike and Foot Locker (Tkacik 2003). It may be an extreme option, but it is one that retail concentration and the development of large international retailers make possible in terms of volume of sales. It is an option that lies in-between manufacturer brands and private labels, which can

grant considerable advantage to manufacturers and, for this reason, it is very likely to be chosen by some of them.

5 Concluding Remarks

The traditional focus of marketing research has been on the choice of goods, sometimes integrated to account for the influence that in-store marketing has on brand choice. The increasing complexity of the retail environment introduces a new research area: channel patronage. It is an issue of obvious relevance to retailers. To them, channel patronage is the guiding factor in innovating formats and directing investments towards new stores. But it is also relevant to manufacturers, as different channels offer specific assortments to an increasingly targeted consumer base. Sales across product categories change, and also brand types play different roles. It is an opportunity manufactures can capture, differentiating products and brands sold to specific store formats.

There is no way of establishing a general rule to guide firms in choosing among the many alternatives represented in Figure 2. The choice depends on many variables, from the product category involved, to the market positioning of each producer. But these options, until now explored by a small number of manufacturers, in product categories mostly outside the FMCG industry, may be a way to improve producer-retailer relationships, and move along a path where channels become an important variable for defining product specifications and consumer segmentation. Along this path, manufacturers' and retailers' collaboration in product conception and design, until now very difficult, may also become easier, leading to the sharing of their diverse and, to a great extent, complementary knowledge.

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Designing Alternative Store Layouts for Internet Retailing

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1 Introduction

Elaborating on Vrechopoulos et al. (2002), this chapter presents the methodology used towards developing the three major conventional retail store layouts (i.e. grid, free-form and racetrack) within a Web-based shopping interface. It begins by reviewing the existing hypermedia design methodologies and the graph theory that is used as a consumer navigation representation tool. Then, it proceeds by adopting the methodology developed through the above discussion towards designing the concept and structure that each of the three layouts under study should follow.

2 Hypertext/Web Design Approach

2.1 Design Approach

The development of the alternative virtual store layouts (i.e., grid, free-form, racetrack) incorporated in the Web-based virtual store requires an understanding of the consumer behavior possible patterns within each particular type of conventional store layout. To that end, an appropriate customer navigation representation instrument is employed, followed by the discussion and selection of a particular methodology for hypertext application development.

2.2 Visual Representation and Graphs

Proceeding with the development of the virtual store, it is necessary to develop a visual representation of the navigation or browsing in a real store, employing each of the alternative layouts. To that end, “graph” as a well-

documented instrument for representation and modeling, is employed. This instrument is a result of a scientific discipline of discrete mathematics, called "graph theory." A graph is introduced here as an abstract mathematical system. Graph theory is applied in such diverse areas as communication engineering, social sciences, physical sciences, information organization and retrieval, artificial intelligence, switching theory, formal languages, operating systems and compiler writing (Wilson 1987).

According to the literature (Chartrand 1985, Gross and Yellen, 1998, West 1996), a graph $G = <V, E, \varphi>$ consists of a nonempty set V that is called the set of nodes (points, vertices) of the graph, a set E that is the set of *edges* of the graph, and a mapping φ from the set of edges E to a set of ordered or unordered pairs of elements of V. A graph, depending on whether its edges are directed or undirected is called "directed (digraph)" or "undirected" (Figure 1). Any sequence of edges of a digraph such that the terminal node of any edge in the sequence, is the initial node of the edge (if any) appearing next in the sequence defines a path of the graph.

A graph is preferred over other techniques for consumer navigation representation within the selected store layouts of this study for the following reasons:

1. It is a standard structure from discrete mathematics that can be used to build models for several situations.
2. It is applied in the area of information organization and retrieval.
3. Navigation and browsing in a store is accomplished following paths when seeking specific products located in specific shelves.
4. According to Spence (1999), "hypermedia worlds are typically based on node-link representations and permit only discrete movement."

In a graph representation of a customer shopping in a grocery store, the customer follows one or more paths to reach a specific group of products or a specific brand of a product category. The path is represented by a sequence of edges and the desired product or group of products, is represented by a node.

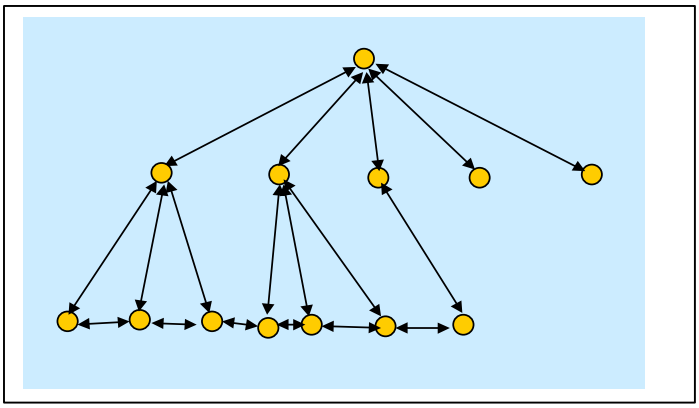

Fig. 1: An "Undirected" Graph for navigation in a store

For example, one can get into a grocery store, stop and ask an employee for the location of vegetables (e.g., in order to buy tomatoes). The employee shows the customer which way (i.e., path or walk) to follow. Following this path he/she passes through several other product categories (i.e., nodes). Eventually, he/she reaches the vegetables' category (i.e., node) and looks there for tomatoes. Finally, she/he locates tomatoes (i.e., final node in his path) and picks one or two pounds of them.

A representation of the relevant customer behavior for each of the three alternative store layouts is attempted later in the chapter.

2.3 Hypermedia Design Methodology Selection

As Isakowitz et al. (1997) note, hypermedia projects are very different from traditional software development projects. First, hypermedia projects may involve people with very different skill sets: authors, content designers, artists, marketers, as well as programmers. Second, the design of hypermedia applications involves the capturing, understanding and organizing of the structure of a complex domain and makes it clear and accessible to users. Third, according to Miles et al. (1999), hypermedia applications that support electronic commerce should take into account the distinct goals and constraints of this activity. The primary goal of an e-commerce Web site is to facilitate economic actions. This goal is supported by information retrieval techniques as well as by consumer behavior and human factors' analyses.

Web development in general and Web development for e-commerce in particular, is therefore, a very challenging process that demands support

from a well-defined methodology adjusted to specific requirements. Such a methodology is necessary to ensure that the hypermedia product meets its objectives, and is completed on time and within budget limitations (Lee et al. 1999).

Research on the development of design methodologies for the support for hypermedia projects has resulted in the development of a number of methodologies, e.g., RMM and Extended RMM (Isakowitz et al. 1995, 1997), ERM (Kiountouzis 1997), OOHDM (Schwabe and Rossi 1995), SOHDM (Lee et al. 1999). This research is currently in progress and a few of the methodologies are being updated.

The Relationship Management Methodology (Isakowitz et al. 1995) is based on the development of an Entity Relationship Model. RMM includes the following steps:

1. E-R design
2. Slices Design
3. Navigational Design
4. Conversion Protocol design
5. User Interface Design
6. Runtime behavior design
7. Construction and Testing

RMM has been updated recently, resulting to the development of the Extended RMM which is based on the following prototyping and iterative process (Isakowitz et al. 1997):

1. Define the information domain
2. Define what the application will do
3. Define who will use it
4. Define how the users will use the application
5. Design the E-R diagram
6. Design the initial application (navigation) diagram (top-down)
7. Decompose the application diagram into the *m-slices*
8. Regenerate the application diagram from the *m-slices* in a bottom-up fashion
9. Repeat steps 6-9
10. Design the user interface
11. Implement the system

Entity relationship modeling (ERM) is used for presenting the entities in a system and identifying the relationships between them. It is used mainly for the creation of models for data. ERM could be used for identification of relationships between products or product categories. The relationships that can be used are expected to be of the “belongs to,” or “contains,” or “located to” types. This technique is proven very effective for the representation of semantics' relationships between entities but it does not

contain sufficient information for the representation of the navigation (e.g., between aisles, product categories or products).

The Object Oriented Hypermedia Design Model (OOHDM) is an object-oriented method (model). It is continuously updated and revised. It consists of the following steps:

1. Domain analysis
2. Navigational Design
3. Abstract Interface Design
4. Implementation

OOHDM has been complemented recently with the techniques of *use cases* and *scenarios* for the determination of the requirements accomplished in domain analysis. It contains a very important tool, the navigational context schema that is used for the development of navigational models which include a sense of context for the user. A navigational context is a set of nodes, links, context classes and other navigational contexts. This model assists the author of a hypermedia application to consider the way in which the user explores the hypermedia, avoiding redundant information and getting "lost in the hyperspace."

More recently, a Scenario-based Object-oriented Hypermedia Design Methodology (SOHDM) was developed (Lee et al. 1999). SOHDM is based on experience collected from the application of the RMM, OOHDM, and other methodologies. It consists of the following phases:

- Domain Analysis
- Object modeling
- View design
- Navigation design
- Implementation design
- Construction (physical database schema)

A specific methodology was developed in order to meet the requirements of this study. This methodology is basically based on the OOHDM presented above, using however, various elements of the aforementioned methodologies. Finally, it employs graph theory as a modeling instrument, and consists of the following phases:

1. *Domain Analysis* (use of graph theory along with conventional retailing theory for consumer navigation representation within each layout pattern).
2. Identification of *Entities and Procedures* within the virtual store for each layout pattern.
3. Development of *Entity-Relationship diagrams* for each layout pattern.
4. *Abstract Interface Design* for each layout pattern.

5. *Implementation* of each type of layout (use of Human Computer Interaction principles and guidelines for effective Web site design toward providing user friendly interfaces).

It should be clarified that this chapter discusses steps 1 and 2 of the adopted methodology.

3 Virtual Store Layout Analysis and Design

3.1 Grid Layout

Graph theory can be used for the representation of the navigation in a grid store layout. A store that is laid in this way, divides its space using gondolas of merchandise and aisles. When the customer enters the store, he/she makes sense of its geometric organization and is directed to the aisle(s) where the product(s) that he/she needs are located. Figure 2 presents an initial step to the representation of the grid layout.

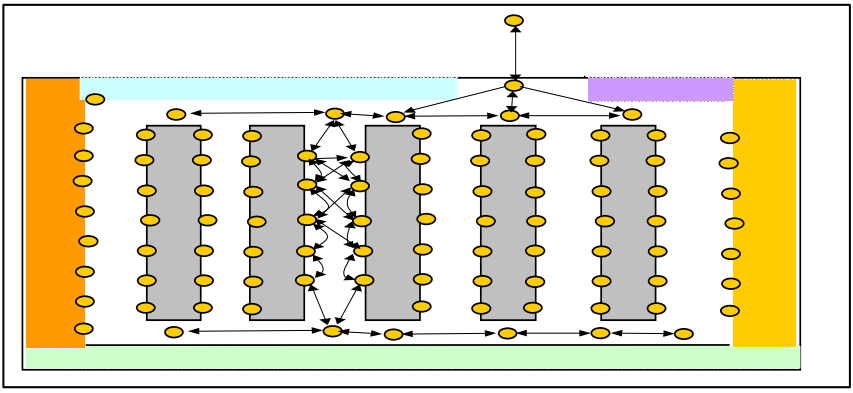

Fig. 2: Grid Layout Representation - Step 1

For this representation an undirected graph is used. Its structure stems from the geometric organization of the grid store layout. The central feature of this representation is that a customer may move backward and forward between nodes (i.e., end-products, sub-categories or product categories), but only according to specific aisles that are separated from gondolas. A customer located at a node in aisle 1, for example, can not move directly to a node in aisle 2 without passing from the main or the internal corridor nodes, as depicted in Figure 3.

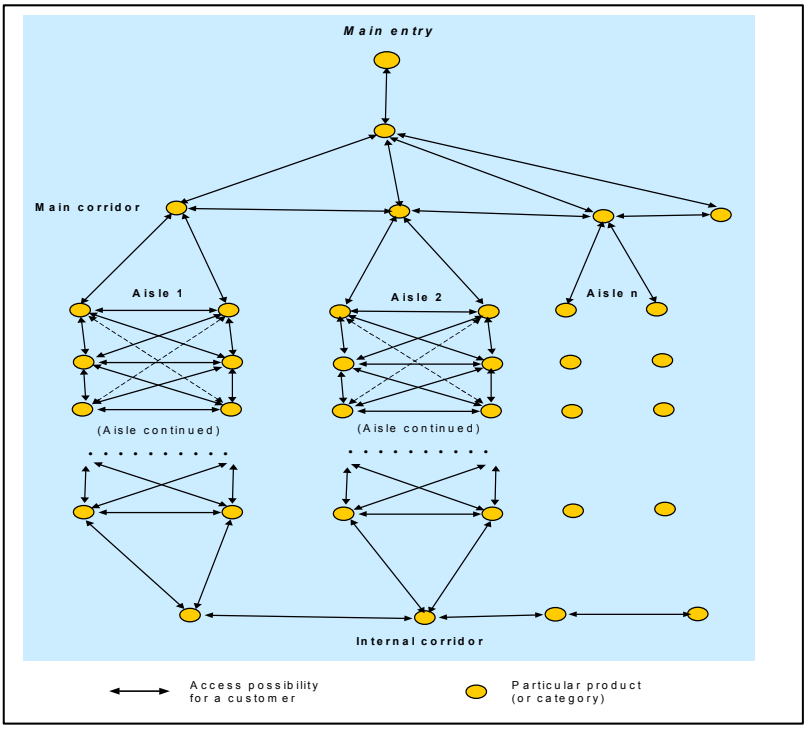

Fig. 3: Grid Layout Representation - Step 2

Figure 4 presents an example of a real 3-dimension situation. In this Figure, the third dimension represents the gondolas that consist of multiple shelves. When a customer gets into an aisle, he/she turns to the left or to the right to see the merchandise that is arranged in the shelves of the gondolas. He/she picks the product that he/she wishes from the particular shelf of the gondola.

A virtual store over the Internet can be designed according to the concepts and rules of the conventional retail store grid layout. The basic characteristic of the grid layout, therefore, is that the user is permitted to browse the store through a number of aisles. Each aisle has two opposite sides. After the entrance in an aisle, the user is guided to a number of subcategories that have been selected to be displayed in the specific side of that aisle. In a physical grid layout design, the customer is not permitted to exit from an aisle before walking to its ends. Moreover, the customer can go "directly" to the position of a specific product after the assistance of an

employee. These concepts can be translated and followed during the design of the virtual store as follows:

The main entities of the virtual store employing the grid layout are:

1. Category
2. Subcategory
3. Product
4. Aisle
5. Shelf
6. User
7. Purchase
8. Navigation

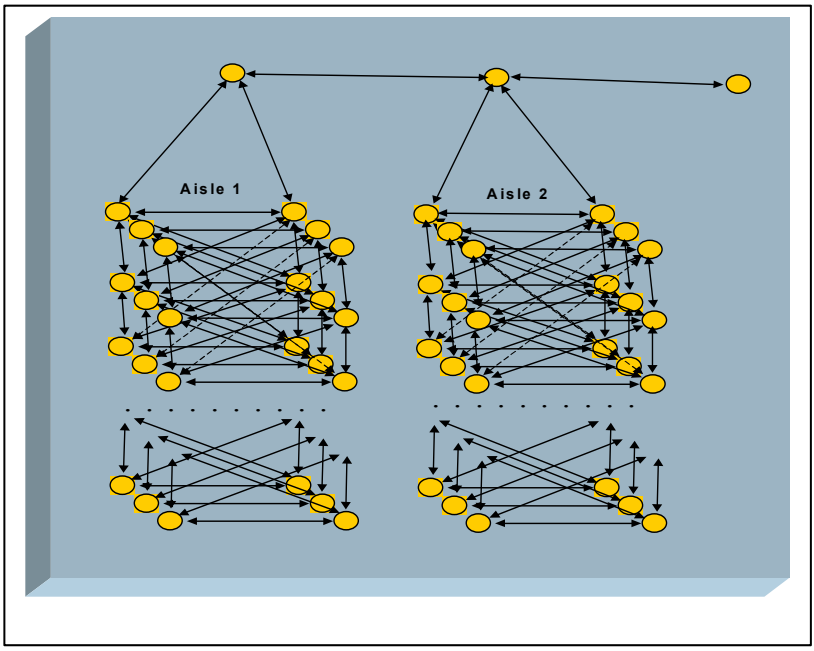

Fig. 4: 3-dimensional view of the shelves

The products placed within the virtual store are structured according to a three level format. More specifically, the first level refers to the product categories. Each product category contains some product subcategories and, finally, each subcategory contains single products (i.e., brands). Each aisle contains one or more product categories. The shelves, which are located within each aisle, contain subcategories and single products. A user (6^{th} entity) is the subject who logins into the store. Each time a user logins into the store he/she is provided with a basket. Therefore, the "purchase"

entity refers to information related to purchases (i.e., product codes, quantities, total price, etc.) that each subject conducts. Finally, the navigation entity refers to the collection of data related to time spent within the store and other navigation related issues.

Detailed procedures that take place within the grid layout pattern are presented below:

- Entrance to the store.
- Selection of an aisle.
- As discussed above, an aisle in conventional retailing has two sides. However, within a Web-based virtual store such a categorization seems to be useless. However, the "side concept" was initially followed in the development of the virtual store in the sense that whenever the customer selects an aisle, the product subcategories of this aisle are presented to him/her in a similar to conventional aisle way (i.e. in two sides). In addition, each side is divided into subcategories of products.
- Before a user enters a specific aisle, there is a node that permits access or selection of different aisles.
- After the entrance of a user into an aisle, there is a number of nodes that he/she is permitted to access or pass. The number of nodes equals the number of subcategories of each side.
- A set of permanent buttons or links is required for user assistance in each Web page:
  - View basket
  - Home page
  - Quit
  - Banners (advertisements)
- At this point, it should be noted that based on Vrechopoulos et al. (2002) classification of Internet retail stores, the attributes used for classifying the existing retail stores were also used in the same way in the development of the virtual store for each layout type. For example, the "home page" button is the attribute, which was used for the grid layout, as the other two (i.e., menu bars and product catalogues) are sufficiently represented by the structure of the virtual store (i.e., aisles, shelves, view basket and quit buttons).
- Whenever the user selects a page/node that corresponds to a specific subcategory he/she can have direct access to the products of this subcategory. Moreover, the user may have access to a number of products of neighbouring subcategories by using the back button. The concept of neighbouring is defined as the distance of two nodes.

Summarizing, the main procedures that the customer implements into the store are:

1. Entrance to the store
2. Selection of an aisle
3. Selection of a subcategory or a shelf
4. Selection of a product
5. Addition of a product into the basket
6. Update basket
7. Check out

Moreover, there are three different stages during the navigation in a grid type store:

1. Entrance in the store
2. Navigation in an aisle
3. Concentration to a specific product

The entrance in the store involves the selection between the available aisles to follow. The navigation in a specific aisle involves the selection or concentration to its left or right side (Figure 5). As discussed above, each side contains subcategories of products.

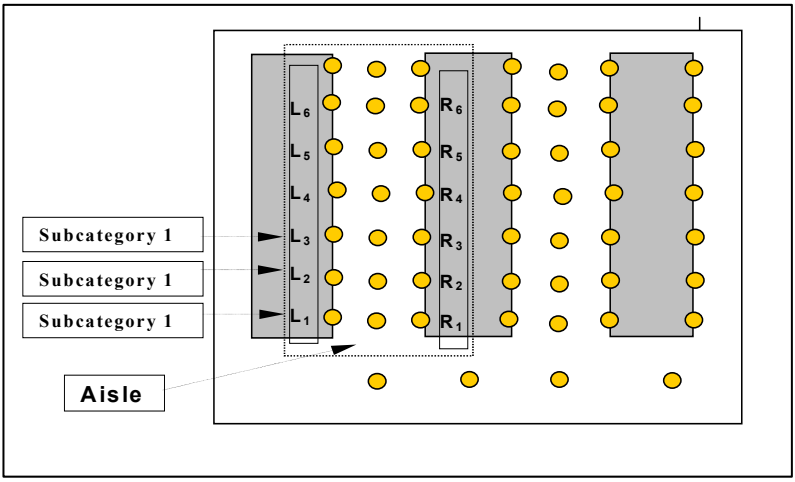

Fig. 5: Aisle structure

The concentration to a specific product involves the following issues:

1. Concentrate on the product
2. Reach neighbouring products or subcategories
3. Return to the aisle

Finally, it should be clarified that the issue of neighbouring is implemented within the grid layout among products belonging to the same subcategory (e.g., the customer can select product Coffee 1 or Coffee 2 at

once, in case he/she is in the coffee subcategory). In addition, the same also stands for subcategories that belong to the same product category (e.g., Marmalade and Honey belong to the same category named "Breakfast"). Finally, in case an aisle contains more than one product categories (e.g., Confectionary – Breakfast), the neighboring issue is implemented in the same way among all subcategories included in these product categories but not among the end products.

3.2 Free-Form Layout

When the customer gets into a store employing a free-form layout, he/she can have a direct perception of the entire store along with the placements of products (or product categories) in it. For example, he/she can at once see where the store beverages are located. This situation is graphically represented in Figure 6. The customer from any particular node in the graph can have access to every other node, at a minimum cost compared to the grid layout.

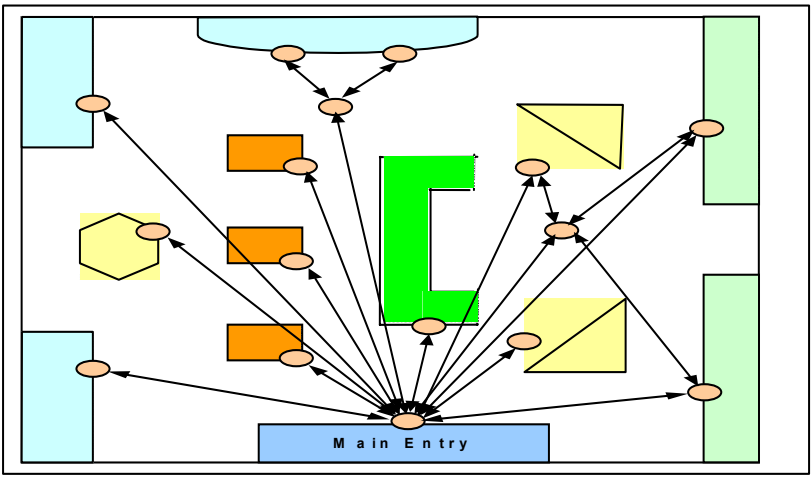

Fig. 6: Free-form Layout Representation - Step 1

In other words, when the customer enters the store, he/she can have an integrated view of its contents. This situation can be represented as an undirected graph, with a link from every node to every other node (Figure 7).

However, this is a simplified representation of the situation. In a detailed representation of the searching or browsing process, a customer may follow more than one steps. In particular, a customer wishing to buy a

product, e.g., milk, gets into the store, locates the related category, approaches the particular display area and selects the desired product.

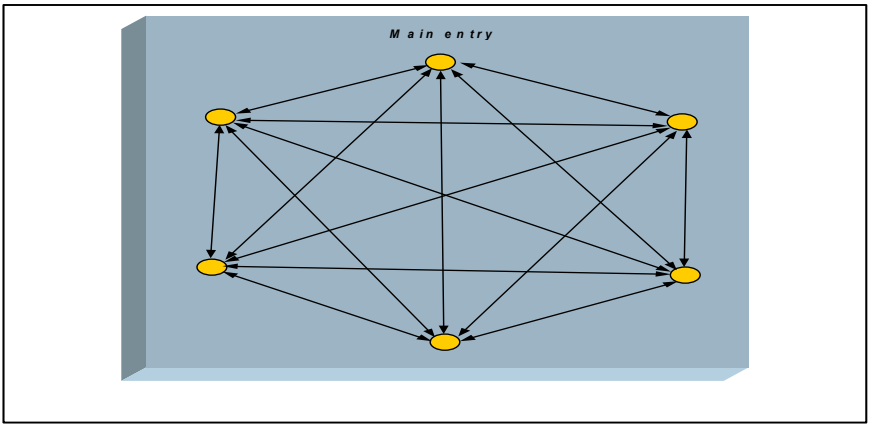

Fig. 7: Free-form Layout Representation - Step 2

In Figure 8, the yellow node represents the location of a category. The green node represents the location of a particular product. The customer searching process consists of two steps: a) the selection of a category, and b) the selection of a particular product in the store.

The main characteristic of the free-form layout design is the option of having direct access to every product category or subcategory from any place in the store. The customer, depending on the size of the store, can have visual access to the products or subcategories that are near his/her current position in the store and those categories that are located further away.

In the free-form design layout, the store is divided into displays (see Figure 6). A display does not have an internal structure. Every display has a set of subcategories of products. Therefore, a question that arises here is how these subcategories could be defined. In other words, questioning was generated regarding the subcategories assortment within each display. To that end, and in order to proceed with the development of the virtual store, it was assumed that every display corresponds to the set of subcategories that constitute a category of products. In other words, it was assumed that every display refers to a single product category, which in turn contains several subcategories. It should be noted that this decision was based on conventional retailing theory insights which suggest that each display within a free-form layout usually refers to one product category.

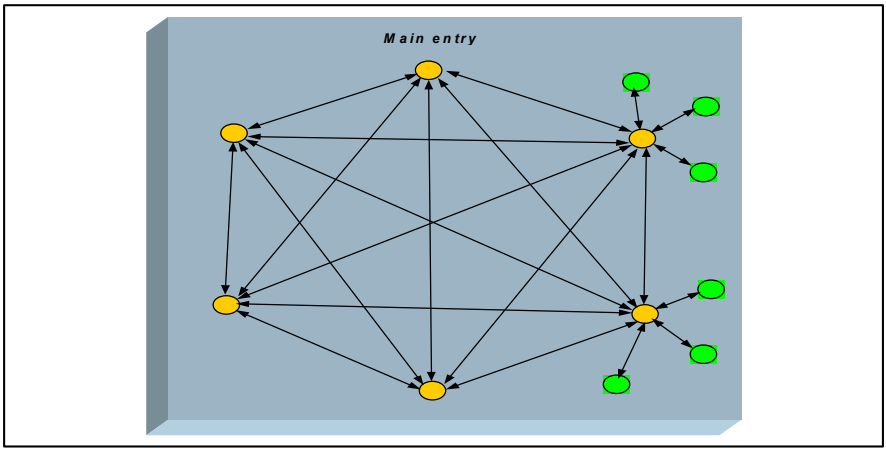

Fig. 8: Free-form Layout Representation - Step 3

One of the most critical points was to define the levels of visual access from every customer position in the store, as well as the neighbouring displays, subcategories, and products. Of course, some concessions and assumptions should take place in order to proceed with the development of the virtual store, as the relevant literature cannot support every single step taken. Therefore, it was assumed that for every location within the virtual store, there are three levels of visual access for the customer, something which in fact seems to effectively simulate the conventional store navigation experience (Figure 9):

Level 1 - More visible area: In this case, customers have visual access to product categories (i.e., displays), sub-categories and even single products as all the above are very close to their current location.

Level 2 - Less visible area: In this case, customers have visual access to product categories (i.e., displays) and sub-categories. The fact that customers do not have access to single products is due to the fact that the specific displays are located away from customers' current location.

Level 3 - No visible area: In this case, customers have access only to product categories (i.e., displays). This happens because the displays are placed far away from the customers' current location.

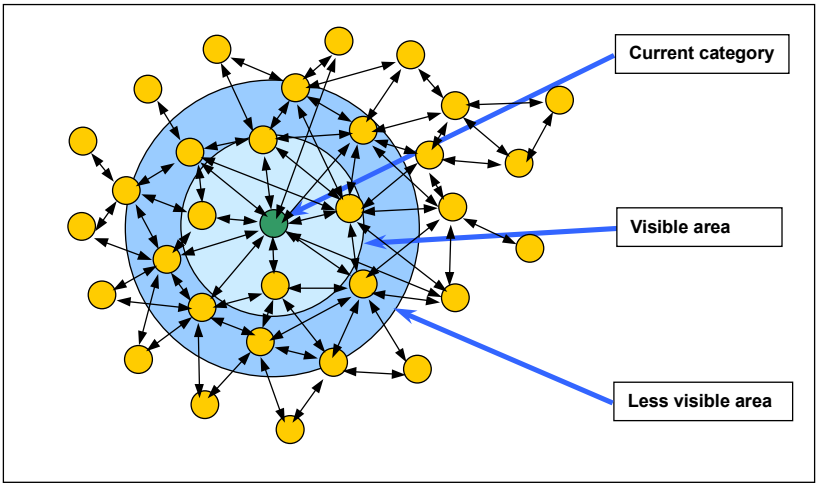

Fig. 9: Network of (sub-) categories in a freeform type store and its visibility

It should be also clarified that the aforementioned levels of visual access in conventional free-form stores, are highly dependent on the store size. For example, in a big free-form store, a customer may not even have visual access to some displays, as several obstacles (e.g., stairs, large displays, etc.) may hide them. In this situation, the customer may request the assistance of an employee. Based on the discussion above, the following main entities for the freeform design layout are identified: (1) Category, (2) Subcategory, (3) Product, (4) Display, (5) User, (6) Purchase, (7) Navigation.

Every display has a one-to-one relationship to a category of products. Each category has many subcategories while each subcategory belongs to only one category. Each subcategory has many products, while every product belongs to one subcategory. Furthermore, as discussed above, each display has one product category. Finally, as far as users, purchase and navigation entities are concerned they follow the same concept as in the grid layout.

The concept of the neighbourhood must be defined for product categories (i.e., displays), subcategories and products. The following approach was used. Every display, subcategory and product has a rank number. The displays, subcategories and products that are near the center of the store will have rank number = 1. Drawing away from the center, the rank number will increment by 1. So, if a customer is in front of a display with rank number “x” then the first level of visual access will be all the displays,

subcategories and products with the same rank number. The second level of visual access will be all the displays, subcategories, products and nodes whose rank number is "x+1" or "x-1". All other (the rest) displays, subcategories and products are in the third level of visual access of the customer.

Therefore, the main procedures that take place within the virtual store employing the free-form layout are the following:

- Entrance to the store.
- Search for a product (this can be implemented through the use of the "search" button offered within the free-form layout). As discussed above, initial research and, more specifically, the Internet layout classification framework, provided input to this phase of the research as far as the classification attributes is concerned. Therefore, the "search" attribute was offered only to the free-form version of the laboratory store.
- Selection of a display
- Selection of a subcategory
- Selection of a product
- Addition of a product into the basket
- Update basket
- Check out
- Purchase

Moreover, there are three different stages during the navigation in a freeform type store:

1. Entrance to the store
2. Navigation
3. Concentration to a specific product

At this point, it should be noted that as free-form and racetrack layouts are not employed by conventional grocery stores, there is not a scientific theoretical background which could be used towards the effective assortment of products in the virtual store employing the two layouts. This means that, inevitably, some concessions should be made in order to proceed with the product assortment within these layout types. Considering that the product assortment within the three different versions of the online grocery store will follow the same placement concept it was concluded that the lack of relevant theory in that point does not weaken the reliability of the analysis and design concept.

3.3 Racetrack Layout

Racetrack layout design is mainly used by department stores, i.e., large stores that have different sections, which promote and sell completely different categories of products (e.g., handbags, cosmetics, electronics, etc.). These sections require a large area in order for the products to be effectively arranged and adequately promoted. In this design, the customer gets into the store and follows one of the alternative paths that are available to him/her. At crossing points/nodes, he/she makes his/her decision according to the merchandise that is displayed in the alternative routes or according to a predetermined plan for seeking a particular category of products, in case he/she knows the specific store's layout (Figure 10).

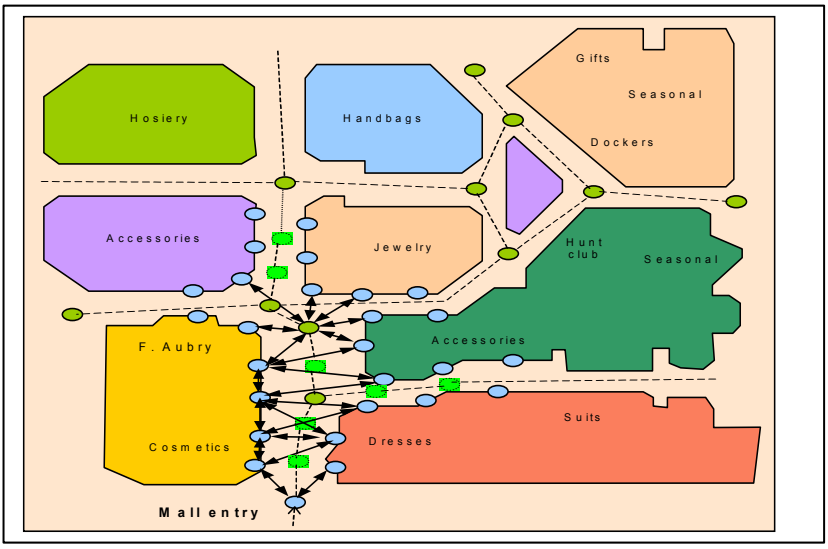

Fig. 10: Racetrack representation

The crossing points are represented with a colored node in Figures 10 and 11. At a crossing point, the customer can see various product categories (e.g., accessories, jewelry, etc.) and may select to follow one of the alternative routes provided.

As in the free-form layout, a decision was taken to place a single product category in each of the racetrack layout displays. In addition, this is also usually the case in conventional retailing. Moreover, each department has multiple shelves which, in the case of the virtual store, refer to product subcategories and single products, always included in the same product category (Figure 11).

In the racetrack layout, customers do not have an immediate access to every point of the store but have to follow specific paths in order to reach their desired products. Racetrack resembles the grid layout in that the navigation is restricted in a number of specific paths/corridors (aisles in the grid layout). However, in some cases (i.e., at the crossing nodes), it resembles the free-form layout as customers have access to quite a big number of products. Nevertheless, customers visiting racetrack-layout stores cannot have direct visual or physical access to every direction around their current position. Therefore, customers are restricted to have access only to the displayed products located near their current position or within the current corridor.

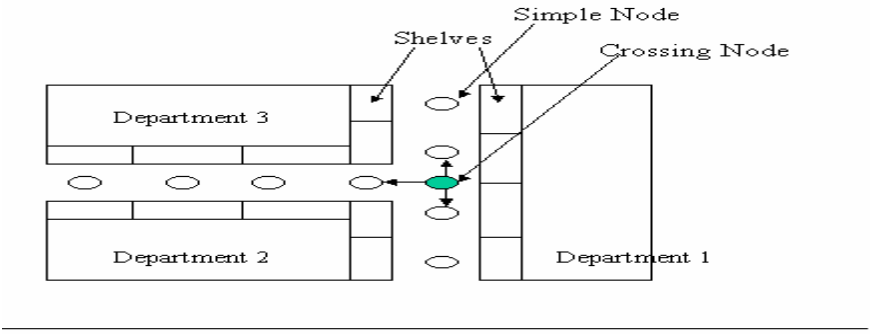

Fig. 11: Graphical presentation of the racetrack layout

The virtual racetrack layout entities are the following:

- Racetrack entities – characteristics
  1) Display
  2) Category
  3) Subcategory
  4) Product
  5) Corridor node
  6) Corridor
  7) Corridor shelve
  8) Navigation
  9) User
  10) Purchase

Except for the crossing node, the node, the corridor and the corridor shelf, the rest of the entities retain the same structure as in the grid or the free-form layouts. The racetrack related entities are described below:

- *Node:* This entity refers to the case where the customer has selected a specific corridor and navigates within it.
- *Corridor:* This entity contains basic identification information about each corridor (e.g., corridor id number).
- *Corridor node:* Used to meet the many-to-many relationship between corridors and nodes.
- *Corridor Shelf:* This entity contains detailed information about each corridor's contents.

The basic procedures that take place within a virtual store's racetrack layout are described below:

- Entrance to the store by keying in the corresponding user name and password
- Selection of a specific corridor to navigate through among a list of alternatives (at least two alternatives/corridors are provided)
- Navigation into a corridor
- Selection of a specific subcategory
- Selection of a specific product

4 Concluding Remarks and Future Research Directions

Further research can test the effectiveness of the three layouts under study against shoppers within causal research designs (i.e. laboratory or field experiments). To that end, the researcher can manipulate a series of variables (e.g. layout, advertising banners, etc.) and test their effects on the corresponding dependent variables (e.g. sales, time spent within the store, impulse purchases) under study. Furthermore, the methodology adopted by the present study can be replicated in similar to the present one research situations. For example, conventional grocery retailing Category Management principles and models can be transformed and adapted to the virtual world (e.g. Web, Mobile 3G-enabled Retailing, Interactive TV Retailing, Vending Machine Retailing, etc.) in order to investigate significant cause-and-effect relationships and offer valuable managerial implications as well as contribute to theory building.

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In Search for Viable e-Solutions

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1 Introduction

The progress of e-commerce has been extensively researched in academia, as well as by consulting firms and forecasting institutes. Hence, there is extensive information available about the early state of e-commerce. We can conclude, from this information, that the initial expectations of researchers, consumers, and business representatives have not yet been met. After a backlash around 2002, there is now a certain recovery in some e-service industries, even a considerable growth of market share. In spite of the shortcomings that still remain in the e-channel, consumers continue to believe that new technology will eventually become helpful in managing their everyday life. Likewise, business representatives and social service agents still believe that ICT not only has the potential to support the communication process, but also make the marketing of their products and services more efficient. Moreover, governments in several countries have declared their intent to connect their citizens with high performing broadband networks that will provide instantaneous and powerful Internet connections (Virtel 2001). All of this indicates the necessity to adapt the technology as well as the services offered on the Internet to the consumers' capabilities and their wants and needs. With such an approach, useful complementary channels can be created for the consumers, and new, viable business logics for firms serving the end-users can be developed.

Hence, the aim of this paper is to explore criteria for successful e-commerce. This task is based on results from Swedish research on e-commerce, some of which is still in progress. First, we present conclusive

data from the Households in Cyberspace Project, a research program at Stockholm University that studied consumers' attitudes towards and use of e-commerce. We next present new data from ongoing research focusing on the strategies of successful e-commerce companies. By integrating findings from both studies, we can identify qualities and contexts that are not only useful for consumers, but also profitable for firms.

2 Consumers' e-Commerce Behavior

2.1 Households in Cyberspace

The Households in Cyberspace project collected empirical data over time regarding Swedish consumers' adoption of and attitudes towards e-shopping for both products and services. The data covers the period from 1996, when consumers were first given the option to shop on the Internet, until early 2002, when they became mature e-shoppers. During this period, a number of separate studies were completed (Frostling–Henningsson 2000; Carlell 2001; Lennstrand 2001; Persson 2001; Frostling–Henningsson 2003).[5] Altogether, more than 300 consumers in the metropolitan area of Stockholm were interviewed. These early adopters were computer literate, mainly well educated, often from dual-carrier families, they frequently had young children, and most had an income and educational level above average.

2.2 Early Adopters' View of Benefits and Shortcomings

The driving force motivating the early adopters to start using the new e-buying system was a vision of enormous gains to make their everyday life easier and more comfortable. However, with growing experience they became more critical towards the defects of the e-system with respect to access and design of the interface. The computer technology (hardware and software) did not yet meet their expectations, and their opinion was that the quality of the e-services also had defects and limitations. The consumers gradually became more pragmatic and selective in their use of e-services. They continued to use e-services for products and services they considered well suited for e-shopping. They also used the e-shopping me-

[5] The data have been collected as part of the four doctoral theses, but also of 14 masters' theses. For a summary report of the findings in section 2, see Wikström, S. (2002)

dium when traditional systems functioned poorly or when the local market was limited. When summarizing the research on early adopters' views of the e-channel for purchasing, we identified three clusters of essential themes:

- E-buying saves time and offers flexibility in time usage, provides convenience, and often gives access to good prices. Internet is also a helpful source of information about available product alternatives on the market, product qualities and prices. *These are the main driving forces for early adopters.*
- However, there are certain flaws in the management of the e-channel. These flaws include an unreliable payment system, slow and unreliable delivery times, and poorly functioning after-sale-service. These defects hold consumers back, although they should be easy to correct.
- Moreover, the e-channel has certain limitations that are more difficult to overcome. Consumers quite often report difficulties orienting themselves in the new virtual shopping context. They also frequently lack a feeling of security and trust for the new channel. In addition, the websites do not always have the extensive and complete information needed to complete a transaction. Furthermore, the limited stimulation offered by the website compared to a physical store creates its own restrictions.

2.3 Early Adopters' e-Buying Behavior

Although the e-channel has proven to be of limited use when purchasing many products and services, the Internet is a valuable channel for information about categories, varieties and prices available on the market, although consumers still turn to a physical channel to complete the purchase. An example illustrating this behavior is taken from the purchase of leisure tours. 15% of such purchases in Sweden have recently taken place on the Internet, but only one visit out of 100 to a website resulted in the closing of the transaction.[6]

Two characteristic features are emerging regarding this purchasing behavior:

- Consumers tend to use the e-channel alternatively with the physical store, depending upon their buying context.
- Consumers tend to alternate between both channels during the purchase. They may begin searching for alternatives on the Internet, and then go

[6] Statistics from the organization 'My Travel', based on the activities of travel agents covering the bulk of the Swedish market.

to the physical store for inspection. They may also reverse the process, and start by viewing a product in the physical store and then searching on the net for alternatives and prices. The closing of the purchase may take place at either of the store types. From this, we can conclude that the e-channel and the physical channel are complementary.

2.4 The Potential of the e-Channel

Based on the above information about consumers' experiences with the e-channel, we can ask the following: What are the implications in realizing the potential benefits of the e-system? What can be learned from this information to improve the user-friendliness of all components of the e-channel, so that it can fully reach its potential? Three paths are visible.

First, enormous gains can be obtained with the improvement of the hardware and software of the e-system. An easier-to-use and simpler system is needed. Since even computer-comfortable consumers complain about the often-arduous task of using the system, the difficulties are likely to compound with the less computer experienced.

Secondly, close attention should be paid as to whether all types of products and services are suitable for mediation on the Internet. Based on the inherent limitations of the e-system, there is a common view that the e-channel is primarily suitable for products and services with special attributes and in special purchasing situations. There are four types of purchase situations that are mentioned as beneficial for e-buying. (see e.g. Alba et al. 1997; Peterson et al. 1997; Hoffman and Novak 1996; Lindbeck and Wikström 2002).

- Products and services whose attributes are easy to assess before the purchase, such as standardized products and services, popular name brands, or products and services that are well known to the user from earlier purchases.
- Products and services of low involvement or low personal importance to the consumer, where the precise attributes of the products are less important than easy access.
- Products with a small local market, where the e-channel is the only available channel for easy access.
- Products and services with credence attributes, i.e., attributes that cannot be assessed during the purchase, but rather, only after a certain period of use. Such products and services are suited for the e-channel when consumers begin using structured information about product attributes from other consumers (virtual communities) as an additional information channel (Lindbeck and Wikström 2002).

Finally, from the consumers' reactions we assume that quite a few individuals have difficulties orienting themselves in the virtual context. What is more, we hypothesize that this difficulty fuels their feelings of insecurity and distrust, which they have repeatedly demonstrated towards offerings on the Internet. Hence, we suggest that the consumers' difficulty in this respect should be handled in different ways. This research indicates, for instance, that more references to elements of the physical world helps consumers orient themselves on the website. We also conclude that more transparency in the content of the offerings should create better trust.

3 Strategies by Successful e-Commerce Companies

In an ongoing study of e-commerce companies' success after the dot.com downfall, we examine their strategies for continuing achievement. The aim of the study is to evaluate the status of active e-commerce firms right now. We use this study to compare their strategies with the above research results on consumers' attitudes and behaviors when using the e-channel, and how they view its benefits and shortcomings. The method is case study research based on qualitative interviews of a purposeful sample of five Swedish companies. These companies have been chosen to meet the following criteria:

- Have a relatively long history selling goods on the Web, including survival through the dot.com downfall
- Are often mentioned as examples of successful e-business
- Sell products that call for physical distribution – something our earlier research has shown to be both difficult and costly
- Represent two kinds of product categories: technical and non-technical goods
- Are at least partially active in the consumer market, and are not only active with business-to-business sales
- Are willing to give access and information to our research

Based on these criteria, we selected the following companies: Elfa AB (electric equipment), Clas Ohlson AB (tools), Jula (tools and related products; similar to Clas Ohlson), Ginza (music CDs), and Panduro (hobby materials). For further information of their products and sales in different channels, see the overview in Table 1.

Table 1. Company characteristics and sales in different channels (Sweden only)

Company	Company description	Annual turn-over M.USD	Internet sales (%) *Site visitors per month*	Catalogue sales (%) *Catalogue distr.*	Store sales (%) *Number of stores*
Ginza	Music CD, film and games. Founded 1968. Internet sales since 1997.	40	80 *1.000.000*	20 *225.000 monthly*	Marginal *1 store*
Elfa	Electric equipment, mainly B2B (98 %). Founded 1950. Internet sales since 1997.	65	26 *135.000*	64	10 *5 stores*
Clas Ohlson	Tools and related consumer products, computer parts and mobile phones. Founded 1918. Internet sales since 1999.	150	5	10 *2.100.000 yearly*	85 *16 stores*
Jula	Tools and related consumer products. Founded 1980. Internet sales since 2001.	60	5 *60.000*	25 *500.00 twice a year*	70 *7 stores*
Panduro	Hobby materials. Founded 1950. Internet sales since 1998.	50	2	23 *300.000 yearly*	75 *31 stores (300 retailers)*

The interviews took place either face-to-face, by phone, or by e-mail. The e-mail interviews can be characterized as dynamic dialogue over time with the respondents. Usually, an interview was made in one session. However, when new aspects appeared in later interviews, the earlier interviews were followed up by e-mail. This interview form closely follows the principles of chatting, and will probably gain importance in the development of future interview methods and techniques.

Different strategic objectives guide the interviewed companies in their effort to establish e-retailing. All five companies report that they view the Internet as an important marketing tool. The decision to utilize the Internet was viewed as a means to receive more attention in the market. Their main purpose was to strengthen their position with their current customers, rather than target new customers and sell more products.

All five companies strongly emphasized the synergy effects resulting from their multi-channel strategy. Jula, for example, tries to synchronize its different sales channels in order to obtain maximum synergy effects between them. Even if the catalog is the number one marketing tool for Clas Ohlson, they recognize the Internet activity as an important supportive channel in their marketing effort. At the same time, all companies clearly state the catalog is irreplaceable in their business.

The Net shop would not work without the catalog and traditional mail order. Without these, we would only be an ordinary dot.com company that might end up in bankruptcy (Marketing Director, Ginza).

The catalog is our most important marketing tool. The paper version will never disappear. The catalog and the website complement each other (Director Mail-Order/Internet Sales, Clas Ohlsson).

Another important strategy of e-commerce is that the Internet channel offers a broadened service to consumers. One significant aspect of this expanded service compared with the catalog is the possibility to present updated assortment lists on the website. The combination of Internet together with more traditional channels, the physical store, catalog and telephone ordering, offers alternatives to the consumers.

A third major strategy of e-commerce is to offer more convenience to customers. With the help of the Internet, customers are able to shop around the clock. At the same time, e-commerce offers faster shopping compared to mail order and telephone order. E-commerce, together with the catalog, also means more convenience to those customers that live far away from a physical store. Only one of the interviewed companies, Elfa, offers a discount to its Internet customers. They offset the 3% discount with lower internal administration costs, when the customers place the orders themselves. However, we must remember that Elfa is mainly a business-to-business company. Ginza, with just one physical store, says their strategy is to offer convenience and low prices to their customers.

4 Comments on the Two Perspectives

4.1 Impact of the Purchase Situation

In Section 2, we hypothesized that e-buying is beneficial for consumers in four different types of purchase situations. The case studies in Section 3 support two of these hypotheses. All companies that are significantly expanding their e-sales offer either standardized and/or brand-name products, or products that are well known to the user from earlier purchases. This supports the first purchase situation. Furthermore, for many customers in a large part of Sweden, the third purchase situation is viable, since the e-channels the only means available for easy access, other than phone or mail order. However, the results do not support the hypothesis that the e-channel is suitable only for products with low personal involvement, since the majority of the companies supply products that require a high level of personal involvement, such as hobby or do-it-yourself products.

The cases show other seemingly powerful success criteria:

- A strong, well-established brand name
- Good logistics
- A well-established understanding of consumer needs in distance shopping
- A stable customer base
- A well-integrated database system

The case studies also show examples of how consumers use the e-channel either alternatively with the physical store, or in combination with the mail-order catalog, and how they sometimes alternate between different channels for the same purchase.

4.2 Benefits of Multi Channel Retailing

All case companies can be characterized as multi-channel retailers. In Section 2, we hypothesized that combining traditional physical stores and web shops is a success factor. We hypothesized that the more the website is built on artifacts from a physical store, the easier it is for customers to orient themselves in the virtual context. This study has opened up a new way of looking at these issues. One successful company, Ginza, sells music CDs by mail order. They only have one shop, located in Gothenburg, which is probably not known by most of their customers in other parts of Sweden. Their catalog is distributed once a month to a large segment. This case study illustrates that all successful e-commerce companies have mail-order activity based on catalogs, but not all of them have physical stores known by the customers. From this, we can conclude that successful catalog and mail order activities can complement a less well-known physical store. In a way, all of the companies use physical artifacts to facilitate the web visitor's navigation. The websites are often built as replicas of the paper catalogs with the same structure and classification. A customer who is well acquainted with the catalog may feel familiar with the website because of this resemblance. The site can be regarded as an artifact of a physical catalog.

4.3 Costs and Prices

Initially, low cost was the expected benefit of e-retailing. Most of our case companies, like other companies we have studied, were not able or willing to disclose their profitability for the different channels. However, there was one exception; Clas Ohlson provided detailed data. Contrary to common

belief, they show that the cost of e-retailing is higher than the cost of their physical stores. This is true even though their stores are located in prime locations within city centers. Their physical store margin is just 13.7%, while the margin for their mail-order business, including Internet (which is treated in the same way after the order has been registered) is 9.1%. They attribute this difference to the high cost for logistics. The transportation costs probably explain why multi-channel retailers are unwilling to offer lower prices on the Internet when delivery is included. A cost barely considered when the ease of entry into e-retailing was initially discussed is the cost of designing a website to present products in a structured and comprehensive way. It is no coincidence that all of our case companies representing successful e-retailers have their origin in mail order. For them, it is relatively easy to convert their catalog to a web format.

4.4 Essential Themes in Consumer Expectations

In our earlier studies, three clusters of themes characterizing consumers' attitudes towards and expectations of e-commerce were identified. We consider some especially relevant to this new study. They also seem to be well heeded by the case companies. All companies offer fast and reliable delivery time. They also offer good after-sale-service and solutions that provide security and trust. Additionally, they have a payment system that makes e-buying reliable. Elfa offers a 3% discount on the website (lower price is important), but the rest of the companies keep the same price in all channels with no discount for web buying. The web assortment can be updated more easily and more often than the catalogs, which is important for fast delivery times. This aspect also strengthens an important benefit of e-buying: Internet as a good source of information about products and prices.

5 Discussion

In this article, we have used past research on consumers' use of and attitudes towards e-buying, and have integrated these findings with results from our ongoing research on the marketing strategies of successful e-commerce companies. Our purpose has been to identify important preconditions for developing e-channels that are useful for consumers and profitable for business firms. We conclude that the results from the two research perspectives largely support each other. There are two hypotheses we will discuss in depth in this final passage: the benefits of a multi-channel re-

tailer when serving consumers on the web, and the products and services suitable for purchase on the web.

5.1 From the Physical to the Virtual and Back

Our analysis has reinforced the hypothesis from our past and current research that an established physical store retailer is better off serving consumers on the web than a new e-retailer, i.e., a stand-alone e-retailer. Seeing the channels as complementary is beneficial when building a resemblance of the physical store on the website. We hypothesized above that the more the website is built on artifacts from the physical store, the easier it is for consumers to orient themselves in the virtual context. When the artifacts mirror a physical store familiar to consumers, there is a good chance many of the difficulties consumers have orienting themselves and feeling confident in the virtual environment will be mitigated. Consequently, firms have started to adapt to the changes in consumer purchasing to the extent that they have increasingly incorporated their e-firm as part of their traditional business. This is the case for, e.g., banks, travel agencies, and insurance companies.

We learned from our case companies that there are some other important preconditions for establishing profitable e-commerce. First, you need a strong and well-established brand name (provides security and trust). Secondly, good logistical arrangements are needed. It is also useful to understand customer needs when distance-shopping. Moreover, for developing and fine-tuning the e-business, it is useful to have a stable customer base and a well-integrated database system.

The consumer studies identified similar criteria as important for developing e-offerings. It is essential to attend to the difficulties that consumers experience in their e-buying: arrange for safe payment systems; establish well-managed delivery systems; and, last but not least, build an efficient after-sale-service function. There is one other important aspect that should be taken into consideration. Our consumer studies, as well as other research, have confirmed that many customers need help to orient themselves on the web. They need support to feel confident and at ease in the new virtual context. We suggested earlier that extra care be given when designing the website, so that it is easy to comprehend. We also thought consumers would find it beneficial if firms incorporate artifacts from their physical counterparts onto the website, and even fit in elements of human support.

It is important to notice that all of our case companies are not only dual retailers, but also mail-order companies that use their catalog as an important marketing tool. Is this a coincidence or an indication of something im-

portant to help us understand the prerequisites for consumers to absorb the web offerings?

Venkatesh (2002) presents a contribution to elucidate this question. He clarifies how the conventional catalog with its symbolic expression connects the virtual space and the physical space. The catalog functions as a liaison between the virtual space of the website and the physical space of the store. Through the catalog, the company represents itself and its products in material terms. Hence, the catalog is both an image and an object, although never an alternate space (Venkatesh, Meamber and Firath, 1998). You can look at it, pick it up, and touch it. Since the most highly recommended way to experience objects is to touch them, catalogs provide this touch when the material is printed on a glossy paper. According to Venkatesh, the communication power of the catalog is the combination of the imaginary and the physical world.

	The store ⇨	The catalog ⇨	The Internet representation
The Product	Physical products and service encounters	Representations in text and images only	Representations mainly in text on the screen
The Setting	Physical settings of a store, a bank office or public service centre	The physical catalog	An empty space or images of some physical artefacts
The Environment	Physical environment, the local place/community	The physical catalog often including a presentation of the company, its origin, location, etc.	An empty space. Local, national or global. Who knows?

Fig. 1: Real life objects and common Internet representations (adapted from Wikström 2001)

Another way of emphasizing the in-between role of the catalog is to compare the different levels of representation in the store and the website. When mapping the physical into the virtual context, plotting has to take place on at least three levels, as shown in Figure 1. However, most web de-

sign today covers very little of the three. The catalog, on the other hand, offers a physical setting for the product presentations, which seems to make the representation more real.

From the above discussion, we conclude that it is no coincidence that all of our case companies have a catalog business as a basis for their e-commerce activities. We hypothesize that the catalog background is beneficial not only for managing the e-business, but also for helping consumers orient themselves in the virtual context. This offers them a physical artifact to provide continuity, security and trust. This observation, however, is likely part of a more general finding.

There is extensive research showing the benefits of dual retailing, i.e., combining the physical store with e-retailing (see e.g. Otto and Chang 2000; Wikström and Persson 2001; Steinfeld et al. 2002). In these works, the authors emphasize the advantages of hybrid approaches to e-commerce mainly on theoretical grounds. Furthermore, to understand the benefits of dual retailing, robust frameworks have been constructed by a combination of classic competitive advantage and inter-organizational network theories (Johnston and Vitale 1988; Porter and Miller 1985) and transaction cost theory (Bacos 1997; Malone et al. 1987). These frameworks mainly focus on lower cost, differentiation through value-added services, improved trust, and geographic and market extension (Steinfeld et al. 2002). However, our case studies, together with our research on consumer buying behavior, show that the mail order company provides specific input into the hybrid retailer concept: the possibility to complement the information on the virtual web with the information from the physical catalog at the exact same moment when searching for information or completing the transaction. The possibility to combine the physical and the virtual may explain why the mail-order companies seem to be more successful serving consumers on the web than a stand-alone e-retailer or a physical retailer offering complementary e-retailing.

5.2 E-buying – Product or Situation Specific?

A common view among researchers is that the e-channel is not suited for the purchase of all types of products. Complex products, as well as products that consumers want to closely inspect, touch and smell, are considered particularly unsuitable. We have hypothesized that the virtual channel is suitable mainly for (1) standardized and brand-name products, i.e., products known to the buyer before purchase; (2) products with low personal involvement, and (3) products with a thin local market. However, we have seen important exceptions to these hypotheses. Could it be that this broad

generalization is mainly valid, but that there are also other criteria that distinguish what is suitable and when it is suitable to buy on the web?

From our case companies, we learned that high involvement products and non-standardized products are also bought on the web (See e.g. Panduro's hobby material and Clas Ohlson's assortment denoted "old men's kindergarten". In our research on grocery buying via the Internet, we found that consumers fill their shopping baskets with all kinds of fresh food as well as standardized products. This presents no problem as long as consumers trust the one that "picks" their products (Frostlin-Henningsson, 2003).

The product qualities of standardization and low involvement are not the only qualities to consider when assessing the risk of getting unsatisfactory products. Other important factors affect the choice of the purchasing channel. In fact, the choice is affected by a number of variables, both utility variables and input variables. Kaufmann and Lane (1996a, 1996b, 1997) have proposed a model for analyzing consumers' choice of shopping alternatives in a traditional shopping situation. This model can also be used to understand the consumers' choice between physical and virtual channels. It assumes that people have a limited set of resources they can combine to attain an optimal utility according to their individual preferences.

Utility variables in focus	*Input variables*
• Convenience	Money
• Low price	Time
• Safety	Information (knowledge)
• Pleasure in shopping	Energy (physical and mental)
	Space (transportation)

If convenience, for instance, is important in a specific shopping situation, consumers may trade it in for money. Conversely, when a low price is imperative, the input variables of time, information, energy, and space may be used. When pleasure is sought, all input variables may be used. Hence, input variables may be used in many combinations in consumer shopping.

As has been shown above, the different channels, physical stores, mail order companies and e-stores put various demands on the input variables. Therefore, the more alternatives a retail company can offer, the greater the chances to attain consumer loyalty and attract new customers. Hence, the answer to the question if it is a coincidence that the successful e- companies in our case studies are mail order companies supplemented by physical stores is 'no'. Mail order companies are superior not only in their knowledge of managing distance shopping; their catalog bridges the gap be-

tween the physical and the virtual world, which seems to solve several of the problems that consumers experience in their e-shopping.

6 Conclusion

Our purpose has been to identify important preconditions for developing e-channels that are useful for consumers and profitable for business firms. We conclude that the findings from our past research on consumers' use of and attitudes towards e-buying, when integrated with results from on-going case studies of successful e-commerce companies, have reinforced the following hypotheses:

- An established physical store retailer is better off serving consumers on the web than a new e-retailer, i.e., a stand-alone e-retailer.
- The more the website is built on artifacts from the physical store, the easier it is for consumers to orient themselves in the virtual context.

The latter is especially important since we have concluded from our consumer studies that many customers need help to orient themselves on the web. They need support to feel confident and at ease in the new virtual context. We also hypothesize that the catalog background is beneficial not only for managing the e-business, but also for helping consumers orient themselves in the virtual context. The catalog offers them a physical artifact providing continuity, security and trust.

The case studies have also reinforced our previous finding that consumers tend to alternate between available channels during the purchase process. They may begin searching on the Internet for alternatives, and then go to the physical store for inspection. They may also reverse the process and start by viewing a product in the physical store, and then search on the net for alternatives and prices. The closing of the purchase may take place at either of the store types. From this, we can conclude that the e-channel and the physical channel are complementary. The different channels, physical stores, mail order companies and e-stores also put various demands on consumers' input of resources, i.e. money, time, knowledge, energy and space. Therefore, the more alternatives a retail company can offer, the greater its chances to attain consumer loyalty and attract new customers.

All of our case companies are not only dual retailers, but also mail-order companies using their catalog as an important marketing tool. Is this a coincidence or an indication of something important to help us understand the prerequisites for consumers to absorb the web offerings? The possibility to combine the physical catalog and the virtual website may explain why the mail-order companies seem to be more successful serving

consumers on the web than a stand-alone e-retailer or a physical retailer also offering e-retailing.

It could be regarded as a limitation in our work that only multi-channel retailers have been studied in the company case studies. However, this limitation depends on difficulties to find examples of successful stand-alone e-channel actors in the retail trade business in Sweden. Although such companies may exist, we have not been able to identify and access them. The situation can be different in the service business provided by the e-channel.

Are the above-presented hypotheses of a permanent character, or are they in any respect time-dependent? The question about the consumers' ability to adapt to the e-channel and its unique characteristics over time compared to the more traditional physical retailing and post order retailing will be an important question for further research in the field. Another important question is how technological development will affect the consumer's choice of purchase channel. The spreading of broadband networks will increase the use of other media forms than text and still pictures for product presentations on the Internet. Will such product presentations also affect the consumer's choice of purchase channel? Only further research can answer these questions.

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PART 3

BEYOND CPFR: DEFINING THE FUTURE OF SUPPLY CHAIN COLLABORATION

On Shelf Availability: An Examination of the Extent, the Causes, and the Efforts to Address Retail Out-of-Stocks

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1 Introduction

Several trade associations such as the Grocery Manufacturers of America and the Food Marketing Institute, and joint trade-industry bodies such as ECR Europe or ECR Asia have sponsored and/or released major reports on out-of-stocks (OOS) in the past few years (see, e.g., ECR Australasia/PWC 2001; GMA 2002; ECR Europe 2003). All of this attention to OOS points to one thing: availability of products to the customer is the new battleground in the fast-moving-consumer-goods (FMCG) industry. Moreover, our research shows that 75 percent of the responsibility for OOS rests at the store level, but our research also found that improved availability will be found through retailers and suppliers working together.

In an era where retail competition is so fierce than ever, retailers continue to search for ways to enhance performance. In our view, retailers are not spending enough attention to examining their own shelves, where according to our research retailers can boost earnings per share up to five percent by addressing their OOS issues. After all, where else can a retailer find so much potential revenue without spending to attract new customers? In the pages that follow, we summarize and elaborate on the findings of our OOS research project (Gruen, Corsten and Bharadwaj 2002; described in Appendix 1).

2 What Is the Extent of Shelf Out-of-Stocks?

The average worldwide out-of-stock rate we found was 8.3 percent, as is shown in Figure 1 (see Appendix 2 for discussion of what makes up an OOS). The average of the reported highs in the studies was 12.3 percent, and the average of the lows was 4.9 percent. This is similar to, the primary USA benchmark of 8.2 percent that was reported in the 1996 Coca-Cola Research Council. Our finding also falls within the range of two other recent studies. A 2002 GMA study on direct-store-delivery in the USA reported an out-of-stock rate of 7.4% with categories ranging from 3.2% to 11.2%. ECR Europe's 2003 on-shelf-availability study reported an out-of-stock rate of 7-10% with categories ranging from 5% for canned food to 18% for fresh meals and even 32% for ladies stockings. Keep in mind that the studies used slightly different measurement methods, different people, measured different categories, and examined different durations and different daily and weekly factors. All of these can affect the measurement of out-of-stock rates. Regardless of the method, when all factors are considered together, the averages regress to an uncanny similarity. This provides a sense that the findings are reliable in the aggregate.

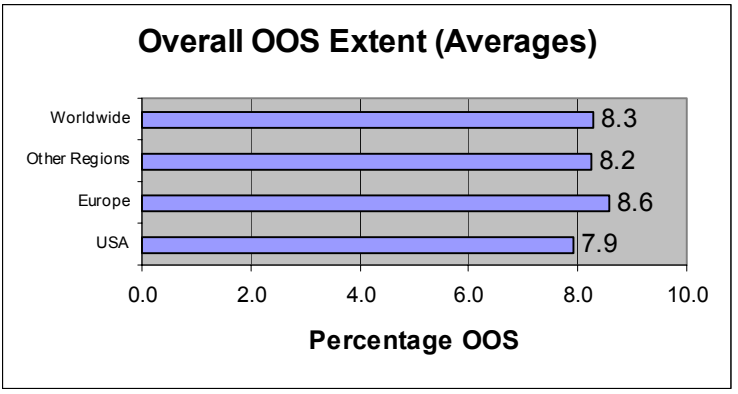

Fig. 1: Composite OOS Averages

When we split Europe into its northern and western region (Norway, Denmark, Sweden, France, Belgium, Netherlands, Germany, Switzerland, Austria, United Kingdom, Finland) and into its southern and eastern region (Portugal, Spain, Greece, Poland, Hungary, Czech Republic, Slovakia), we found that countries within each of these two areas showed similarities in OOS rates, but differences between the two regions were substantial. Northwest Europe showed the lowest OOS rates of any region in the

world, while Southeast Europe showed the highest. OOS rates in "other regions" (South America and Asia) were lower on average although details varied.

We found several factors to affect OOS rates that were consistent across geographies. First, for promotional effects, our research consistently found OOS rates to be higher on promoted items than on non-promoted items. In some cases, the differences are minor, but in most the difference is substantial – even though promoted items should be receiving retail store managers' attention. While the differences vary among studies, in general, we found a 2:1 ratio of promoted vs. non-promoted OOS rates. Second, OOS rates varied by day of the week with Sunday and Monday having the highest levels, and levels decreasing throughout the week. This pattern makes sense when one considers that shopping will be highest on weekends, while retailer ordering and delivery to stores does not occur until Monday and Tuesday.

3 What Are the Consumer Reactions to Shelf Out-of-Stocks?

We also looked at a worldwide study of more than 71,000 consumers that was conducted in a series of 29 studies across 20 countries across a variety of FMCG categories. The results of this analysis are presented in Figure 2. Academic research has identified and categorized up to 15 possible consumer responses to an OOS, though typically, managerial researchers measure five primary responses (see, e.g., Campo et al. 2000; Emmelhainz et al. 1991; Fitzsimons 2000; Progressive Grocer 1968; Schary and Christopher 1979). All five responses result in direct and/or indirect losses to both retailers and manufacturers. These are: (1) buy item at another store (store switch), (2) delay purchase (buy later at the same store), (3) substitute-same brand (for a different size or type), (4) substitute-different brand (brand switch), 5. do not purchase the item (lost sale).

In the aggregate, delay of purchase and not purchasing at all are reasonably similar worldwide. The major overall difference between USA and European consumers is the lower willingness of USA consumers to switch brands. European consumers are almost 50% more likely to switch to a competing brand when faced with an OOS on the desired item (see Figure 3). Alternatively, USA consumers are more likely to substitute a different package size or variation within their preferred brand. Thus, in the aggregate, USA consumers act in a more brand loyal manner than do

consumers outside the USA. Store switching is greatest outside the USA and Europe. Europeans are the least likely to switch stores due to OOS.

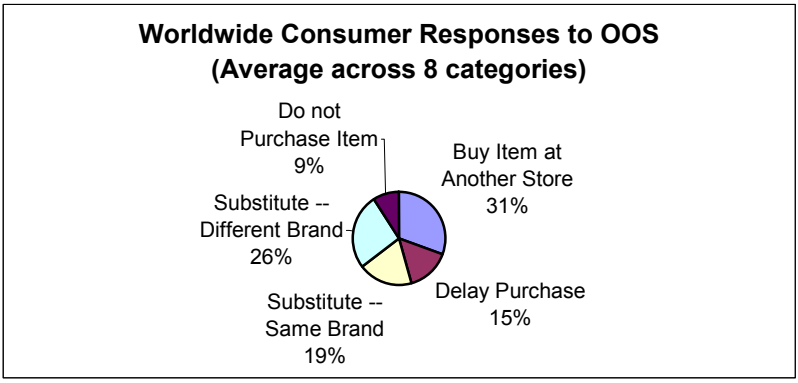

Fig. 2: Composite worldwide consumer responses

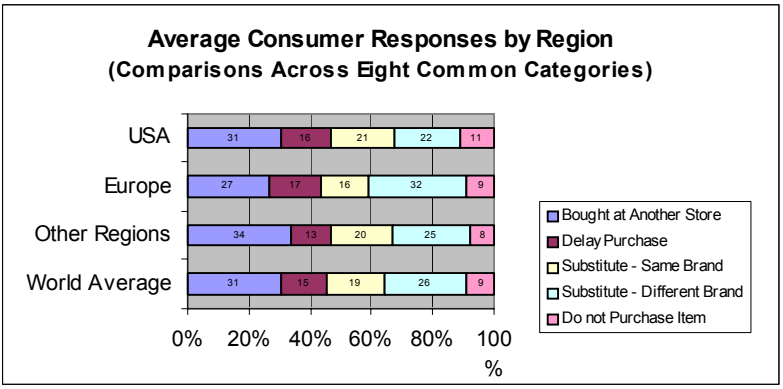

Fig. 3: Composite consumer responses by region

Consumer Responses vary considerably by category. Figure 4 shows the worldwide average for several of the categories examined in the study. Several factors affect the consumer response to OOS items. Traditionally, these have been categorized based on the nature of the category, type of product, type of consumer, the immediacy of need, and the general brand loyalty. However, all of these factors interact, making it difficult to develop a generalized scheme to help determine the likelihood of a consumer's reaction.

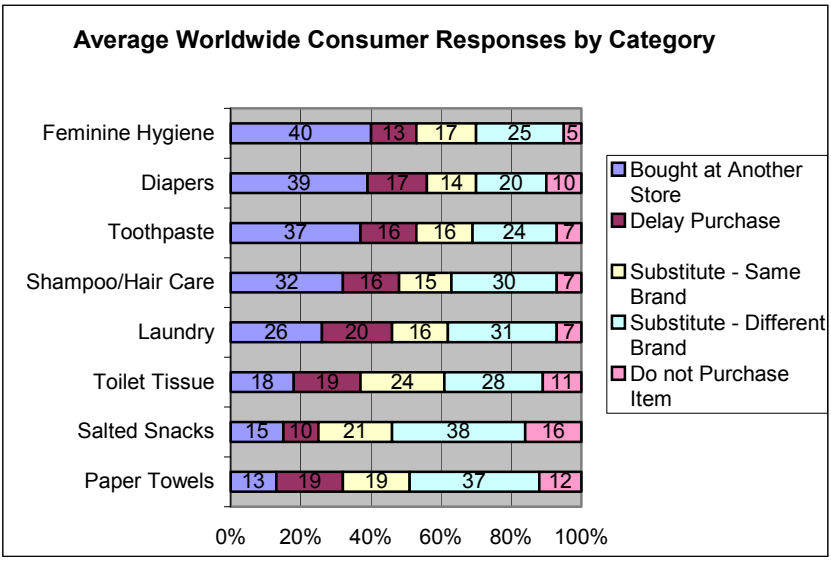

Fig. 4: Consumer responses by category

To present a generalized approach, we found that there are three primary drivers that interact and cause the consumer to take one action over another. Using economic theory, Campo et al. (2000) present the opportunity cost of not being able to consume the product immediately, the substitution cost of decreased utility of a less preferred alternative, and the transaction cost of the time and effort required to obtain the preferred item. When the opportunity cost of not being able to immediately consume the product is high (for example when one runs out of diapers), the consumer will either substitute or find the item at another store. Alternatively, a low opportunity cost will lead to either purchase delay or cancellation. When the substitution cost of using a less preferred brand is high (for example in the case of feminine hygiene and laundry), the consumer will take any action except to substitute another brand. When the transaction cost is high in terms of the time and effort required to purchase later or elsewhere, the consumer will either substitute or cancel purchase. This perspective explains why consumers tend to switch more in some categories than others. For example, we found that feminine hygiene has low substitution, since these are very personal products and there is a high substitution cost. However, when the brand is less personal e.g., paper towels, more substitution between brands may occur.

4 What Is the Cost of Shelf Out-of-Stocks to the Retailer?

While most studies concentrate on the sales loss to the retailer created by OOS items, the total "cost" of OOS can be divided into four areas: 1) *retailer shopper loss risk,* where shoppers permanently switch stores due to OOS situations; 2) *retailer sales loss risk,* where consumers buy the OOS item at another store, cancel their purchase, or substitute a smaller and/or lower priced item; 3) *manufacturer shopper loss risk,* where consumers switch to a competitor's brand within a category, not only for the immediate purchase but also for ongoing purchases; and 4) *manufacturer sales loss risk,* where consumers substitute a competitor's item or cancel a purchase. The key to understanding the implications of OOS (as well as the benefits of addressing OOS at the retailer) is that the four areas of loss are interdependent. A reduction in the sales loss to the retailer also reduces the resulting shopper loss risk, the risk to the supplier, and the resulting supply-chain inefficiencies.

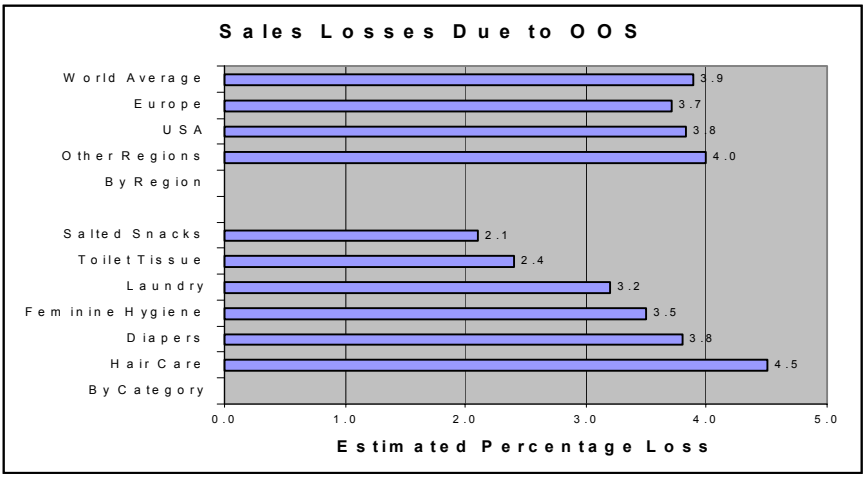

Fig. 5: Computed losses due to OOS by region and category

Most of the attention in measurement has been in the area of retailer sales loss, which is typically estimated based on the following formula:

Percentage of consumer responses that negatively affect the retailer x OOS Extent.

Figure 5 shows that the worldwide benchmark average is 3.9% sales loss at retail due to OOS items. The regional averages as well as worldwide averages by category are also presented. The chart shows that overall sales losses are similar worldwide, with a narrow range from 3.7%-4.0%.

However, category sales losses vary dramatically from 2.1% to 4.5%. Regardless of how the data is cut, the implication is still the same: both the manufacturer and the retailer have created value for the consumer, but nearly 4% of this effort is wasted because the retailer cannot extract the value from the consumer due to OOS items.

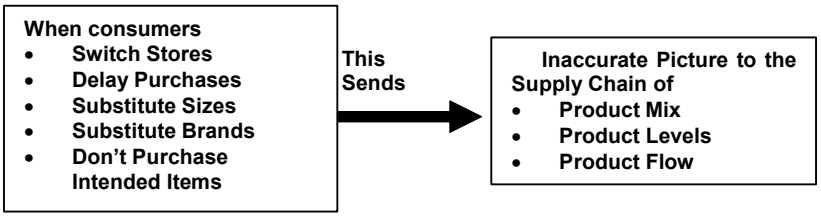

Fig. 6: Consumer responses to OOS negatively affect information flows

Other implications of OOS include logistics and information inefficiencies in the supply chain. Irregular, fill-in, and "rush" orders due to OOS situations cause logistics-fulfillment inefficiencies. These are subject to "demand amplification" or the "bullwhip effect", where small shifts at the retail level become magnified further up the supply chain. Information inefficiencies are created when the ordering signals sent up the supply chain reflect a pattern other than true consumer demand. What is worse, out-of-stocks not only disappoint customers, but perpetuate themselves and drive up costs throughout the supply chain. When a retailer needs to reorder a product, the buyer will typically examine the sales history of that product. When the item has been out of stock, the sales history data provides inaccurate information on what is the necessary purchase quantity to meet actual consumer demand. If the out-of-stock has not been detected, then the buying decision will most likely be too low to meet the normal customer demand plus those consumers who delayed purchase until the retailer received additional stock. Alternatively, if the buyer is aware of the OOS situation, the tendency may be to over-order, because the buyer is unable to determine the permanent customer loss to the brand caused by the OOS through brand substitution or to the store due to store switching. In sum, the OOS forces the buyer to work with a greater margin of error, and this increases the variability in the ordering, as summarized in Figure 6.

5 What Are the Root Causes of Shelf Out-of-Stocks?

Previous studies have placed most of the responsibility for OOS on retailer store ordering and forecasting practices. Our research confirms this, as Figure 7 shows. Between two-thirds and three-fourths of OOS are caused in the store, while one-fourth to one-third is due to upstream causes. Worldwide, the two greatest causes are inaccurate forecasting (34%), an indicator of increasing demand volatility, and shelf-replenishment (25%). The latter is particularly surprising when compared to the much-cited 1996 Coca Cola Research Council study. That study attributed a higher percentage to ordering (19%) and forecasting (54%), but it traced an average of only eight percent of the OOS situation to product being available in the backroom but not on the shelf.

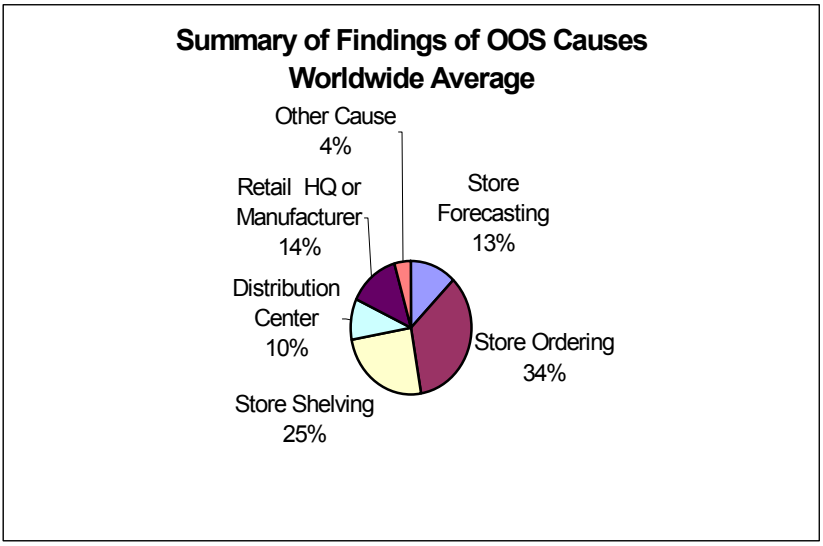

Fig. 7: Composite average causes of OOS

Figure 8 shows how OOS causes vary by region. We were surprised to find that, in the USA, significantly more causes of out-of-stocks are attributed to ordering practices (51%) than in Europe (32%). On the other hand, in Europe, there seem to be more problems with regard to replenishment (47%) than in the USA (32%), particularly shelf replenishment (i.e. when the product is already in the store). This is counterintuitive, as one would have guessed that smaller back rooms and efficient transport networks in Europe would alleviate this cause. Somewhat striking, 72% of all OOS

across the world are caused in the store, by poor store processes, late and insufficient ordering, incorrect forecasts, or shelf restocking problems. Retailer store managers must simultaneously manage thousands of stock-keeping units and work with hundreds (often thousands) of simultaneously promoted items (which cause demand to fluctuate), while keeping personnel costs in reason (Dubelaar et al. 2001). Furthermore, retailers face complementary issues, such as shrinkage that becomes more difficult to control as inventories increase. Thus, it is not surprising to see a strong linkage of out-of-stocks with store ordering practices.

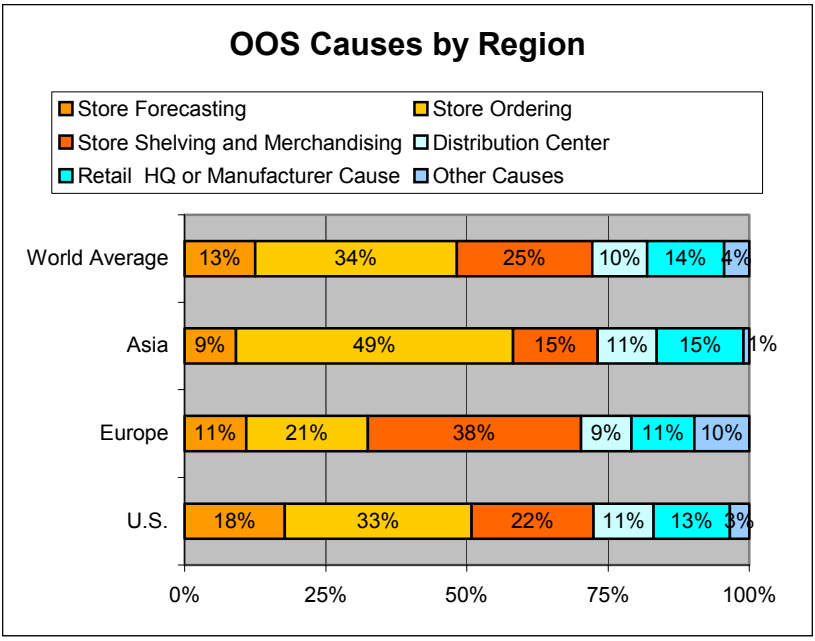

Fig. 8: Regional differences in OOS causes

However, the real story is more complex. Broadly speaking, causes of out-of-stocks tend to be assigned to one of the following three general processes, detailed in Figure 9.

Root Cause		
Planning	**Ordering**	**Replenishing**
Store		
• Incongruence between shelf capacity and replenishment frequency. • Product purchasing frequencies. • Large number of SKUs in assortment.	• Data (bad POS data, inaccurate records). • Forecasting (inaccurate forecast, long cycles). • Inventory (inaccurate inventory or book-stocks). • Ordering (no order, late order, wrong order, backorders).	• Staffing (insufficient or busy staff). • Backroom (congested). • Receiving (receiving errors, inaccurate records). • Shelf replenishment (infrequent, late or no shelf filling). • Planogram (bad execution and compliance). • Shrinkage (damage, theft).
Distribution Center		
	• Data (bad data, inaccurate records). • Forecasting (inaccurate forecast). • Inventory (inaccurate inventory or book-stocks). • Ordering (no order, late order, wrong order, backorders).	• Transportation (shipping, loading). • Receiving (loading errors, inaccurate records). • Storage (put away/ break pack). • Replenishment (infrequent, late or no store replenishment). • Lead times (long and infrequent). • Shrinkage.
Wholesaler/Retail Headquarter		
• Assortment (new or discontinued item). • Data and communication (master data). • Planogram design and implementation (shelf allocation). • Promotions and pricing decisions. • Advertising and display planning. • Store layout and service levels.	• Data (bad data, inaccurate records). • Forecasting (inaccurate forecast). • Inventory (inaccurate inventory or book-stocks). • Ordering (no order, late order, wrong order, backorders).	• Availability (shortage).
Supplier		
• Assortment (new or discontinued item). • Data and communication (master data). • Promotions and pricing decisions. • Advertising and display planning.	• Data (bad data, inaccurate records). • Forecasting (inaccurate forecast). • Inventory (inaccurate inventory or book-stocks). • Ordering (no order, late order, wrong order, backorders).	• Availability (packaging, raw materials and ingredients).

Fig. 9: Root Causes of OOS by Supply Chain Level

They are described as follows: 1) *ordering practices,* which is when the retail store may have ordered too little or too late, so that the warehouse could not deliver before the retailer ran out of the item, or when the retailer forecast may have misjudged demand for an item and ordered an insufficient supply; 2) *Replenishment practices*, which is when the product is in the store (often in the backroom, but also sometimes in another area of the store) but not on the shelf when the consumer comes to buy the product, or when the warehouse may have insufficient inventory to meet demand and "scratches" the retailer's order; and 3) *planning practices*, which is when the item may have been discontinued but not communicated to the retailer, the manufacturer may not have shipped adequate inventory, or there may be a product "drought", namely the manufacturer is unable to produce enough to meet demand.

6 How Can On-Shelf Availability Be Improved?

The previous discussion showed that the majority of the root causes are in the store, however, that's not the place to start in order to find a solution. Ideally, a sustainable on-shelf availability management process consists of a set of linked decisions on category tactics and shelf space allocation, as well as the mode, frequency and quantity of ordering and replenishment. An integrated process must address the three supporting pillars of process responsiveness, operational accuracy, and incentive alignment in order to effectively address the root causes of out-of-stocks.

Remedy 1: Process Improvements

Assortment Planning and Space allocation. Given the continuously changing and growing assortments, most stores end up in a dilemma where they allocate relatively too little shelf space for fast movers and too much shelf space for slow movers (Corstjens and Doyle 1981). Fast movers are particularly susceptible to out-of-stocks and, counter-intuitively, we found that fast movers often get less than their fair allocation of shelf-space given their sales potential. Clearly, a fast mover or a promoted item with high demand volatility needs more, rather than less, shelf space to fulfill consumer demand at any given moment otherwise it runs the risk of being out-of-stock.

Automatic Ordering systems: Traditionally, store managers evaluate inventory by walking through the store, and order products based on intui-

tion rather than on accurate forecasts. This of course leads to lost sales because near and complete out-of-stocks are spotted too late. While shelf-replenishment remains, even today, a predominantly manual process, automatic or computer-assisted store ordering has emerged as a key lever for better on-shelf availability. Spain, for instance, has improved availability by more than 66% (i.e. from 13-15% OOS to 5%) in test stores that moved from manual ordering to computer-assisted store ordering.

EDI, Internet and Real-time Ordering: Batching orders disrupts the product flow to the shelf, and causes the well-known "Bullwhip Effect" throughout the supply chain (Lee 2002). To address this, many retailers have already increased their ordering frequency, implemented EDI and internet ordering, introduced mixed truckloads, adapted minimum pack sizes, reworked delivery schedules and automated ordering to break batches. Tesco has gone even further, by exploring how its systems can pass orders continuously to its suppliers, rather than once a night.

Inventory Control: Retailers and suppliers can and should work together to reduce total supply chain inventory. While, intuitively, most would think that supply chain inventory levels positively correlate with on-shelf-availability, we found the contrary to be true. Higher supply chain inventory actually correlates with higher out-of-stock rates! This apparent paradox can be explained by the fact that retailers with lower inventory levels tend to manage their supply chains better and have their inventories in the appropriate places.

Remedy 2: Improve Operational Accuracy

Automatic Availability Measurement: Advanced technology-based solutions have emerged that automate out-of-stock measurement and detection. For example, Sainsbury's has introduced an automatic "Shelf Availability Monitor" (SAM). This system tracks the sales transaction data (rather than the inventory) for a store's top 2,000 products, and can be used to flag items that may be out of stock. It is in use at most stores, with regular reports highlighting where sales have been missed, how long items have been unavailable, and converting these numbers into a cash figure of lost sales. Furthermore, it tracks a store's sales in 15-minute blocks, and stores can plan their activities to ensure products are available when there is likely to be shopper demand. Since the introduction of SAM in early 2001, there has been an improvement across the company of 1% on-shelf availability. Another solution has been developed by Data Ventures and Procter & Gamble. The "Item Velocity Monitor" predicts with 90% accuracy the

out-of-stock status for items that move four or more times per day. This can provide a real-time signal to store managers and does not depend on store inventory records. These new solutions all share the ability to utilize technology (as opposed to inventory or manpower) to address out-of-stocks items on a rapid basis. This provides the potential benefits of reduced out-of-stock levels without committing high cost labor to address the problem.

Inventory Record Accuracy: Inventory inaccuracy presents a major obstacle to on-shelf-availability, and needs to be addressed. This is crucial, since ordering and inventory models assume that inventory records are accurate. However, recent research indicates that inaccurate inventory levels and misplaced stock-keeping-units are both significant and expensive, contributing to a profit reduction of more than 10 percent (Raman and Ton 2001). Due to data inaccuracy, retailers have to hold larger safety stocks, which increase the inventory costs. In addition, when inventory records (that are based on point-of-sales data) differ significantly from physical inventory levels, retailers cannot effectively use point-of-sales data for inventory management purposes.

Automatic Identification: One exciting technological advancement that provides great hope for improving on-shelf availability is based on the emerging technologies of intelligent tags or smart chips such as those promoted by the Massachusetts Institute for Technology's Auto-Identification center. Recently, Procter & Gamble and SAP announced a joint trial of the use of radio-frequency identification (RFID) transponders. In Rheims, Germany, Metro introduced a test of this technology in a retail store.

Remedy 3: Improve Incentive Alignment

Ordering Incentives: Store managers are faced with a confusing array of incentives. We found that many retailers penalize their store managers for out-of-stocks instead of encouraging them to improve on-shelf-availability. Simultaneously, store managers are generally liable for stolen merchandise and other sources of shrinkage. This encourages managers to purposely keep shelves "empty" or lock up merchandise behind the counter. Furthermore, when store managers are penalized for high inventory they will reduce stocks despite the risk of out-of-stocks. Hence, rather than penalizing inventory, stores should focus on on-shelf availability.

Incentive System: An even larger problem than the mixed incentives to managers is the lack of connection between headquarters buyers and the retail store managers. Buyers determine which products should be held by

the stores, but often they do not base their decisions on store sales information, nor do they account for the store managers' understanding of their shoppers' behavior. Rather, the buyers' decisions are governed by a range of functional factors, including purchasing term negotiations, margin, and volume-based performance incentives. To compensate for this, many stores deviate from the list of products prescribed by the buyers at the headquarters.

Change Culture: To motivate associates to have a real passion for availability retailers such as Delhaize or Safeway have begun to create a culture with a passion for availability. They have launched comprehensive initiatives involving supply chain and store associates, internal competitions and awards. By setting tough targets, aligning incentives and controlling the process, they have achieved a change in employee attitudes to availability.

7 Conclusions

What does one conclude from all of this? There are several lessons.

- First, all of the studies we examined point to a common concern: OOS has been, is, and will continue to be a problem. The aggregate extent we found of 8.3 percent (and the similar results found through other industry studies) continue to (and should) raise alarms throughout the FMCG industry.
- Second, OOS is costly. While the total costs to the supply chain have not been investigated, we found that, worldwide, average sales loss due to OOS is 3.9%.
- Third, not all OOS are the same. A slow moving item that is OOS will be less costly to the store than a fast moving item. Similarly, consumer substitution varies extensively among categories, affecting the retailer and manufacturer to different degrees.
- Fourth, duration of OOS is important. While techniques for measuring the duration of OOS are fairly new, the impact of long-term OOS problems affects not only the sales of the item, but also the likely potential of a consumer to switch stores.
- Fifth, most of the responsibility for lowering OOS rests in the retail store. Unfortunately, manufacturers have placed their resources towards lowering OOS on solving supply chain problems. This focus will need to shift, if the problem of OOS is to be effectively addressed.
- Sixth, as we examined consumers across the world, we found that consumers are indeed localized in their choices. However, when their choice is taken away through an item being out-of-stock, consumers

behave in a similar manner globally. In the end, the retailers (and their supply chains) that satisfy customers on this issue will be those more likely to succeed.

In summary, improving availability is imperative but it comes at a price. Reducing OOS requires initiatives that cut across functional boundaries and may require a fundamental rethinking of retailer processes. We believe most retailers have not yet reached the threshold where it will cost them more not to reduce the incidence than it will cost them to invest in solutions. Clearly, there is a minimum out-of-stock rate where cost to reduce further is more than the benefit. In fact, in some categories occasional out-of-stocks can be even beneficial, as certain availability may eventually increase price competition. Regardless, out-of-stock (or its counterpart, availability) remains a major issue not only for retailers, but also for all parties in the supply chain.

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Appendix 1: The Research Study Description

This paper is based on a report entitled, *Retail Out-of-Stocks: A Worldwide Examination of Extent, Causes, and Consumer Responses* (Gruen, Corsten and Bharawaj 2002). This report presents what is believed to be the largest and most current single compilation of findings regarding the extent, causes, and consumer responses to retail out-of-stock (OOS) situations in the fast moving consumer goods (FMCG) industry. This is also the first study that enumerates OOS on a worldwide basis. Funded by a grant from the Procter & Gamble Corporation, the study was conducted in 2001-2002.

The inputs for this report come from 52 studies that examine OOS. This includes previously published results of 16 industry and academic studies, as well as the results from an additional 36 studies proprietary to this report. To provide a sense of the extensiveness of the studies that were used to develop this report, consider the following:

- Number of retail outlets examined: 661
- Number of FMCG categories included: 32
- Number of consumers surveyed world-wide: 71,000
- Number of countries represented: 29
- Studies addressing extent of OOS: 40 (of 52 total studies)
- Studies addressing the root causes of OOS: 20 (of 52 total studies)

- Studies addressing the consumer responses to OOS: 15 (of 52 total studies)

The basic process used in the research followed five general steps:

1. Collect and review published and unpublished OOS studies worldwide.
2. Collect and review related research on OOS from academic and applied sources.
3. Delineate findings from research.
4. Isolate limiting factors.
5. Synthesize findings and determine areas of consensus, trends and key findings.

More specifically, to develop this report, information was collected and synthesized from the following general sources:

- Previously published industry reports and studies of out-of-stocks.
- New data provided by two large-scale consumer studies conducted in 1999-2000 (one in the U.S. and a second identical study conducted in 19 countries outside North America).
- New data provided by studies of three retailers' scanner and inventory data conducted in 1999-2001.
- New data provided by a series of traditional store audit studies conducted in 1998-2000.
- Various academic articles published from 1962-2001 on out-of-stock studies.
- Industry press and articles that addressed and/or reported on other out-of-stock studies.

The academic and industry studies provided background and theory regarding the way out-of-stocks have been measured, the likely consumer responses to out-of-stocks, and the value of addressing the issue at the retail level. The majority of the academic studies focused on consumer responses and provided important theoretical and categorical approaches to examining consumer response data. The industry studies were examined to provide baselines for evaluating the information we would then examine from the new studies. The review of the industry studies led us to systematically arrange the information contained in all studies into the following categories:

- Methodology.
- Categories examined.
- Extent of out-of-stocks found.
- Consumer responses.
- Root causes identified and assigned.

- Efforts examined / suggested to address out-of-stocks, the costs and returns.

The logic of the arrangement is straightforward. First, the methodology was reviewed to determine any likely limitations or concerns faced when examining the data from the study. This methodology also provided a way to categorize the studies. Second, the categories examined were listed in order to make comparisons among the studies that examined the same or similar categories. Consumer responses to OOS situations tended to vary widely among categories, thus category identification is a key variable.

Following general categorization, examination of the extent of out-of-stocks in the report was the logical place to begin, since it answers the question: "Is there a problem?" After identifying the extent, the logical next question is: "Does the OOS matter?" This is answered by examining the consumers' responses to OOS situations. The search for the cause to the problem leads to the next question: "Who is responsible for causing the problem?" This leads to the final questions: "Can and should it be fixed? If so, how?"

Appendix 2: Measuring Out-of-Stocks

The definition of what makes an OOS affects the extent that gets reported in studies. While many variations exist, recent studies tend to settle on a consumer-based definition. Two general alternative definitions emerge based on the method of measurement. As the first and most accepted approach, the OOS rate is measured as a percentage of SKUs that are out-of-stock on the retail store shelf at a particular moment in time; i.e., the consumer expects to find an item that the store usually carries, but it is not available. Normally, the OOS rate is reported for each category individually, and then the categories are averaged (normally unweighted average) to create and report an overall rate for the study. Due to the number of studies that have used this approach, a major advantage of using this method is the availability of excellent baselines. The limitations to this type of measurement include the arbitrary nature of selection of the categories, frequency and timing of the audits, duration of the study, and human error that can and does enter from many sources. In addition, differences in sales volume are not taken into consideration hence this definition does not indicate lost sales.

A second definition of an OOS is the number of times a consumer actually looks for the SKU and does not find it. The percentage rate is calculated as the number of times the consumer does not find the SKU divided

into the sum of the times the consumer does find the SKU *plus* the number of times the consumer does not find it. Instead of relying on physical audits, the second approach is measured through the use of models that determine OOS rates from store scanner and inventory data. This view provides the advantage of determining the extent of out of stocks that actually matter to the retailer and the upstream supply chain members. The major limitation of this method is that the OOS rates are estimated based on historical sales patterns, and thus can only be calculated for SKUs that sell with a minimum frequency (thus, it cannot detect OOS for very slow moving products). Few studies have used this method, and therefore baselines do not readily exist.

Increasing Shelf Availability Through Internet-Based Information Sharing and Collaborative Store Ordering

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1 Introduction

Consumer value and satisfaction are fundamental to building consumer loyalty (to the brand) and shopper loyalty (to the store) and increasing sales and category profitability (Colacchio et al. 2003). A powerful way to create value and satisfaction is to keep shelves fully ranged (Roland Berger 2002), but out-of-shelf (OOS) is still a frequent phenomenon.

Out-of-shelf rates vary wildly among retailers and their outlets depending on a variety of factors, but the majority tends to fall in the range of 5-10 percent. In their analysis, which is a compilation of many global surveys on the extent, causes and consumer responses to retail out-of-shelf situations in the grocery retail sector, Gruen et al. (2002) estimate an overall average OOS rate of 8.3 percent. There seems to be a consensus that an out-of-shelf level of about 2 percent must be accepted. However, in most European countries levels between 10 and 15 percent are not unusual (Roland Berger 2003). Interestingly, slower-moving items experience more out-of-shelf than items with higher rotation (Vuyk 2003).

A number of prior studies (Schary and Christopher 1979; Straughn 1991) have examined how product unavailability (via a temporary out-of-stock) influences sales for a given product (SKU). Bell and Fitzsimons (2000) have studied the impact of out-of-stocks on category sales, while other studies have analyzed the possible consumer reactions to out-of-stocks from a marketing and retail management perspective (Verbeke et al. 1998; Campo et al. 2000; Fitzsimons 2000; Emmelhainz et al. 1991). Emmelhainz et al.'s (1991) research results show, for instance, that a stock-out can make a manufacturer lose more than half of his/her buyers to competitors, whereas retailers face the loss of up to 14% of the buyers of the missing product. This revenue loss not only stems from lost product sales during the OOS period, but can also extend to later periods or other prod-

uct categories (Campo et al. 2000). Loyal consumers that don't find the products they want to purchase in their local store would simply shop elsewhere, while less-loyal ones would switch to another brand or type of product. In many cases, the consumer will forget about the impulse to buy the product and will not purchase it at all. Fierce competition in the industry means that this problem is a major concern for both retailers and suppliers, who have to ensure that their products are in the right place on the right time, or risk losing out to the competition.

Despite the extended literature on consumer reactions to out-of-shelf situations, very little has been written on the reasons behind the problem. In the relevant texts that are available (which are fairly sparse and largely empirical), we see a classification of the causes of OOS into three areas (Gruen et al. 2002; Vuyk 2003):

a. *Retail store ordering and forecasting causes*, i.e. the product was not ordered or the ordered quantity was not enough to meet the actual consumer demand.
b. *Retail store shelving and replenishment practices,* in which the product is at the store but not on the shelf. This category comprises all reasons relating to shelf-space allocation, shelf-replenishment frequencies, store personnel capacity, etc.
c. *Combined upstream causes*, meaning that the product was not delivered due to out-of-stock situations or other problems with the retailer's distribution center (for centralized deliveries) or the supplier (for direct-store-deliveries).

The analysis by Gruen et al. (2002) shows that 70-75 percent of out-of-stocks are a direct result of retail store replenishment practices (either underestimating demand, or having ordering processes/cycles that are too lengthy) and shelf-restocking practices (product is at the store but not on the shelf). The same distribution of causes is also reported in a pan-European study, where 70% of out-of-stocks are again attributed to retail store ordering and shelf replenishment practices (Roland Berger 2003). An earlier study in the US draws similar conclusions, with the main causes found in the store ordering process and forecasting inaccuracies (Supermarket Business 1996). These results indicate that further development of the warehouse and distribution operations will not significantly improve the out-of-shelf situation in grocery retailing. Most problems are caused inside the store, or in the replenishment process, independent of who is the player taking care of ordering or replenishment (Kaipia and Tanskanen 2003).

In this article, we address the issue of out-of-shelf by focusing on the ordering and replenishment practices at the store level. More specifically, we

suggest a new process and Internet-based information infrastructure, which enables the daily, store-level collaboration and information exchange between retailer and supplier, supporting the replenishment process for the full product range at store level. In the following sections, we describe the suggested new approach in dealing with the store replenishment process and the underlying e-business infrastructure. We further discuss the impact on shelf availability and the implications and lessons acquired from implementing and applying the suggested approach in practice, with one big retailer and several suppliers. We conclude this discussion with some closing remarks and suggestions for further development and research in this area.

2 Internet-based Information Sharing and Collaborative Store Ordering

2.1 The Store Ordering Process

The main objective of the store replenishment process is to ensure that the right products and quantities are replenished back to the store either from the retailer's distribution center (centralized deliveries) or directly by the supplier (direct-store-deliveries). The replenishment process is mainly kicked-off by a command, which is the order, specifying which products and what quantities to be replenished. The order may be prepared by a store manager and sent to the retailer's distribution center (for centralized deliveries) or may be prepared and agreed in collaboration with the supplier's salesperson for direct-store-deliveries.

The objective is to always have the products that consumers demand on the supermarket's shelves, i.e. not to have any stock-outs, and maintain optimum levels of stock in the store, given a pre-defined mix of products to be offered by the store (store-assortment), a fixed ordering schedule and store capacity. The two objectives are performance tradeoffs, as increasing the stock minimizes the possibility for stock-outs and vice versa (Clark and Lee 2000).

This process can be hardly automated at the level of the retail store, due to the many different factors affecting consumer demand. These factors are difficult to integrate in a complex computer system, since, to be evaluated they require human intuition and knowledge. According to Ogawa (2000), what increases or decreases the effectiveness of this decision-making process is the information that the user has available in doing the right judgment.

We claim that, if all this information was available to the order decision maker (either the store manager or the supplier's salesperson) at the time he or she makes the decision on what products and quantities to order, then this would greatly increase the effectiveness of the ordering process, leading to reduced out-of-stocks and optimized stock levels, but also the efficiency of the process, as that person wouldn't spend time searching right and left for the necessary information. We also claim that the effectiveness of the process could be further improved if the supplier got involved not only in the ordering of direct-store-delivery goods, but also in the ordering of centralized goods, as the supplier has a much better knowledge of his/her products, the appeal they have to consumers, the product marketing activities, etc. The question is how we can enable extended information availability to the order-decision-maker, on one hand, and retailer-supplier collaboration, also from a distance, on the other, so that out-of-shelf rates for all the products in a supermarket store can be reduced.

2.2 The Process of Collaborative Store Ordering

The advent of e-business has created several challenges and opportunities in the supply chain, and has made it easier to share information among supply chain partners. The current trend in the industry is to try to leverage the benefits obtained through information sharing (also called visibility) across the supply chain to improve operational performance, customer service, and solution development (Swaminathan and Tayur 2003). A related issue in supply chain information sharing is sharing forecast information, which, in grocery retailing, takes the form of Collaborative Planning Forecasting and Replenishment (CPFR) (VICS 2000; Seifert 2002). More specifically, CPFR operates as a set of business processes in which trading partners agree to mutual business objectives and measures develop joint sales and operational plans and collaborate to generate and update sales forecasts and replenishment plans (Hölmstrom et al. 2002). In CPFR, the two parties (typically manufacturer and retailer) jointly collaborate to generate a forecast and plan for that forecast.

Pramatari et al. (2002) provide a framework for classifying the various CPFR initiatives undertaken to date, as reported in Accenture (2002), by examining the implementation scope of CPFR across the axes of place, product, time and extent of information sharing. This classification shows that the focus of the various CPFR projects reported is on the replenishment of the retailer's distribution center. These projects deal with promotion items and new introductions, rather than regular line products, while the information shared is POS data (mainly electronically) and promotion

plans. They also refer mainly to mid/long-term replenishment planning and not to the day-to-day replenishment in the store. However, Holmström et al (2002) suggest that collaborative planning will only be successful if it involves very little extra work for the retailers. Collaborative planning cannot just be a solution between close partners. The goal must be solutions that enable mass collaboration in order to obtain economies of scale.

Building on the previous discussion and the notions of CRP/VMI and CPFR, in this section, we describe a practice of daily, store-level collaboration and information exchange between retailer and supplier, supporting the store replenishment process for the full product range. This practice, which we name Process of Collaborative Store Ordering (PCSO), utilizes an Internet-based collaboration platform in order to enable real-time or near real-time information sharing and supplier-retailer collaboration in the store ordering process. The Internet and new information technologies allow this type of collaboration also from a distance, both for direct-store-delivery suppliers and for the suppliers of centralized goods. Utilizing a common platform to support both the cases where collaboration exists and the cases where the store replenishment is the sole responsibility of the retailer, further facilitates the management of the store ordering process for retailers and enables mass collaboration.

The PCSO model brings together, over the Web, the expert opinion of the product suppliers and the unique knowledge of the store managers with the ultimate objective to eliminate out-of-shelf situations, while maintaining optimum levels of store inventory. It is a new collaborative practice that supports the daily store-replenishment process, based on the online-sharing of critical information such as: sales data (POS), store assortments, stock-level in the store, promotion activities, out-of-shelf alerts, etc. This process is supported by special IT infrastructure (collaborative platform) to enable the daily online sharing of all critical information, the sales forecasting and order generation, the online collaboration of the trading partners, and finally the order exchange and order status tracking. Any user connects to this collaborative platform through a secure Internet connection using a simple Web-browser interface.

The following description illustrates the practical aspects of this process in more detail. By connecting to the collaboration platform, a supplier can monitor per store the product assortment, the product sell-out, the promotional activities, the level of stock, etc. on a daily basis. Moreover, the supplier can view the system's proposed order quantities and make an order proposal to the respective store manager. He/she can also track the order status throughout the fulfillment cycle. All this information is also available in dynamic online reports, allowing statistical analysis of these parameters down to store level.

The store manager, on the retailer's side, has an overview of the full product assortment per category or supplier, and can submit an order based on both the system's proposal and the supplier's proposed quantities, as well as on the rest of information on product sales, promotions, stock, etc. The submitted order is automatically sent to the platform, and then forwarded either directly to the supplier or to the retailer's central warehouse. Automatic order-generation tools are also in place to help both the salesperson and the store manager identify the right products that need to be replenished on a daily basis.

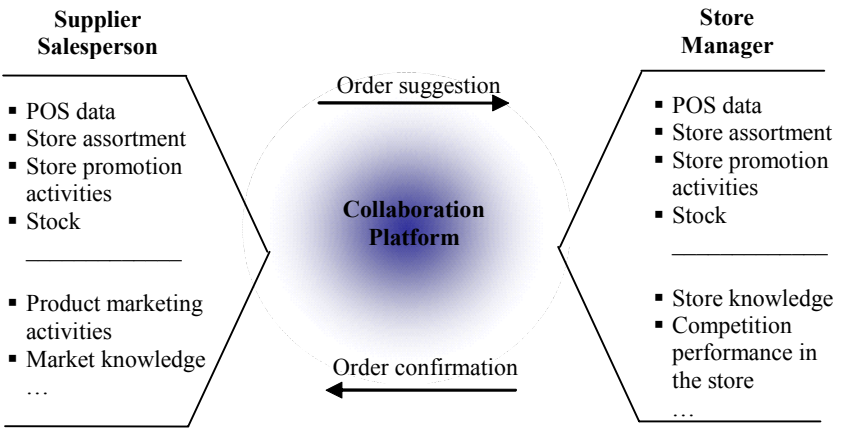

Fig. 1: Web-based information sharing between retailer and supplier

Figure 1 gives an overview of the information that the store manager and the supplier's salesperson share for the products and stores they have in common. In a user-friendly format, they see the products per category or brand, the sales of each product (average weekly sales, sales since last replenishment cycle, etc.), the product's stock in the store as well as visual indications ("flags"), identifying exception cases, such as new products, promotional products, not-selling items, etc. By looking at this screen, the supplier's salesperson prepares an order suggestion, which he/she sends for confirmation to the store manager. The store manager, having the same information available and using his/her own intuition and knowledge, can then confirm, change or reject the supplier's suggestion.

This process can be used both for products delivered to the store directly by the supplier and for products delivered via the central warehouse, leaving it to the system to separate to whom the actual order should be sent. In addition, this process can be combined with the non-collaborative ordering

process from the store to the central warehouse, i.e. the process of ordering the centralized products of all the other suppliers not collaborating with the retailer. In this case, the store manager sees a system-suggested order for all the products replenished via the central warehouse, containing more or less the same information as depicted in Figure 1. In addition, the ordering suggestions by the suppliers collaborating with the retailer in this process are incorporated into the same screen and are indicated with special flags. In this way, the store manager can evaluate in one round both the system's and the collaborating salespersons' order suggestions. This is an important element enabling the gradual adoption of this collaboration process by the suppliers without disturbing the retailer's internal operations.

PCSO does not focus on the forecasting aspect of CPFR but on the collaborative replenishment at store level based on extended information sharing on a daily basis. From another perspective, PCSO can be seen as an intermediate strategy between centralization and direct-store-delivery. Many suppliers select to be direct-to-the-store so that they can better control the ordering and shelf-placement of their products, especially if these are not best sellers in their categories, or are found in slower-moving categories. PCSO gives suppliers the possibility to separate the physical distribution of products from the ordering process, offering to suppliers the logistics benefits of centralized deliveries and the merchandising/ sales benefits of direct-store-deliveries.

3 Measuring the Impact on Shelf Availability

The objective of PCSO is to tackle the problem of out-of-shelf by improving the effectiveness of the store ordering process through retailer-supplier information sharing and collaboration. In order to get measurable business results, a pilot case was setup to test the feasibility of a technical solution supporting PCSO and the impact of PCSO on shelf availability and inventory levels. The case setting was provided by the Greek grocery retail environment, where the third biggest retailer in Greece and three of its top suppliers (one direct-store-delivery supplier and two centralized suppliers), together with a service provider, started a pilot implementation to experiment with collaborative store ordering. The pilot involved the ordering from the retailer's stores to the central warehouse as well as to the direct-store-delivery supplier. The implementation of the required infrastructure started in spring 2001, with the definition of the requirements for the Internet-based collaboration platform. The implementation and testing of the system was completed in September 2001, and the pilot went live on Oc-

tober 1st 2001. The pilot ran in five (5) stores (pilot stores), which were representative of all the stores in the retail chain, and lasted six weeks, from the 1st week of October to the 2nd week of November 2001. At this stage, the five pilot stores used the Internet-based collaboration platform for their collaboration with the direct-delivery-supplier and for ordering the products of the two centralized suppliers to the retailer's Central Warehouse. For the rest of the centralized products, they followed the traditional process.

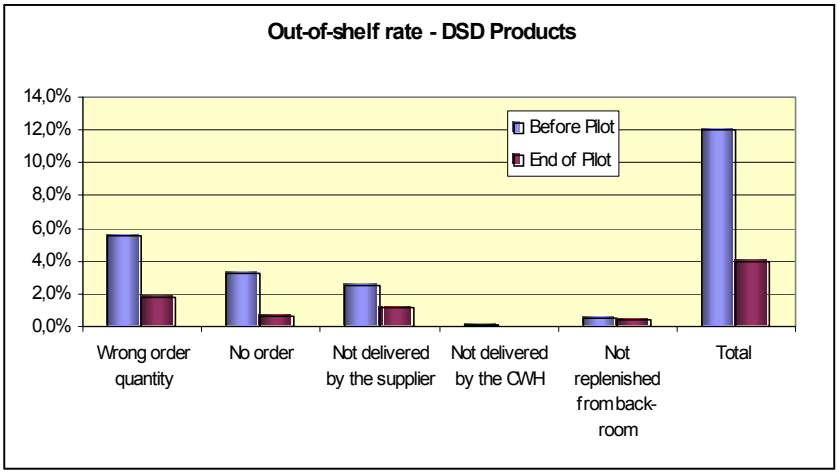

Fig. 2: Comparing the OOS rate for DSD products before and at the end of the pilot

In order to measure the impact on shelf availability and inventory levels, pre- and post-pilot measurements were performed. Based on the findings of shelf availability measurements before the pilot start, in September 2001, more than 70% of the OOS for the products of the two centralized suppliers were attributed to two main reasons: wrong order quantity, i.e. the quantity ordered was not enough to meet consumer demand till the next replenishment cycle, and no-order at all, i.e. the product had not been ordered during the last replenishment cycle, although it did not exist in the store. The distribution of OOS causes for the products of the direct-store-delivery supplier was similar, again with more than 70% of the OOS attributed to 'wrong order quantity' and 'no order'.

At the end of the pilot, the out-of-shelf rate for the products of the direct-store-delivery (DSD) supplier who was using PCSO in collaboration with the retailer for ordering in the five pilot stores had been reduced from 12% to 4%, a 67 per cent reduction (see Figure 2).

In September 2002, the same weeks a year afterwards, the shelf availability measurements were repeated in three of the initial five pilot stores. At that time, the process of collaborative store ordering between the retailer and the direct-store-delivery (DSD) supplier had been used for eleven months continuously. The overall out-of-shelf rate for the products of the DSD supplier in these three stores had been reduced from 15.4% to 7.5%, a reduction of 51%. At the same time, the OOS ought to wrong order quantity had been reduced by 93%, from 9.5% in 2001 to 0.7% in 2002 (see Figure 3).

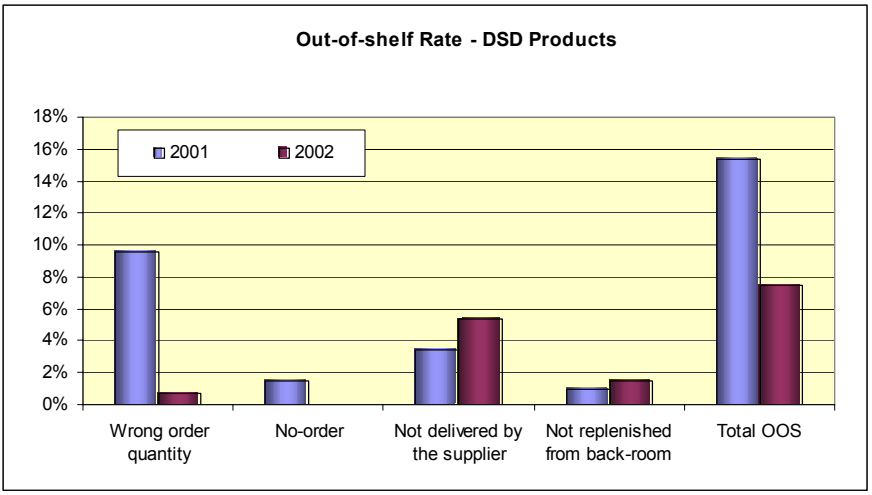

Fig. 3: Comparing the OOS rate for DSD products between Sep. 2001 and Sep. 2002*

For the centralized products of the two suppliers, we see a reduction of 59%, from 9.8% to 4%, in the 'Total OOS' level, and a similar (60%) reduction in the OOS caused by 'wrong order quantity' before the pilot and at the end of the pilot (see Figure 4). However, an important weakness of the experiment relating to the use of PCSO for centralized products was that, due to the way the experiment was executed, we cannot distinguish to what extent this effect was caused by the introduction of the new system in the internal store ordering process to the Central Warehouse, and to what extent it can be attributed to the supplier-retailer collaboration in this context.

* Note: On this graph, the comparison takes into account only the three out of the initial five pilot stores, which is why the total OOS rate differs to that presented in Figure 2.

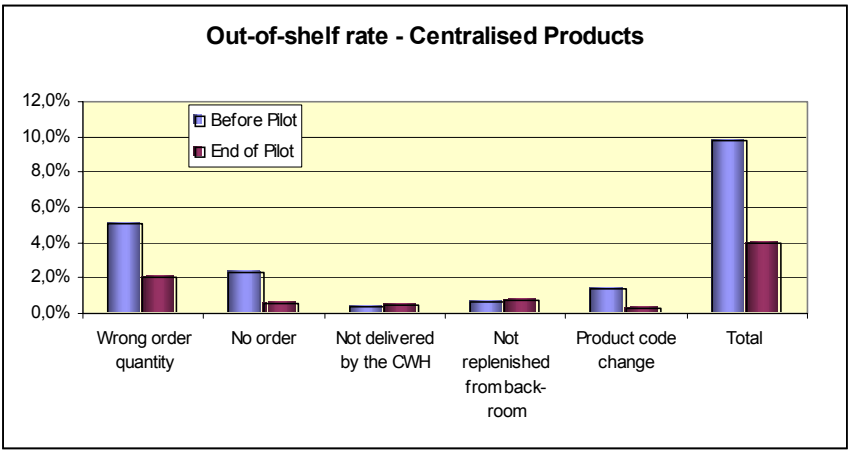

Fig. 4: Comparing the OOS rate for centralized products before and at the end of the pilot

In order to check whether any changes in the shelf availability were ought to an increase in store inventory we also measured the store inventory before and at the end of the pilot for the same sample of products. The stock measurements showed that the store inventory was maintained at the same levels throughout the experiment.

Based on the positive results of the pilot running, the retailer expanded the use of the collaboration platform to cover the ordering of all the products to the central warehouse, rolled it out to all its 160 stores across the country, and encouraged collaboration with the rest of its suppliers.

4 Practical Implications

The impact of the adoption of collaborative store ordering for the retailer and the supplier organizations is a whole new area for further research. In this section, we briefly describe some initial lessons learned from the four organizations that took part in the experiments, focusing on the process of collaborative store ordering, as this represents the area of greater change in an inter-organizational context.

A first lesson comes from the simple observation that retailers and suppliers had to adapt their internal business processes so as to start working with the process of collaborative store ordering. This change initially appeared to be local, relating only to the sales department, but there is a clear potential for the involvement of the other organizational units towards

supporting upward supply chain integration (Stefansson 2002; Lee and Whang 1998) as well as the management of the demand side (ECRE 1997).

Based on the feedback that the users involved in the experiments provided to the statement "I believe that changing to the new way of work, as implied by PCSO, does not present any difficulties", the users of the centralized suppliers expressed the highest concern of all (see Figure 5).

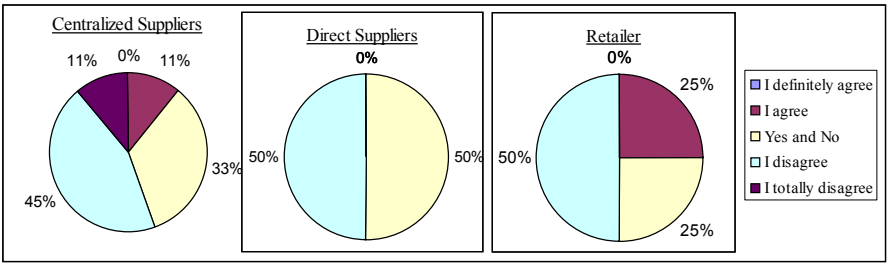

Fig. 5: Users' feedback on 'The new way of work does not present any difficulties'

Comparing the attitude of direct-store-delivery suppliers against that of centralized suppliers, we see that direct-store-delivery suppliers saw more incentives for moving to PCSO. For direct-store-delivery suppliers, PCSO represents an important change for the sales organization, as it separates the order-taking process from the rest of the tasks performed during a physical store visit (e.g. informing store managers about new products, checking the shelves, etc.). This fact gives a salesperson the possibility to dynamically schedule the physical store visits and focus on the stores that need more attention according to his/her judgment, rather than blindly following a fixed order-taking schedule. Another possibility offered to the salesperson is to synchronize store visits with product deliveries to the store, so that he/she can take better care of the shelf situation and replenishment, with the objective to further reduce out-of-shelf situations.

From another perspective, this fact may be associated to less physical store visits for the same or better end result, which is further translated into cost reduction opportunities and an important incentive for direct-store-delivery suppliers. Furthermore, PCSO gives suppliers the opportunity to move to centralized replenishment without losing control over the store ordering process. This fact is very important for some direct-store-delivery suppliers, usually with products in slower moving or specialized categories, who deliberately decide to incur the higher logistics costs of direct-

store-delivery in order to avoid out-of-stock situations due to centralization.

However, a prerequisite for a supplier's salesperson to place a suggestive order from a distance without visiting the store, as emerging from the actual field experiments, is that the information provided in the collaboration platform is accurate, including both sales data and stock data. In addition, back-end-integration between the supplier's information system and the collaboration platform is necessary for this process to work as a daily practice.

On the other hand, centralized suppliers seem to be more reluctant to invest in resources to support their ordering process at store level. The changes in their internal organizations are too many for them to take such a decision just because of one retailer. In addition, they seem to prefer to leave this responsibility to the retailer, as this is covered by the overall centralization policy they agree with the retailer. A scenario that appears attractive under this perspective is for centralized suppliers to get involved in the ordering process of selective stores, probably those generating higher volume sales for them or representing lost business opportunities. In any case, borderlines of responsibility, for all users, have to be clear enough in order to avoid overlapping areas and confusion, especially in regard to the process of store ordering to the Central Warehouse, where, currently, responsibility lies with the retailer. Furthermore, centralized suppliers expressed great interest in having access to the daily point-of-sales data of the store, in order to monitor their out-of-shelf rates, their promotional activities, etc. They seem more eager to get this information in the form of statistics, which is also in-line with their organizational structure.

Retailers, on their part, may confront PCSO as a possibility to outsource the store ordering process to their suppliers, also for centralized products, which is not the current practice at the moment. This practice is currently used in CRP/ VMI supply-chain collaboration models at the Central Warehouse (Cooke 1998). However, retailers cannot put pressure on their suppliers to move to new forms of collaboration, if the suppliers are not convinced to do so by themselves. Actually, such practices entail significant organizational changes for the suppliers' organizations. In addition, whether retailers will be open to sharing all this information with their suppliers over an independent service provider platform, whether they will do this through private retail exchanges, or whether they will do this at all, is still to be answered.

Such a decision may greatly affect the adoption rate of PCSO and other similar collaborative practices, such as CPFR (Hölmstrom et al. 2002). From informal discussions with all major Greek retailers, it appears that many of them feel concerned about the prospect of having a big proportion

of their internal data hosted on the platform of an Application Service Provider (Soliman et al. 2003). On the other hand, suppliers do not feel comfortable with the idea of being connected to a separate platform for each retailer. The existence of a third party provider may also play an important role in facilitating and performing the project management for new collaboration projects, as well as supporting the data-alignment between retailer and supplier.

Most of the issues discussed in this last section need further study and analysis in order to lead to more concrete findings. The objective was to communicate, in an informal way, some preliminary findings that we consider interesting and capable of stimulating further research and development in this area.

5 Conclusions

In this paper, we have suggested a new collaboration practice that addresses the problem of out-of-shelf by streamlining the store ordering process. The first pilot results give some strong positive indications. Yet, the application of this new practice is still in its preliminary stages, giving rise to many questions still to be answered, as for example:

- To what extent will this new collaboration practice be adopted by suppliers? Which is the model that will lead to greater and faster adoption? Will the way forward be that retailers put pressure on suppliers to adopt this new practice? Or will the pressure come from the suppliers? Who receives the greatest benefits in such a collaborative model?
- Will suppliers undergo the organizational changes required to adopt this new model? What should be the benefits of convincing them to do so?
- Is the current status of technological and communications infrastructure adequate to support this new collaboration model, or is technology still a barrier? Should PCSO be supported by private retail exchanges or by independent exchanges supporting many-to-many collaboration?
- Will retailers be open to sharing information with their suppliers, or will they adopt a more conservative stance? Will retailers and suppliers trust a third party, such as an independent retail exchange/ service provider, in supporting and managing critical business processes?
- What other opportunities emerge for suppliers, e.g. for building a more responsive supply chain, for efficient promotions management,

for efficient product introductions, etc. by getting access to the daily POS data of the stores?

- How are existing CRP/VMI processes affected by the possibility to obtain, not only information on store demand, but also on consumer demand? How does category management extend in the context of supplier-retailer collaboration and dynamic information exchange?
- What new possibilities are revealed with the introduction of intelligent product tags in retail operations?

These are some of the questions raised. What is certain is that these new replenishment and collaboration models raise many more issues that deserve academic scrutiny, while revealing new ways for tackling the traditional problems.

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Towards the Development of an Algorithm to Discover Out-Of-Shelf Situations

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1 Introduction

At a supply chain level, the adoption of novel practices like Vendor Management Inventories (VMI), Continuous Product Replenishment (CRP) and Automatic Replenishment Products (ARP), aims to increase the efficiency and effectiveness of the business operations. From an operational management perspective, several studies have already examined the implementation details of these practices, thoroughly investigated special cases, and suggested further improvements. However, the wide body of literature is mainly concentrated on what happens with inventory levels and the warehouse business, while little attention has been paid to the retail store. The store level had been a traditional battlefield for the marketing literature, but few studies exist regarding its operational efficiency. It is generally accepted, both from a marketing and management perspective that the retail store is the last hop to the consumer. The provision of the right product, at the right time and at the right place is the ultimate objective that marketers set. However, the question of how business operations could support this objective is a subject of investigation.

A crossroads between marketing and operation management research is the Out-Of-Shelf (OOS) problem. From a marketing perspective, the OOS problem is highly dependent to consumer loyalty, while from an operations management perspective, the same problem is interpreted as an inefficiency problem, due to low shelf-availability. Out-of-shelf refers to situations where a product is not on the shelf, although it has to be there. According to a global survey, the OOS rate varies between 5 to 10 percent, which is rather high (Gruen, 2002). Campo et. al (2000) argue that the revenue shrinkage, either for the supplier or the retailer, is not only coming from lost sales during the period of OOS, but it could be further extended in the future due to the impact on consumer reactions. For this reason, OOS is considered to be a major drawback within the fast moving con-

sumer goods industry, and it is still a problem that suppliers and retailers are facing on a daily basis.

In this paper, we investigate the possibility of developing an algorithm that identifies the OOS situations, utilizing information systems capabilities. In more detail, having available the POS data, orders details, products assortment etc., we present and develop a method for constructing an algorithm that will automatically discover OOS situations on a daily basis. Currently, the identification of OOS rates is based on physical audits, which consumes resources and is only an approximation to the problem. In the next section, we describe the factors affecting the OOS problem. We further discuss the accuracy of an existing method that identifies OOS situations, namely the European Out-Of-Shelf Index (EOI), and finally present our method of work, followed by some preliminary results.

2 Rating the Out-Of-Shelf Problem

2.1 A General Model for the OOS

The OOS problem is examined from two major perspectives. The first is a consumer-oriented perspective, coming from the marketing literature, and mainly addresses the reaction of consumers when they cannot find a product on the shelf. This approach considers consumer loyalty and underlines the importance of the problem, because, nowadays, supply chains tend to be consumer-driven. The second approach focuses on the management of the business operations. Activities like category management, inventory management and supply chain management are combined to effectively settle the problem of OOS situations. Within a management approach, various models exist, dealing in their majority with the stock-out problem, but not fully addressing the OOS. The Out-Of-Shelf problem is often overlaid with the product stock-outs. A stock-out implies an out-of-shelf situation, while the opposite is not supported, because there is a possibility that the product might be in the backroom facilities of the retail store. In general, various models exist for avoiding stock-out situations (Sculli and Shum, 1990; Fong and Gempesaw, 1996), while none exist for the OOS problem. The major differences between these contingent problems are the frequency at which they occur (we consider that the OOS is more frequent), the focal point of investigation for the stock-out problem is inventory levels, while the OOS explores shelf-availability, the number of factors that affect each problem, and finally the approach to tackling the problem.

We argue that the OOS is a binary variable, which defines two mutually exclusive states. The first state is that there are products on the shelf, regardless of the available quantity, and the second state is that there aren't any products on the shelf. We consider that OOS situations are exceptional events, and through the impact of several factors, it is possible for a shelf to be left empty (e.g. the employees did not replenish the shelf, or the supplier did not deliver the required quantity during the last delivery order). The thorough examination of the factors giving rise to OOS occurrences could act as framework for the investigation of the problem. The following are some empirical examples describing the exceptional events that possibly happen when a shelf is empty:

- Today a product didn't sell even one unit, while every day the specific item is selling over 15 units.
- The product has not been ordered for a month, while during the previous periods an order was placed once a week.
- The product has not sold even a single unit, for over a month.

Although, the above-mentioned examples are indications that a product is not on the shelf (sometimes it might not even be in the store), it is very difficult to establish a valid causal relationship between the binary OOS variable and the sales rate of the product or the stock level. Indeed, the identification of several variables is required in order to more accurately determine the OOS situations within the retail store. For the purpose of this study, we have identified three major categories of factors (Product-related, Category-related and Context-related) that could be utilized in order to describe an Out-Of-Shelf situation. The inclusion of variables in every factor has been based either on literature review, or the experience we gained by studying the phenomenon of OOS. We propose that the examination of the OOS situation for a product within a store should consider the following exploratory variables (Figure 1):

- *Product Factors:* This category includes the variables observed at the product level, which could be associated with the OOS situations. More specifically, the average sales and the standard deviation are primary and important variables to determine the OOS. For example, if a product is selling on average twelve units with a standard deviation of three units, we could argue that the product is not on the shelf, if one day it does not sell a single unit (according to statistical theory, the probability of zero sales for this product is lower than 0,005). Other variables included in this category are the inventory levels, the existence of a promotional event, the date and size of the last order, if the product is new or not, and the delivery method for the product (if it is

ordered from the central warehouse, or delivered to the store directly from the supplier).

- *Category Factors:* Each product is a part of a general category, where complementary products co-exist. In the case that a category product is under a promotional event, then, it is expected that this product would affect the sales velocity of the rest of the products within the category during the promotional period. Thus, the promotional items of a category may slow down the OOS situations for the rest of the products. Therefore, in our case, it is possible that a product does not sell the expected volumes, not because it is not on the shelf, but owing to the fact that another contingent product is on promotion. In addition, at a category level, it is easier to capture seasonality issues affecting the sales and frequency of OOS rates. Last but not least, is the market share of each product within the category.
- *Contextual Factors:* The contextual variables are rather general, but important indicators for the identification of OOS situations within the store. As contextual variables, we consider the average transactions of the store, which could determine the store size, the day of purchase, because sales are different between Tuesdays and Saturdays, while Mondays have the largest OOS rates, the number and the commitment of the store's employees, and the number of products in the product mix of the store.

It is worth mentioning the various interdependences that exist among the variables. For example, the average sale of a single product (Product factor) is affected by the day (Contextual Factor). Discovering all possible interactions among variables is a complex issue and is not feasible, since it would be required for all the products within a store on a daily basis. Thus, the formulation of exploratory Out-of-Shelf patterns is suggested for every product (or categories of products). This means that a simple approach would be to discover the similarities between the variables, when an Out-of-shelf situation occurs. For example, a pattern is that, if today a fast moving item did not sell one unit, then this product is not on the shelf. Although this might not be true for all cases, we argue that it is a good approach, because it reduces the complexity of and effectively manages the problem of OOS.

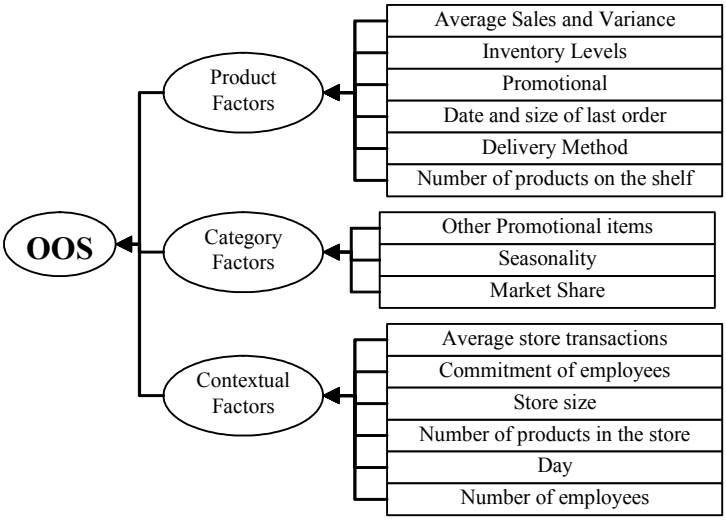

Fig. 1: A proposed theoretical model for Out-Of-Shelf situations

It is important to note that the list of the above-mentioned variables is not exhaustive, and many other variables may be added. However, the variables presented are considered to be important. In general, the OOS situation function could be expressed in general terms as follows:

$$OOS(t)_{i,s} = f\left(\text{Products Factors},t\right) \times f\left(\text{Category Factors},t\right) \times f\left(\text{Contextual Factors},t\right) \quad (1)$$

The above-mentioned formula expresses that an OOS situation for i-product in j-store may occur at a time t, depending on the several factors and the interrelation among them. Thus, the development of an analytical formula for all products and all stores on a daily basis is almost impossible, because of the high degree of interdependence among the factors, the importance of qualitative factors (e.g. the brand name) that are very difficult to incorporate in a formula, and the volatile environment of retail business (e.g. introduction of new products). Again, the existence of the factors affecting OOS rates acts as a compass to better understand the problem.

In the next sections, we will show how we utilize the theoretical framework in order to approach the problem and present some preliminary results regarding the algorithm we have implemented so far.

3 Development Method for the OOS

3.1 Experiment Setting

The objective of the new method is the identification of OOS products at the end of the day for every store of a retail chain, without requiring a physical audit by the employees of the store. The algorithm will be based on the data available from suppliers and the retail stores. The selection of a case study was the most appropriate research method, because it could provide the in-depth knowledge needed about the business processes and the structural arrangements of the organizations. Our research primarily focuses on the store replenishment process, and involves a retail chain with two hundred retail stores and few major product suppliers, working together with an application service provider (ASP), which facilitates the collaboration of the trading partners. The collaboration platform provided by the ASP is an Information System that aggregates data either from the suppliers or the retailer and enables the implementation of CPFR principles (Seifert, 2002). We consider that the aggregation capabilities of the platform set up a hospitable context for the development of our OOS algorithm, because of the available information richness.

The first step in our research was to investigate the extension of the OOS problem. Thus, we selected nine representative retail stores from the retail chain based on their size (Small, Medium and Large), and conducted a physical OOS survey. We visited the nine stores during the first week of February 2004, and examined if a sample of products were on the shelf. The sample was a representative list of 110 items selected with the method of stratified clustering utilizing the store's assortment. We developed nine clusters of products based on sales velocity and sales volatility, and added an individual cluster containing promotional items only. The products were from several categories like Shampoo, Diapers, Coffee, Detergents, etc. In total we had 5940 counts, and, surprisingly, the OOS rate was close to 14 percent (889 counts). We considered that this OOS was rather high compared to other surveys (Roland Berger, 2002), thus we further examined the survey's results. From our point of view, we found that the 60 percent of the OOS rate was caused by de-listed products (items that seemed to be in the product mix, but were not in the store). Eventually, we found a 5 percent OOS rate, which is in the range of the global survey conducted by Gruen et al. (2002). The rest 8 percent of the OOS were addressing a product discontinuity problem, which was significantly important to small size stores. However, the existence of a contract between the suppliers and

suppliers and the retailer allowed us to treat the product discontinuity as part of the overall OOS problem.

The data from the physical survey were utilized in a manifold manner. On the one hand, we utilized the data in order to determine the accuracy of an existing algorithm in the discovery of OOS situations, namely the European OOS index as proposed by the ECR, and, on the other hand, as a basis for the development of our algorithm. The next section briefly presents the results from the evaluation of the EOI.

3.2 Evaluation of the EOI

An approximation measurement method for OOS situations is referred to as the European OOS Index (EOI). The EOI only addresses products having sales velocity over 10 items per day, and sales volatility ($\mu_{i,s}/\sigma_{i,s}$, for the i-product at s-store) lower that 1. Thus the EOI is utilized for highly moving products with narrow variations in sales. According to the EOI, if a product satisfies the preconditions of sales velocity and sales volatility, and additionally sold zero items on the current day, then the product is characterized as OOS. According to the general model of OOS presented above, the EOI exploits part of the product factors to explain the OOS situations.

The accuracy evaluation of the EOI was based on a comparison between the result set of the EOI and the results of the physical survey. In more detail, we implemented and produced the results of the EOI during the period of the physical survey. In doing so, we calculated the average value and the standard deviation of sales, for every product at each store that participated in the physical survey, having available POS data over a five-month period. Note that each product could have been introduced at a different day in each store, which was also taken into account. Then we selected only those products that were subject to the precondition of the EOI, and produced the results. Through the comparison we collected the following findings:

- The precondition of the EOI is supported only by 5% of products, specifically the fast-moving goods. These items belong to important categories, which cover almost the 22%-36% of total sales per store.
- The EOI captures only the total OOS situations. The partial OOS (meaning that during the day that the self was empty) could not be identified.

- The EOI was able to capture the total OOS cases for the whole reporting period, which means it is 100 percent accurate. However, the results of the EOI also contained products that were characterized as OOS, but according to the physical survey they had been on the shelf. The noise level that EOI introduces in the result set is up to 25 percent, which means that, from the results of the algorithm, only 75 percent is definitely an OOS situation.
- The EOI is sensitive to seasonality. More specifically, products introduced in the store to cover high seasonal demand would probably support the precondition of the EOI, after the seasonal period too. For example, assume that a store introduces candles to capture the seasonal demand of Christmas. During January, the sales of candles would decrease dramatically, almost no unit. The statistical nature of the algorithm will describe these products as OOS, although they are on the shelf. In general, products that were addressing seasonal demand would be characterized as OOS situations by the EOI after the end of the seasonality. This is a special but frequent case for the EOI, which increases the noise. The utilization of exponential smoothing, or other techniques that remove the seasonal component did not produce satisfactory results.
- The calculation of sales volatility and sales velocity for each day of the week (e.g. calculating six different $\mu_{i,s}/\sigma_{i,s}$, one for each day) decreases the noise of the index. This happens because in sales, the daily average and the daily standard deviation are considerably different between days (e.g. sales on Saturdays are significantly different than on Tuesdays for a wide variety of products). In addition, the existence of such calculation adjustments increases the number of products addressed by the EOI.
- The size of the store affects the sales volumes, thus the products that are under the control of the EOI.

On the basis of these findings, we consider that the employment of the EOI is satisfactory for fast-moving items, but there are important limitations. The EOI does not address about 95% of the store products, so it has a limited usage. This constitutes a motive for the development of a new measurement method. The objective of the new method is to extend the EOI into the slow-moving products, and to use it independently of sales volatility and sales volume. Consequently, we seek to include parameters like past orders, the length of the day's interval between non-zero sales, the estimation of inventory levels, etc.

3.3 Development Method for the New Algorithm

The objective of the new algorithm is to identify OOS situations utilizing all the available data sources. The new algorithm should create a list of OOS products at the end of every day for every store, examining all required parameters of the problem. Utilizing the theoretical model, we needed to examine the relationship between certain variables and an OOS occurrence as reported by the physical survey, following an exploratory method of work. For simplicity reasons, we will provide few details regarding the method of work that we followed, concerning the product-related factors.

The first step was to identify the available data that we can utilize from the collaboration platform. Almost all the variables presented were able to be included in the algorithm, except the number of products on the shelf. The next step was to establish an appropriate benchmark. The existence of the EOI acted as a baseline for the development of the algorithm, because it addresses exactly the same problem, and comparisons regarding the accuracy and noise of the results are valid.

The crucial step was the selection of the appropriate analysis method. In our case, several well-known research streams exist, like Time-Series Analysis, Bayesian Analysis, Markov Analysis, etc. For the purpose of this study we selected a mix between simple statistics and association rules. The idea was to structure and analyze the problem following a statistical approach, and then utilize data mining techniques to discover patterns within a narrower data set.

The objective in utilizing statistics is to enhance the problem with valuable information that will be then utilized for the development of association rules. Thus, based on the product variables, we automatically calculate a set of statistical measures for each product at store level, examine if we could accurately determine the inventory levels of the product, examine the replenishment cycles, etc. Based on these characteristics, we create groups of products, and for each group, we try to explore possible association rules.

The objective of the association rule technique is to detect relationships (associations) between specific values of variables in large data sets. It is a powerful exploratory technique seeking to discover "hidden" patterns between the variables (Agrawal and Srikant, 1994). An association rule has the form *"If X then Y"*. In our case, Y is always an OOS, while X varies (e.g. Inventory Level = "Low", and Average Sales <=1.2 units per day), depending on the product variables we are incorporating in each test. Following several iterations between the development of statistical variables

and the association rules technique, we produced association rules with an accepted significance level, which are then compared with the EOI results. Currently, this is an ongoing research issue. In our model, we incorporate almost all the variables presented in the theoretical model. We observed that the product-related variables are good enough to develop satisfactory association rules for slow-moving items. Through the utilization of the product-related variables, we could capture almost 31 percent of the OOS situations. This result is considerably higher than the EOI, because we are targeting the whole product population.

We are expecting to identify eight to ten association rules, which will be then validated through physical survey for a few stores. Having all the required data from the collaboration platform at the end of the day, we will run the algorithm, and receive the results of the OOS situations, which will be then validated on the next day.

4 Conclusions

In this article, we have briefly presented a general model for the Out-Of-Shelf, examined the results of the European Out-Of-shelf Index, which addresses only fast-moving items, and briefly presented our method of work for the development of a new algorithm that could capture more OOS cases. Yet, the development of precise association rules is a matter of investigation. The dynamically changing environment and the existence of divergent cases regarding the Out-Of-shelf problem do not permit the development of one solution that fits all cases. Thus, an OOS algorithm requires careful analysis of the problem, which could be served by the incorporation of several variables.

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Food Value Chain Analysis

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1 Introduction

The U.K. red meat industry is undergoing a period of rapid change. Common Agriculture Policy (CAP) reform, Bovine Spongiform Encephalopathy (BSE), Foot and Mouth Disease, cheap imports, the long-term decline in consumer demand for red meat is leading to structural change in the industry. To counter this hostile external environment, the value of vertical collaboration has been highlighted by previous research (Fearne, 1998, 2000; Hornibrook and Fearne, 2001, 2002; Katz and Boland, 2000; Palmer, 1996). This need for collaboration was recognised by the Policy Commission on the Future of Farming and Food in 2002, and one of its key recommendations was the formation of a Food Chain Centre (FCC) to "… bring together people from each part of the food chain". (see http://www.foodchaincentre.com).

The FCC is promoting and facilitating improvement in a wide range of food sectors including red meat, dairy, horticulture, cereals and organic produce. The focus of this chapter is red meat, where industry bodies including the Red Meat Industry Forum (RMIF), the Meat and Livestock Commission (MLC) and the National Farmers Union (NFU) partner FCC. One of the FCC/RMIF initiatives on red meat is the Department of Trade and Industry (DTI) sponsored Value Chain Analysis project. This study explores eight pilot value chains between farm and retail outlet for vertical collaborative opportunities for improvement.

In the following sections, we outline the VCA technique, report early generic themes emerging from the first four chains, and as a main contribution identify how flexible technological improvements allied to simple process design has potential to improve customer value and eliminated waste in the chain.

2 Value Chain Analysis

The FCC academic partner for applying VCA in Red Meat is FPIU (Food Process Innovation Unit) at Cardiff University. The VCA technique established is based on Value Stream Management in the Lean paradigm (Womack et al., 1990; Womack and Jones, 1996) and Value Chain Analysis originating in the ECR movement. Lean has been widely applied in the fields of operations management, process engineering and supply chain management. Cardiff research programmes have combined Lean and ECR principles in the food industry through a six-year relationship with Tesco investigating new product and supply chain development (Evans and Simons 2000; Jones and Simons 2000).

Table 1. Food value chain analysis

Event Name / Description
Introductory Meeting – Agree main contact and participants from each organise. Diarise all events within three month window
Value Chain Analysis Workshop – Introduce tools and techniques, and adapt if necessary to the team's previous experience. Discuss relationships and how benefits sharing will be approached.
Current State Cross Company Value Chain Workshop. Select a product to map, and create a current state map of the physical and information flows.
Producer on site mapping
Processor on site mapping
Supermarket or a Food Service on site mapping
Future State Cross Company Value Chain Workshop – define the ideal state, and then rationalise to a future state that is attainable within twelve months identifying the measures and projects necessary to achieve the future state..
Presentation Value Chain Summary to Cross-Company sponsors – agree sign-off the future state and projects.

Adapted from (Simons, Francis et al. 2003)

The technique involves assembling a cross-functional team of people from all the key firms involved in the value chain of a specific product. This team is then trained in the use of a number of different process and supply chain mapping tools before collectively conducting a series of structured data collection events designed to identify and prioritise wasteful activities for subsequent elimination. This technique consistently reveals significant waste elimination opportunities (Francis 2000; Hines and Rich 2000; Jones and Simons 2000). FPIU have adapted a series of mapping tools (Rother and Shook, 1998(Womack and Jones 2000; Simons and

Mason 2003) for Food Value Chain Analysis, which is evolving with each pilot application (Simons, Francis et al. 2003; Francis and Simons 2004). The method involves a cross-company team in eight to ten days of collaborative data collection and analysis (Table 1).

3 Key Issues

The Red Meat VCA covers eight pilot cases from producer through to the point of sale. The cases have been selected to be representative of the three species (beef, lamb, pork), channels to market (supermarket, food service, local) and consumer formats (cuts, processed meat, ready meals, organic…). The four chains discussed in this chapter are shown in Table 2.

Table 2: Red meat VCA chains 1-4

	Species	Channel	Format
1	Lamb	Supermarket	Packed Meat
2	Pork	Supermarket	Packed Meat
3	Beef	Foodservice	Packed Meat
4	Pork	Supermarket	Further Processed

From these four chains the following sections describe the technological and process improvement opportunities to deliver better customer value and reduce costs in the chain the prevalent issues observed in this pilot qualitative study. Although the chains observed involved different species and organisations, the supply chain processes are generically similar.

The producer or farmer part of the chain comprises of a number of SMEs (Small to Medium Size Enterprise) that are usually privately operated. The producers breed animals and grow them over a period of one to two years before delivering them to the processor via two routes. The traditional route is *liveweight* via an auction market, and the evolving route is *deadweight* direct from the producer farm to the processor plant. When the animal reaches the processor, it is killed, waste material is removed and it is then assessed for value. The assessment has three parts weight of useable meat including bones, conformation of meat to bone and fat content. The amount paid per kg to producers is based on the conformation and fat content. So a well-formed animal with low fat content receives a higher price than a poorly formed high fat animal of the same weight. At the end of one to two years of breeding and rearing, the producer is rewarded on the way the *deadweight* or *liveweight* route grades and values the animal.

The majority of processor capacity is owned by private companies and has plants that are single species dedicated to a small number of retailers. The processors conduct a disassembly process, splitting the animal into a number of sections called *primals*. The most valuable and easily marketable parts of the animal are the rear quarter *primals* (e.g. beef sirloins), and the least valuable and marketable are the fore quarter *primals* (e.g. front shoulders). The processor's effectiveness and profitability is based on processing and selling all of the primals in balance. This process is termed *carcase balance* and the penalties incurred for imbalance include total loss of product that is kept beyond its storage life, distress selling of product as it approaches the end of its storage life, and excessive storage costs.

The four pilot chains reported here have covered large retailer and foodservice organisations, whilst the other chains that are underway cover other market segments such as local and organic chains. Supermarket meat sales have grown from a small share in the 1980s to the dominant channel of home consumption sales in the UK. These organisations are publicly quoted companies, whose major emphasis is on delivering consistent safety and quality in their meat products. For both retailers and foodservice, on-shelf availability is linked to customer value and to profitability for all products. Meat is an absolutely key product category in this respect due to its high value and short shelf life.

Along the chain there are direct customer value and profit drivers at each stage in the chain. For the producer it is animal grade and price, for the processor carcase balance and for the retailer supermarket availability. Indirectly, each of these drivers impacts the other participants along the chain. The chapter looks at each of the drivers through the symptoms identified and the technologies and processes that are available to deliver improvements.

4 Animal Grading

This discussion of animal grading is based on deadweight direct from farm to processor, which the early pilot chains have investigated, whilst the liveweight route is a major topic to be covered in future chains. The deadweight route grades an animal by conformation or shape. When the profile of the hindquarters of the animal are viewed on the production line, those with an appearance that is shaped in a 'U' are graded higher than those in a "V" as they have a higher meat to bone content. There are at least five conformation grades that are assessed visually by a *grader* person. For the fat content the *grader* makes a further visual assessment of proportion of fat

from one (lean) to five (fat). Pigs are assessed differently for fat content through the insertion of a probe into one area of the animal. So as each animal passes along the production line, a "grader" performs a qualitative assessment of the animal's conformation and fat level. The price per kg paid to the producer varies according to this decision. For the producer's batch of animals, the grading and weight of each animal are recorded on the payment advice, which at the time of data collection was delivered manually by post, fax or telephone. This feedback for cattle can be attributable to individual animals due to an animal passport identification system adopted in the wake of BSE. However, for sheep and pigs, there is no individual traceability, so it is not possible for producer's to directly link finished animal grading with their breeding programme. Therefore it is not possible for the producer to accurately assess the likely future value of for example purchasing new breeding stock.

Our interviews with producers indicated that there were some soft issues with the grading system. One recurring producer view was that grading was subject to achieving a market requirement of x% of one grade and y% of another grade. Therefore in a situation of scarcity an animal would tend to receive a higher grading. Another view was that when a producer accompanied a batch of animals into the plant then the grader would be more generous. To counter these concerns many plants use an external MLC person to grade.

The purpose of grading is to pay for the useful meat, and to be able to select primals for different end uses. For example a forequarter primal of high grade could be used for an end consumer cut, whereas a low grade may be further processed into sausages.

Reduction in animal grading measurement variance with accurate feedback to producers has potential short and long-term benefits. Short term, it offers accurate assessment of the animal carcase to give farmers confidence in the grading received, and gives the processor the ability to accurately sort meat into alternative uses. Longer term, individual traceability can provide feedback on each animal's performance against customer value, and allow farmers from their breeding records to more closely link their breeding programmes to the market place. To do this, in the future state maps within the chains, and secondary literature/web searches, three main technological improvements were identified. These were quantitative grading equipment, animal electronic identification, and electronic data transfer.

Quantitative grading equipment is available in the form of ultra sonic scanning. On the production line this allows rapid and accurate assessment of the whole carcase for quantity and leanness of meat. This technology is in use in the North American pig industry, where a scanner takes 600

measurements 15 times per second to assess all parts of the animal allowing accurate assessment of 1,200 carcases per hour (Young-Huguenin 1999). In the UK pig industry one prominent ultrascan system is Autofom which has "… the potential to revolutionise the pig industry" (Haighton 2002). Autofom has been authorised by the EU and is expected to be adopted into British Law in the near future.

Electronic identification development is prominent in the UK following BSE and Foot and Mouth. The UK is a European leader in individual identification of animals. Cattle have double eartags with unique numbers, that link to a paper passport system that records all of the animal movements from birth to processing. Sheep are also eartagged but enter the system as a batch, and are therefore not fully traceable. The EU requires full sheep traceability by electronic means by 2006. Technology to achieve this is well developed, including electronic tags, hand held readers for producers and walk through static readers for processors. It is estimated that this would increase producer costs by £2.80 (www.defra.gov.uk), which is about 5% of the farmgate price of a lamb. For this on-cost, the UK will ensure it remains at the forefront in terms of food safety. However, there is an opportunity to use the management information that this technology provides, to share information along the chain to improve consumer value and reduce processing costs, through reduction in variance in breeding programmes and manufacturing.

The supply chains analysed comprised of thousands of producers, serving a small number of plants, serving hundreds of retail outlets. Information flows from both foodservice and supermarket retail outlets are entirely based on electronic transfer using Electronic Data Interchange, Business to Business exchanges and retailer specific intranets. By contrast, communications on price inquiries, grading feedback, transport requirements between the UK processor plants and producers are almost entirely telephone, fax or post. In one overseas plant, the researchers observed an intranet system that all producers used to communicate with the plant. Adoption of electronic processor/producer links would provide a reduction in transaction costs and improve data integrity. Longer term if processors and producers vertically collaborate, there is many possibilities for process improvement. For example, producers could monitor weights of animals to provide information on when they will be ready for processing. The processor could then use this information from a number of producer farms to sequence their collection to align more closely with consumer requirements.

5 Carcase Balance

Processors work with retailers to ensure medium term plans should result in a balanced carcass. For example if a retailer were to promote Primal A in Week 1, then Primal B may be promoted in Week 3 to balance the carcass – in time horizon terms this is *Medium Term Carcass Balance*. However, actual events may then distort this well planned system. On the demand side sales of one Primal may exceed forecast leaving a larger surplus of the other. On the supply side the conformance and fat content of actual animals may vary to forecast. This demand and supply side variance in time horizon terms is *Short Term Carcass Balance.*

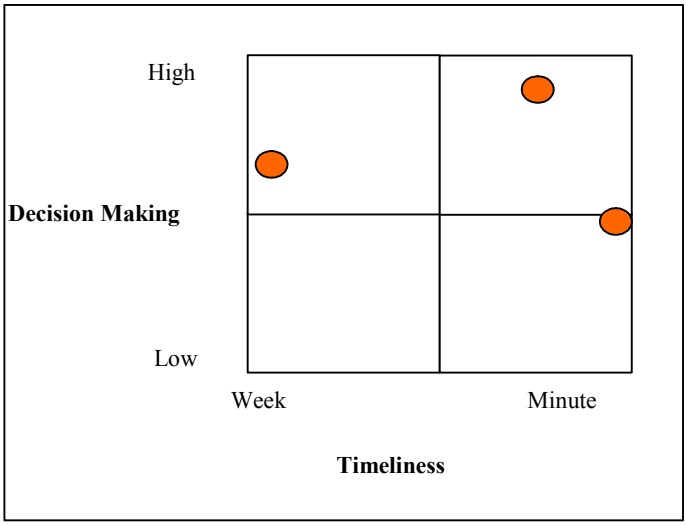

Fig. 1: Short-Term carcass balance systems

All processors recognise the issues of *Medium* and *Short Term Carcass Balance* and invest considerable human effort and systems in prevention and rectification. The team has analysed three different examples across species (one overseas) of how Short Term Balance is managed, and observed a number of other systems. The two critical aspects appear to be the usefulness to decision makers and the timeliness of information. Figure 1 plots the research teams assessment of the three systems:-

From this small sample there appears to be no standard carcass balance IT system(s) in the UK industry. Also, as these companies were in the top echelons of the industry, it may be reasonable to assume that there are many organisations in the bottom left of Figure 1. Other sectors such as

logistics have several software companies competing to provide off the shelf packages to optimise similar issues. Unstructured industry interviews have indicated that this requirement is recognised, and there are initiatives by larger companies to develop solutions. These interviews also indicated that such a system should be based on real time information of the processor pipeline from animal delivery schedule, through slaughter, maturation storage, vacuum pack, retail pack, despatch to forecast sales. This would allow an assessment for each primal in the system in terms of its current and predicted balance. Animal buyers, production planners and customer account managers would then be able to base their decisions on real time information and target carcase balance effectively.

6 Point of Sale Availability

The main opportunity with point of sale availability was in the supermarket chains. As the foodservice case had less of an issue with availability this section will focus on the UK supermarket sector which is contended mainly by an oligopoly - the "big four retailers". Consumer switching between players is dependent on a number of factors. Point of sale or on-shelf availability is documented as an important factor, and is closely monitored especially in the home shopping channel. Consumer switching is based on the availability of all products in the shop, which has been termed "basket fulfilment", which is equal to A^a (A = Availability of one item, a = items required in shop). If a = 40 for a consumer shop, and there are typically just one or two red meat category products, it follows that technological and process changes need to operate across all categories. Therefore, Value Chain Analysis in the Red Meat Sector has limitations in this area as it analyses one sub-category of products.

Figure 2 reports the generic Value Chain Analysis findings identified the main information steps and fulfilment steps in the chain. Examples of information flow accuracy and resultant availability in the chain are shown. The forecast error is based on comparison of weekly forecasts against actual orders. Demand amplification compares these actual orders with actual sales at the retail store. Promotion variance compares actual sales changes to expected promotion increases. Although these variations have considerable impact on costs in the chain, suppliers and retail logistics achieve high levels of availability delivered to store. The loss of availability occurs in the retail store between the back room and the shelf. This loss of availability is due to imbalance between filling capacity and shopper demand at peak times. In grocery categories such as soft drinks, this

has been addressed by rapid filling processes such as Tesco Merchandisable units (Evans, Simons 2000), which allow a shelf filling person to 'one touch replenish' a wheeled shelf ready merchandisable unit. Therefore in terms of consumer value and on-shelf availability the Value Chain Analysis identified process rather than technological improvements. Across all categories improvement in back room areas of retails stores are important, including consistent layout and standard operations. Human Resource issues including labour availability and absenteeism were identified as key enablers to this.

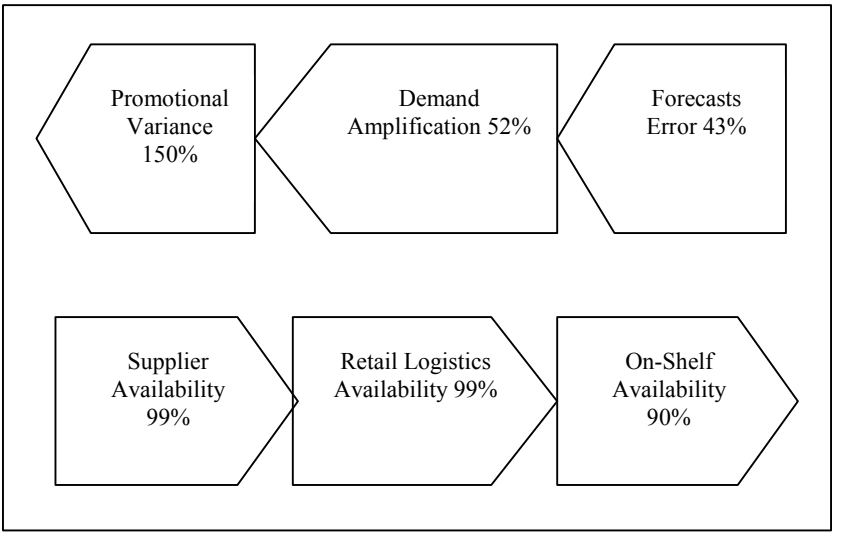

Fig. 2: Supermarket information steps and availability, with example data

Within these retail store constraints, improvements were identified to make shelf filling easier:

- Reduction of the range of products to a level that delivers sufficient consumer choice;
- Merchandisable units for rapid replenishment
- High visibility labelling to help back room identification

7 Integrated Value Chain System

This chapter now contributes a new lean mapping technique based on previous tools (Rother and Shook, 1998(Womack and Jones 2000; Simons and Mason 2003), namely IVD (Information Variance and Delay) Mapping. Figures 3 and 4 present the Current and Future State Maps based on the technological and process improvements discussed earlier in the chapter. The Current State Map shows a typical generic red meat supply chain. The Future State Map presents the technologies discussed, and collective atypical advanced processes observed in a minority of chains and or in pilot activities.

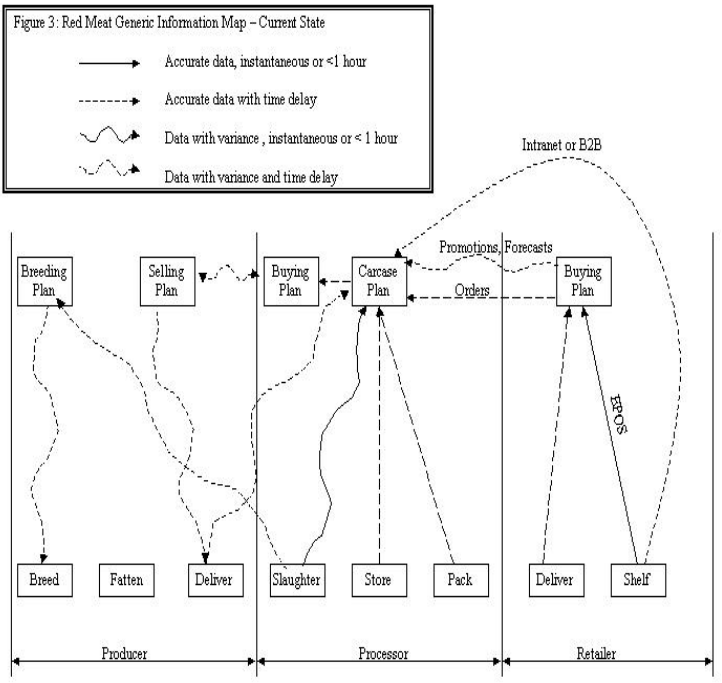

Fig. 3: The Current State of Red Meat Generic Information Map

The Current State Map has the three parts of the chain separated by inter-company boundaries (vertical lines). The physical stages are at the bottom of the map, and the information planning processes are at the top of the map. IVD mapping describes the data flows driving the planning processes in terms of variance and delay (Forrester 1958) in accordance with

the legend in the map title box. The data variance and time lag is high at the producer and processor, but low at the retailer. This reinforces the earlier discussion that processors and producers have information technology gaps, whilst retailers have opportunities to leverage more benefit from their established sales based systems, and physical back store process.

The Future State map alludes to the new technologies and new processes discussed earlier in the chapter. The discussion that follows looks at how the information flow from the consumer to the breeder will improve the whole system. It is in three parts, CPFR (Collaborative Planning and Forecasting), Processor Pull and Breeding.

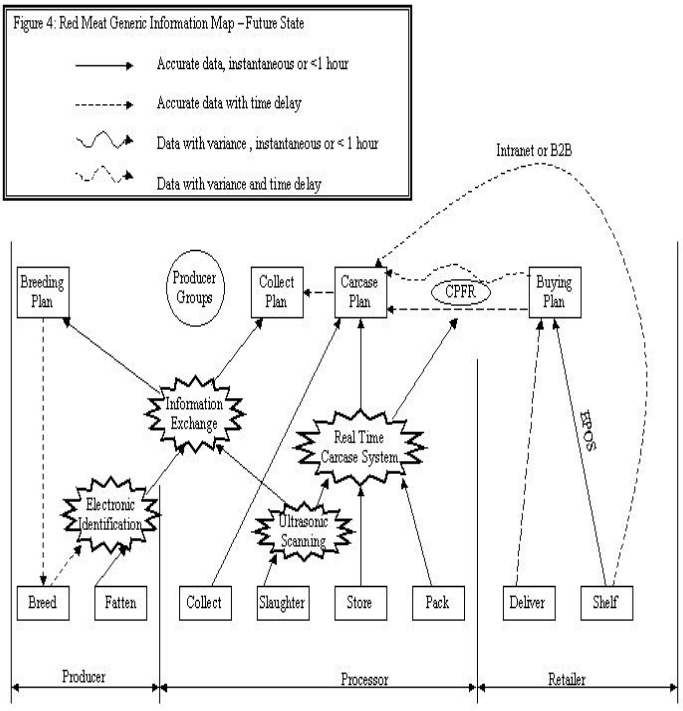

Fig. 4: The Future State of Red Meat Generic Information Map

At the Retailer/Processor boundary the Future State has CPFR to improve promotions and ordering. CPFR is supported by the processor carcase balance system through the provision of accurate real on stock positions and the sensitivity of manufacturing costs to demand variance. The

caracase balance system is in turn dependent on accurate data from the ultransonic scanning system.

Currently many producers will decide on when to send their animals based on spot market price, delivery batch and convenience with other farm activities. As a consequence some animals will go either just too early or too late in their growth cycles. Therefore producers to a large degree operate a *push* system, leaving processors to sort random batches of animals for manufacture and fit to consumer specification. Retailers and producers are active in developing producer groups, but often the farmers within these groups will alternate to other supply routes. To introduce a *pull* system dedicated producer groups would be required to ensure continuity of supply. Processors could then become responsible for collecting livestock (note the vertical line has moved to the left on the Future State Map) from farms reducing logistics costs through better consolidation. These collections could be planned to *pull* animals most closely aligned to consumer value at a particular point in time. To make this happen, producers would need to estimate weight, conformance and fat levels on the information exchange for each electronically identified animal. The processor could then use visibility of the whole producer group's stock when creating a collection plan. Following collection and processing, the producer would receive feedback from the ultrasonic system allowing continuous improvement of the on farm estimate of weight, conformance and fat levels.

This processor feedback by individual animal would allow producers to identify the most effective breeding stock from their records. Acquisition of new breeding stock could then be directly linked to the potential increase in slaughter value.

In summary, the Future State Map shows how technological changes and process improvements can reduce the variance and time delays in information systems leading to each echelon in the supply chain basing there operational plans and future investment decisions on real data. The reduction in variance and delays between the consumer along the chain to the producer makes it more likely that processes will be linked and incentivised to deliver consumer value. The technologies involved require significant investment, and electronic identification is likely to be a legislatively imposed. In this circumstance it is vital that the on-cost is absorbed through connected processes via a processor/producer information exchange.

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Extending ECR into Product Innovation

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1 Introduction

In the past 10 years of joint ECR activities, consumer goods manufacturers and retailers have addresses numerous business processes both on the supply and on the demand side ranging from basic operational to advanced strategic issues. Surprisingly, little activity has been dedicated by practitioners so far to jointly improve the conventional product development and launch activities. While there is little doubt among top managers about the importance of product innovation, the ways of how to tackle this important field are still at question. Recent research has started to investigate several emerging collaborative business practices and experiences of several leading companies.

Intermediary research results and first hand reports from some of the investigated companies were discussed at the 3rd International ECR Research Symposium 2003. The speakers were *Costas Stamatakis*, head of customer marketing at Unilever Hellas and project leader of ECR Hella's Efficient New Product Introductions working group, *Stuart Ross*, distribution & supply chain director of Tesco, *Christopher B. Dunk*, director of international business development/retail & CPG at SAS Institute, *Andrew Hill*, products and services director, as well as *Rod Dowle*, client services director, both at dunnhumby, and *Franz Steigerwald*, head of R&D/packaging development at Wella. This article gives a glance on what was discussed there.

2 Product Innovation - An ECR issue?

In recent years, retailers' and suppliers' efficiency in innovating has suffered. A Procter & Gamble study on new product introductions found that in 1995 16,000 new consumer packaged goods products were introduced in the UK, an eight-fold increase since 1975 (Mitchell, 1997:109). With a

new product life expectancy in 1995 of 9 months (compared to 5 years in 1975), Mitchell points out that 80% of these products lasted less than a year. Paul Polman, managing director of Procter & Gamble Europe, commented on these results: "You don't need to be an accountant to imagine the costs associated with this kind of activity" (Mitchell, 1997:109).

Interestingly, despite their large R&D organisations, the multinational branded goods suppliers fall behind their small and medium sized competitors in launching new products. A survey conducted by Madakom (2000) in Germany reports that the big firms were responsible for only 2.7% of all product launches in 1999. Executives of multinational branded goods suppliers support this finding and express their concern that they might be in the process of losing their ability to innovate. At the same time this survey reveals for 1999 a remarkable difference in average failure rate between small and medium sized suppliers with over 50% and big suppliers with only 13%. Compared to 1997, the small and medium sized companies faced increasing failure rates while the big firms reduced it from a former 22%. It seems that the big firms decreased product failure at the expense of innovation, a dangerous strategy because product innovation is of utmost importance to retailers. A study made by IBM (2002) shows that in 2000 the share of retailers' turnover from new products had increased to over 40% from 20% in 1987.

Many practitioners suspect that the high failure rate causes the industry's low level of innovativeness. Confronted with exceptionally high costs for launching a real innovation, product managers have become scared of the high risk of losing the investment they are responsible for. Hence, a higher new product success rate may be the mandatory basis from which to launch more real innovations and to reduce the amount of launches of me-too and line-extension products. Many practitioners believe that launching more innovative products is the core strategy for bringing back consumer enthusiasm to the frequently-purchased consumer goods business.

Surveys of product launch success barely investigate the reason for product failure. To illustrate some of the many requirements a new product needs to fulfil, we propose to look at the value chain (Figure 1). This illustrates that a new product needs to:

- fit into a firm's own product range,
- convince retailers to put it on their shelves,
- win shoppers' attention and convince shoppers to purchase, and
- fulfil consumers' needs.

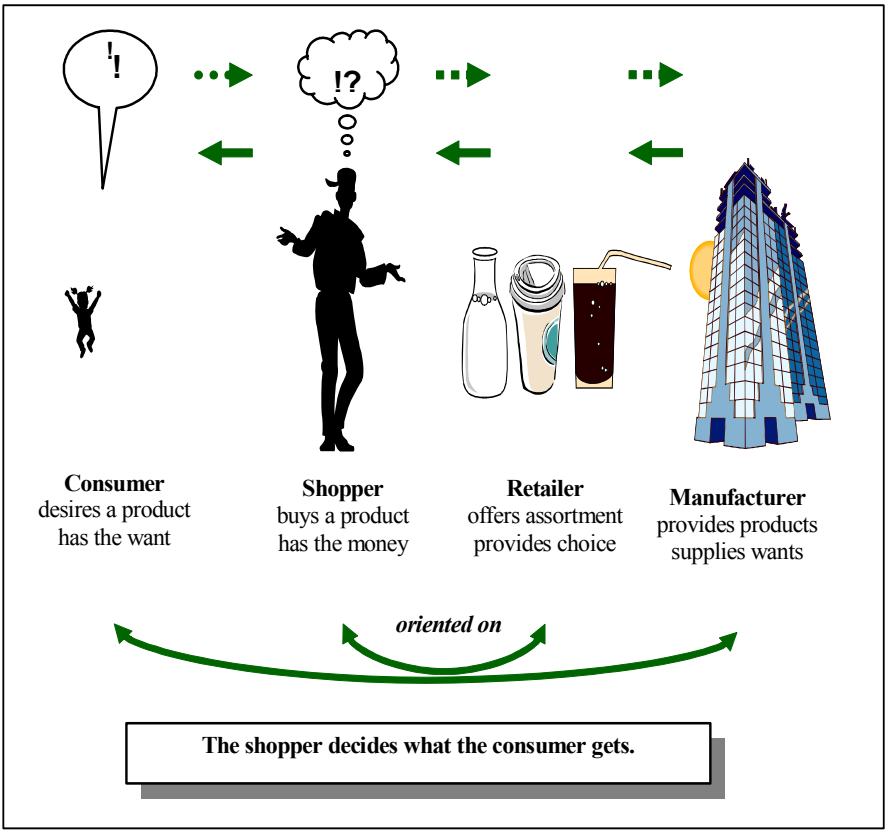

Fig. 1: Roles in the Value Chain

The first factor, fit into the product range, has been treated in the past as a supplier problem. However, since the implementation of category management, retailers have also come into play. They actively manage their product offering (e.g., identifying gaps and searching for solutions) and motivate suppliers to develop so far unavailable products. As Metro Group CEO Dr. Hans-Joachim Körber (Deromedi and Körber, 2003:14) put it, "we have to follow the vision of transforming our business from a pure 'buying organisation' into a 'customer centric company'." The factor "convincing retailers to adopt a new product" has been one of the major problems in the industry and is characterised by distrust between retailers and suppliers. Today, suppliers' most convincing arguments are substantial slotting allowances and large advertising budgets intended to signal to retailers their trust in the commercial success of the new product (Chu, 1992).

Based on experience of working together with retailers and suppliers, there is reason to believe that a substantial number of new product failures is caused by suppliers' limited knowledge about shoppers' behaviour in the shop. While suppliers are experts in understanding consumers in their requirements and use of the products, they have little knowledge and control when it comes to actually selling the product. This is the retailers' territory. Yet, it is this step where products turn into winners or failures; where, for both retailers and suppliers, products materialise into money. A Brandweek's study (1995) on the causes of new consumer product failures identified lack of trade support as one major factor. It is astonishing that suppliers have done so little to increase their control over this crucial step.

The high failure rate is as problematic for retailers as it is for suppliers. First, merchandising new products requires additional efforts from shop employees. Second, the replacement of products in retailers' logistics systems is difficult and costly. And third, shoppers dislike having to search for replacements of delisted products, eventually not buying such a product at all.

Retailers and suppliers of frequently-purchased consumer goods have started to review their business practices in order to re-accelerate economic performance. There is evidence that shows that their conventional tactics for managing new products (i.e., improving processes or increasing marketing budgets) have lost some of their power. Two domains offer major opportunities: improving product range attractiveness and improving control over the sales activities. Leading retailers and suppliers have learned that these two areas cannot be mastered by either the retailer or the supplier alone. Both lack important knowledge; thus only a concerted joint approach allows to realise the identified potentials.

With over 10 years down the road of ECR, has time now come to start extending ECR into product creation? Developing and launching new products is a core aspect for corporate success in any industry. As Deschamps and Nayak (1995:10) put it, "product creation is the core process supporting customer satisfaction and long-term growth in company value [...]. It is useless to put together a world-class distribution system unless you have a decent product to deliver." This is no different for the consumer goods business.

Concluding a conference on food innovation, Galizzi and Venturini (1996:1) note,

> *"the food industry has been characterised by several and profound changes in its structure and competitive environment in the last decades. Although it is not a research-oriented industry, there is no arguing that technological change and particularly product innovations are crucial de-*

> *terminants of firms' performance and consumers' welfare. In recent years food manufacturers have accelerated the development of new products by using new ingredients, processing and packaging techniques. Thus, food markets are increasingly characterised by competitive environments where relevant flows of innovative products, quality improvements and new technologies provide new consumption trends, food habits, market opportunities and firms' strategies."*

The point made by Galizzi and Venturini certainly applies not only to food, but to the entire spectrum of consumer goods sold through supermarkets around the world: innovation has become a major determinant of corporate success for both suppliers and retailers. A specific feature of innovation in the consumer goods industry is that the

> *"innovation process is part of a broad marketing process where branding, packaging and advertising are all strongly involved and related. The result is that, even if product innovation does not require relevant expenditures in R&D, the total resources that a firm has to invest in order to innovate successfully may be quite relevant and, in any case, sophisticated marketing skills are a necessary condition" (Galizzi and Venturini, 1996:3).*

Moreover, as consumer packaged goods are sold to a large extent through retail outlets, marketing activities are performed not only by suppliers but also by retailers. Consequently, retailers play a crucial role in the innovation game in this industry.

Since the massive appearance of own label products retailers have changed their role in the market; they are no longer simple distributors but also competitors to branded goods suppliers, with specific capabilities in market research, product development, and product launch (Dhar and Hoch, 1997). While practitioners find themselves in a new environment, research has generated little knowledge about the mechanisms existing between retailers and suppliers in the new product game, and has often focused on very specific aspects which are driven by emerging practices of suppliers or retailers. This is astonishing, as for over ten years, retailers and suppliers have been integrating collaborative aspects into their business processes by adopting Efficient Consumer Response (ECR) practices (Corsten and Kumar, 2003; Pellegrini, 2000; King and Phumpiu, 1996).

In 1997, the Executive Board of ECR Europe endorsed an international project on Efficient Product Introduction (EPI). The objective of this first reported inter-industry workforce was to identify how suppliers and retailers can join forces in their new product activities in order to increase brand and category value. The group argues that

> *"manufacturers in general are very much focused on brand value - especially being first to market and achieving short term results - while retailers tend to put their energy into category value. With limited alignment between the two strategies, there is a risk that they operate counter-productively and fail to maximise consumer value" (ECR Europe, 1999a:19).*

Indeed, branded goods suppliers share a deep-rooted belief that collaborating with retailers in product development might limit their ability to act independently in their market, and thus fear that their economic performance might decrease. But there is also a more strategic perspective to product innovation activities. Suppliers target not only economic performance but also pursue the development of their corporate capabilities. Many of the large suppliers invest in internal programmes to develop capabilities associated with product development and launch. Also retailers have substantially improved their capabilities over the past ten years. Today, many of them have outstanding knowledge about their current and potential shoppers. And, they have become good at turning shopper demand for innovative products into new private label products that are developed under their leadership. For example, the recently emerged convenience food product ranges are almost entirely in the hands of retailers. In fact, for many retailers their private label programme has become a major element for achieving differentiation in the market (Dunne and Narasimhan, 1999). Thus, from a supplier perspective, retailers have shifted their positioning from being a distributor to being a distributor-competitor-hybrid. However, Dhar and Hoch (1997) argue that, given that retailers have limited resources to develop and produce products, they can fulfill these aspects only by collaborating with excellent suppliers on a win-win basis.

Science has difficulties to treat this phenomenon. In the research investigating customer-orientation, distributors and the relation between a firm and its distributors have attracted considerably less attention than consumers or end users. As Kohli and Jaworski (1990:4) note,

> *"in the 1920s and 1930s, the term 'customer' primarily referred to distributors who purchased goods and made payments. Starting about the 1950s, the focus shifted from distributors to end consumers and their needs and wants."*

It is only recently that several scholars have highlighted the importance of distributors to achieving new product success (Wind and Mahajan, 1997; Crawford, 1997; Deschamps and Nayak, 1995). Despite Kohli and Jaworski's (1990:4) argument that "today the appropriate focus appears to be the market which includes end users and distributors" the latter have

hardly been in the research focus. Wind and Mahajan (1997:7) remind us that

> *"the challenge for marketing researchers is to develop procedures and models that will help obtain the relevant input from all stakeholders, including suppliers and distributors. This input must be obtained throughout the NPD [new product development] process."*

Much research focuses on business practices around retailers' adoption decisions for new products (e.g., the discussion of slotting allowances; see Bloom, Gundlach and Cannon, 2000). But, there is little research investigating whether suppliers might depend on retailers' capabilities in product development and launch. Parts of Crawford's comment, "alliances are growing - upstream to vendors, downstream to resellers and customers, and sideways to competitors and other sources of technical or marketing assistance" (1997:274) sound more like a proposition than knowledge derived from common business practice.

Nevertheless, retailers and suppliers are moving towards closer relations in product development and launch. They have even started to share some of their activities with the public. At the 3rd International ECR Research Symposium 2003, several firms reported parts of their experiences. ECR Greece, a collaborative retailer-supplier initiative in the symposium's host country, showed results from a national investigation of product launch success and failure. UK retailer Tesco presented its latest supply chain initiatives to support new product launch. IT-service firm SAS Institute showed how the combination of retailer and supplier data helps to better identify consumer wishes for new products. Data mining firm dunnhumby explained how through loyalty card and POS data new product success can be forecasted at very early stages in the product launch process. Finally, German haircare manufacturer Wella gave insights into an internal programme to enable the production of retailer-specific variants.

3 Efficient Product Introduction in Practice: ECR Greece

Greece's national ECR initiative has run a project to investigate the potentials created by retailer-supplier collaboration in product launch. The project team, consisting of representatives of Greece's leading retailers and consumer goods suppliers, has looked into several domains to grasp the opportunities of the efficient product introduction concept. The team focused its investigation on three categories in the Greek market: shampoos, juices and toilet paper.

Efficiency in the consumer goods business' new product activities appears to remain at a low level. The number of new product introductions is high and growing; yet most new products are discarded from the market within one year. The results of this new, regionally focused study widely confirm the findings of a Europe-wide ECR Europe project (1999). The three investigated categories show substantial increases in the number of active barcodes (representing SKUs). In 2002, 1289 different barcodes were identified in the shampoo category, 683 in the juices category, and 345 in the toilet paper category. Compared to 2001 this was an increase by 17% in the shampoo category, by 11% in the juices category, and by 8% in the toilet paper category. Yet, 72% of those barcodes that were introduced in 2001 were removed again until 2002.

Innovative products, often claimed as the key driver for economic success, are still a rarity. Among the innovative products launched in Greece in 2001 only line-extensions and upgrades were identified. Still, these innovations represented only 1% of all product introductions in the shampoo category, 0% in the juice category, and 7% in the toilet paper category.

Largely, retailers and suppliers believe that the success of new product introductions is often hindered by the two parties current business practices. Suppliers report that the most frequent and most significant problems are (a) too late shelf appearance of the new product, (b) incorrectly implemented sales support (i.e. wrong promotion at the point of sale), (c) erroneous planning, and (d) too low sales prices. Other problems encountered are (e) wrong placement on shelf, (f) retailers' lack of realising a new product's full potential, and (g) retailers' disagreement with product characteristics. Retailers point to (a) strong restrictions of shelf space, (b) removal of outdated products for replacement by the new products, (c) pricing by other retailers, and (d) sales falling behind the initial planning. Other problems include (e) storage problems, (f) reliability of new product data, and (g) late deliveries.

Consequently, the Greek project team identified several areas for improvement, pointing especially to the potentials offered by collaboratively launching new products. In particular, the team encourages the utilisation of the different parties' knowledge and capabilities. Furthermore, substantial differences among the product development and launch procedures currently applied in the Greek market hinder efficient coordination or collaboration. Yet, it was found that increased collaboration in category management helped to realise some efficiency improvements. The project team interprets these results as a hint towards the potential benefits of increased collaboration in new product introduction.

4 Supporting New Products Implementation: Tesco

Tesco, UK's largest grocery retailer trading in eleven countries, is commonly referred to as a show case example for retail innovativeness as well as for retailer-supplier collaboration. Its progressive supply chain has achieved to replenish 95% of all products via central distribution. Continuous replenishment is realised by multiple deliveries per day for all stores. Today, store orders are entirely driven by electronic POS data. In addition to its own innovativeness, Tesco has managed to learn from their relationship with suppliers of national brands as well as private labels, which account for 45% of Tesco's sales.

In order to keep up with the continuous changes in buying habits and shopper profiles Tesco constantly adjusts its product range. In fact, its strategy refers to three customer-oriented pillars: understanding shoppers, segmenting shoppers (and stores), and ensuring product availability. Consequently, the firm aims to offer a product range that matches the buying profile of each store's shoppers. Some of the identified opportunities for new products are shared with branded goods suppliers, others are targeted by developing new Tesco private label products.

Tesco applies a streamlined product development process. Multiple tasks and interests have been integrated into one defined process: i.e., customer intelligence, concept development, marketing, sourcing, production, quality, and supply chain management. The strength of this process is the early consideration of requirements by the many different stakeholders and the open sharing of information, knowledge and capabilities throughout the process. Collaboration with suppliers enables Tesco not only to ensure being supplied with the desired quality, but also helps Tesco to progress its understanding of customers and competitors. However, the UK retailer has also learned to appreciate the use of large sets of sales data to plan and forecast new product success, as detailed below.

5 Forecasting New Product Success: Dunnhumby

dunnhumby, a UK based data mining firm analysing Tesco's loyalty card data, has turned into an important element in Tesco's customer intelligence. The results from loyalty card data analysis give important insight in shopper behaviour, allowing Tesco to decide based on facts instead of gut feel. Indeed, Tesco's loyalty card programme has achieved substantial reach: about 80% of all Tesco sales can be assigned to loyalty card holders

of which over 10 million exist. Considering Tesco's 25% market share, its database is highly representative for the UK consumer goods market.

Tesco uses its loyalty card data also to identify new product opportunities. Among the countless possibilities to analyse such data, two appear to be highly relevant: the shopper decision tree and category sales analysis. The shopper decision tree results from data analysis revealing shopper behaviour in substituting products. Often, distinct groups of substitutable products exists within a category, yet most retailers and suppliers are not aware of these. For instance, packaging size or specific ingredients may be more relevant criteria for shoppers when choosing a product than brands or tastes. Category sales analysis allows to identify preferences and sales trends by distinct shopper groups, hinting to gaps and opportunities for new products.

Furthermore, loyalty card data helps Tesco in measuring new product sales performance and in improving merchandising activities. Identifying sales performance of a new product over the first weeks of launch offers new opportunities to forecast the product's future sales more reliably. To do so, the analysis of trial purchases indicates the attractiveness of the new product and its marketing programme, while repeat purchases signal emerging loyalty to the new product. A comparison with historical data from former product launches hints to the likely sales performance.

Analysis of retailer loyalty card data is a powerful tool for new product management. Its coverage of a large share of the population and its direct relation to the retailer enables both retailers and suppliers to base their decisions very close to reality.

6 Collaborative New Product Intelligence: SAS Institute

SAS Institute, a US-based supplier of information systems, suggests a collaboration based approach to improving new product activities. Today, most retailers and suppliers run extensive financial analyses to control and enhance profitability as well as analyses of customer data to identify customer wants and behaviour. Yet, the foci of these two players, and thus their knowledge, are different.

Combining the complementary information of retailers and suppliers offers vast opportunities in boosting new product performance by improving consumer understanding. In addition to suppliers' traditionally used customer information from focus groups, sales and customer service, syndicated data, and past product launch experience, retailers may contribute information from point-of-sale, shopper response to promotions and earlier product launches as well as shopper in-store behaviour.

An example comes from a European beverages supplier. The goal was to measure profit impact of a new product in the performance of an entire category as well as to identify optimum package size. To do so it was required (a) to measure change in category profitability by introducing the new product with different sales rates, (b) to determine where the new product would rank in range, (c) to define the cost of the introduction for individual retailers and to calculate how long it would take to recover launch costs, (d) to use the results from this study to support the product introduction and to justify the required space to potential retailers. In other words, the firm wanted to (a) predict shopper acceptance, (b) understand the impact on category sales, (c) determine costs and net profitability, (d) minimise effects on operational and trading infrastructures, (e) optimise pricing, marketing expenditure and on shelf availability. The supplier modelled two scenarios which suggested a profit increase of 40, respectively 51% increase in category profitability. Also an optimum package size was determined based on an analysis of major cost drivers. All this suggested major improvements to sales value and net margin of retailers' categories.

SAS proposes four tools to generate information to improve decision making. First, predictive modelling allows (a) to evaluate the potential performance of a new product, prior to launch, (b) to quantify the possible commercial impact on overall category profitability, (c) to measure impact across supply chain and analyse alternatives, and (d) to compare the performance of a new product (and the category) following a test versus a control trial. Second, automated reporting (a) to evaluate the performance of a new product, at launch, (b) to examine the commercial impact on overall category profitability, (c) to measure impact across the supply chain, and (d) to report the performance of a new product (and the category) following a test versus a control trial. Third, analysis of launch results (a) to determine the causal effects on the performance of the new product launch, (b) to locate best or worst performing channels, (c) to isolate supply chain and logistical bottlenecks, and (d) to understand customer acceptance and switching criteria. And fourth, dynamic update modelling (a) to modify existing launch parameters, (b) to enhance future modelling requirements, (c) to isolate unfavourable cost elements, and (d) to determine future trial algorithms.

7 Getting Ready to Produce Variants: Wella

The continuously increasing number of product variants puts manufacturers under pressure to control costs. Many variants sell in low quantities,

turning traditional mass-production into inefficient approaches. While some manufacturers fight this problem by stopping the production of variants with too low quantities, others search for new approaches in manufacturing and distribution. Especially the increasing request from retailers for and the substantial opportunities offered by retailer-specific product variants motivates leading manufacturers to develop solutions that allow the production of low production volumes. Experience from other industries demonstrates that through product redesign into modules and platforms, often referred to as the mass-customisation strategy, this economic need can be fulfilled without jeopardising marketing strategies.

Modular product design offers consumer goods manufacturers substantial opportunities, yet the creation of such a strategy is tricky. A useful approach appears to tackle the problem from two sides: by looking on customer requests and by analysing internal business processes. While the former can be operationalised by segmenting markets and strategic decisions, the latter requires to describe the cost structure. The ultimate goal is to define few basic platforms, say the common chassis of most products, and an assortment of modules that allow the specification of many different product variants. Of course, such new product designs needs to be investigated not only in terms of product quality but also in terms of manufactureability and ultimately costs. For most consumer goods, a rule of thumb appears to be that content and packaging offer quite independent opportunities for modularisation, the latter also in terms of distribution. Yet next to cost reductions benefits are also found in faster time-to-market as testing and graphics can be substantially shortened.

The implementation of a modular design strategy requires major management efforts. Wella experienced four major aspects to be considered to proceed with implementing their modular design strategy: (1) All departments and people have to be aligned according to the strategy. Different objectives of different departments lead to the development of contrary interest, eventually leading to the proposal of different "modules". (2) Promotion by top management is crucial, as modular design requires substantial investments and the creation of new business processes. (3) The definition of rules eases communication, coordination and decision making. (4) Given the many different definitions of the terms "module" and "platform" and ambiguity in the department strategies a common understanding of the corporate modular design strategy is essential.

8 Conclusion

Overall, it can be experienced that the public discussion on retailer-supplier collaboration in product development and launch is in an infancy stage. Yet, within the companies of retailers and suppliers major work is under way. Retailers are building up customer intelligence, strategic category management and capabilities to quickly turn product opportunities into profits. Suppliers are getting prepared to integrate information they get from retailers into their product creation processes, and are adjusting product, production and logistics design to deliver to retailer requests. So, it is probably not a speculation to say that one of the next fields for major improvement in the consumer goods industry is the redesign of the industry's product development and launch processes.

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PART 4

BEYOND RFID: SUPPORTING SUPPLY CHAIN MANAGEMENT WITH INTELLIGENT TAGGING

Turning Signals into Profits in the RFID-Enabled Supply Chain

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1 The Promise of RFID

If supply chain data was accurate, current, and complete, then:

- Efficiency could be measured in real-time
- Analysis could be done ad hoc, and
- Optimized action could be taken at once.

Consequently, profits will increase significantly.

The promise of RFID is to make this dream a reality. RFID will increase transparency of the flow of mobile assets at affordable cost levels. Higher transparency will result in cost savings - if exploited appropriately. Simply put, RFID-enabled companies will make more money. These days, this simple statement is broadly accepted within logistics-focused industries, such as CPG/retail. Consequently, Wal-Mart, Tesco, Metro, Carrefour and others have been pushing the adoption of RFID. Manufacturing sectors will follow suit and logistics industries will deliver RFID-enabled services. Indeed, RFID has all the ingredients to deliver benefits for a range of reasons:

- RFID is maturing. RFID technology has been around for decades and successful RFID projects in logistics have been implemented since the early 90's.
- RFID greatly facilitates and automates labor-intensive work and is therefore a perfect tool for rationalization.
- RFID is non-intrusive. As a result, the flow of assets is not being disrupted and, therefore, the number of reads, i.e. the level of transparency, will not become a limiting factor.

The Auto-ID Center (ACN AUTOID BC 007; 2003) identified the following value drivers and retail application priorities (Figure 1):

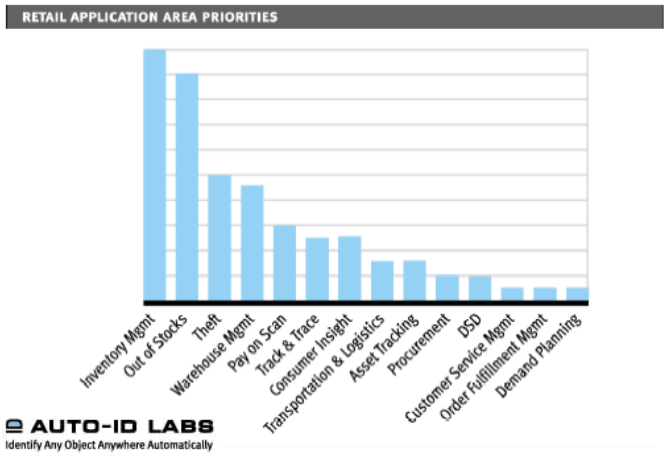

Fig. 1: Application priorities for retail industries (source: Auto-ID Labs)

GMA (Grocery Manufacturers of America) confirm the high priorities assigned to inventory and out-of-stock management and control. GMA emphasize the need for synchronization, flow-through distribution and overall improvements on supply chain efficiency.

GMA quantifies the losses incurred through inefficient supply chain visibility and execution as follows:

- Out-of-stocks = 4% loss of sales; approximately $17.5 billion to retailers. [7]
- Loss to manufacturers = $7.5 billion; primarily due to customer substitution choices. [1]
- The cost of Unsaleables = $2.5 billion, or 1.14% of sales.[8]

An RFID-enabled supply would considerably reduce these losses.

2 Open RFID Questions in 2004

While RFID is widely believed to have significant impact, questions remain about the evolution towards full adoption throughout industries. For fast proliferation to happen, manufacturers, retailers and logistics compa-

[7] Source: Retail Out-of-Stocks; CIES; FMI; GMA
[8] Source: 2002 Unsaleables Benchmark Report; Anne Lightburn; FDI; FMI; GMA

nies will have to be given satisfying answers to the following strategic questions:

- The early adopter question:
  - Do I really gain a competitive advantage or am I simply sponsoring the learning curve of my industry, i.e. my competitors, with my investment in RFID?
  - How can I leverage successful pilots for roll-out?
  - How do I generate and profit from economies of scale?
- The risk of emerging standards:
  - How can I reduce financial and operational risk exposure in a field in which standards are still volatile?
  - Are there ways to reduce fixed cost, thereby limiting my investment?
- The "benefit versus investment" question:
  - Who in the value network (e.g. supply network) benefits at which level and how big will my return be?
- The "RFID readiness" question:
  - What minimum investment will I have to make to be "RFID ready"?

Not all of these questions can be sufficiently answered at present. Therefore, an investment dilemma will continue to exist. While all stakeholders in value networks will have to be "RFID-ready" to be viable business partners, they will at the same time try to avoid committing funds to sunk-cost investments.

Still, the adoption rate of RFID has accelerated. The year 2004 has not only confirmed the viability of the RFID technology in a range of pilots, such as Metro's future store. 2004 is also the year for the start of full rollouts throughout supply chains. Metro's decision to start with 10 distribution centers, 250 stores and their Top100 suppliers by yearend 2004 is being matched by similar plans from Wal-Mart and Tesco to rollout RFID in 2005. Consequently, all major suppliers in CPG (consumer packaged goods) industries will have to adopt RFID in this period.

While standards for the capture and exchange of RFID information are being drafted and refined, it will take some time before widespread adoption. Moreover, companies are keen to leverage their existing signal capture capabilities, so it is highly likely that RFID implementations over the next few years will actually be a hybrid of legacy barcode systems working in concert with RFID equipment. In addition, these implementations are likely to include a mix of standards-based coding conventions like the EPCGlobal Electronic Product Code (EPC) and proprietary coding schemes working in 'closed communities' of trading partners.

The MIT/Auto-ID vision of a ubiquitous, global, Auto-ID information infrastructure (sometimes referred to as the 'Internet of Things') requires that the all the technology deployed operate to 'Open Standards' that will ensure interoperability of readers, tags, coding schemes and information access. These standards will take several years to develop and will, no doubt, go through several iterations before global acceptance (concerns over corporate and consumer privacy will drive much of the discussion). However, companies will move ahead with hybrid solutions in 'closed communities' to gain first-mover advantage. Those large organizations that move first will be in a position to shape and drive standards (as has already been demonstrated by Wal-Mart).

3 RFID Vision 2010

The penetration of RFID in supply chains is not only driven by CPG/retail. Other industries, such as pharmaceutical or automotive will follow suit. In addition, security-related industries will adopt RFID. Most notably, the US Department of Defense requires their suppliers to ship products with RFID tags from 2005 onwards. Therefore, the broad adoption of RFID is on its way. In 2010, RFID will be ubiquitous throughout industries.

RFID will enable value networks, i.e. organizations and their suppliers and/or customers, to permanently synchronize their businesses in the most efficient manner alongside the three dimensions of supply and distribution chains:

1. the physical flow of goods throughout a value network
2. the flow of information about these goods
3. the financial flows

Demand-driven organizations will have an edge in the world of micro-segmentation and fine-grained customer profiling. Forecasting alone will no longer be sufficient, but has to be complemented by demand signals which may be automatically generated when a customer takes a product from the shelf. Distribution centers will receive these replenishment signals, and will have to determine whether to replenish immediately or wait until more replenishment requests have been collected, and a more efficient delivery to store level can be made. Trucks will be loaded according to local store requirements. Capacity utilization will no longer be the only dimension for optimization. Loading at distribution center level will take into account the conditions at the receiving store, i.e. planogram of the local store and free space in its backroom, and will also consider the cost at the receiving desk. Likewise, replenishment of distribution centers through

manufacturers will be driven by demand signals. Manufacturers and the other entities in such a value network will have to make individual decisions in order to optimize their business, while at the same time delivering according to a global service level. Shelf-availability for customers in a store may be such a service level indicator.

The "demand to order network" is an example for a KPI-driven value network (Figure 2). RFID will generate a precise picture of the physical world at any given moment as an input to optimizing and synchronizing value networks. Furthermore, financial flows will be automatically generated by RFID-based information about physical flows. Cumbersome reconciliation of financial obligations will be history.

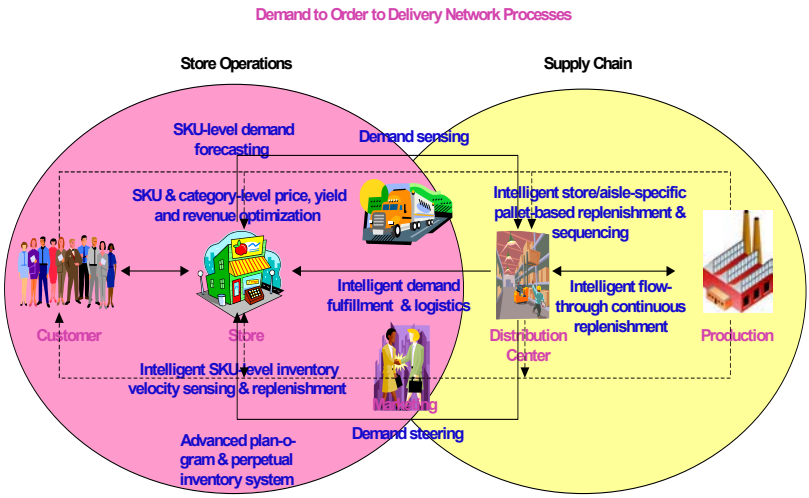

Fig. 2: Demand-driven CPG/retail value network

Even consumers will use RFID and read RFID tags with their personal readers, which may be embedded in their mobile phones. Data privacy issues will be resolved, and consumers will be able to leverage the information on RFID tags to identify the origin of food products, to receive information about an electronic product which they want to dispose of, and to ensure that they take their medication according to the prescription. Furthermore, consumers will be able to tell a counterfeit from a genuine product. RFID will empower them as consumers, while concerns about data

privacy will be resolved. For companies that understand and respect these concerns and behave as good corporate citizens, RFID will pay off.

4 Delivering on the Vision

This section describes what needs to be in place to deliver the 2010 vision. A range of market-led capabilities must be understood and developed incrementally:

- Market Requirements
- Value Network Management
- Mastery of data overload and complexity
- Right-time Event Intelligence in RFID-enabled Value Networks
- Data Privacy
- Auto-ID Managed Services and International Supply Chains
- Commoditization

4.1 Market Requirements

Most logistics-focused industries are working on the adoption of RFID and, as is demonstrated by the table below, the range of business processes being targeted is broad. However, today there is a predominant focus on product visibility and operational process automation. These are seen as the foundational capabilities that will be developed further to cover the entire landscape of requirements identified.

Table 1 presents what RFID is expected to deliver in different industries.

4.2 Value Network Management

A Value Network is an information sharing community that jointly delivers goods or services. The most common example of a value network is a supply chain where many different organizations collaborate with each other around the common goal of expediting the movement of goods at the lowest cost with the terms of agreed service levels. However, other examples of value networks include (but are not limited to):

- Airline Code sharing Networks
- Franchised Operations

- Collaborating domestic Government Authorities
- Seaport Security Communities
- International Customs Authorities

Table 1. Market Space Requirements and Benefits Matrix

Market Space RFID Requirements Matrix										
Value and Supply Chain Requirements and Benefits Matrix	**FMCG**	**Fashion (Brands)**	**High-Tech Electronics**	**Manufacturing**	**Life Sciences**	**U.S. DoD**	**Transportation and Logistics**	**Security**	**Secure Deliveries**	**Financial Documents and Securities**
Value and Supply Chain Visibility										
Tracking & Tracing	x	x	x	x	x	x	x	x	x	x
Automated Inventory Counts	x	x	x	x	x	x	x	x	x	x
Auto-replenishment	x	x	x		x					
Dynamic event disruption management & optimization	x	x	x	x	x	x	x			
Targeted recalls			x	x	x					
Level of visibility										
Item-level	x	x	x	x	x	x	x	x		
case, pallet, tote, pouch	x	x	x	x	x	x	x	x	x	x
container, trailer	x	x	x	x	x	x	x	x	x	x
truck, ship	x	x	x	x	x	x	x	x	x	x
Operational Process Automation										
Data Synchronization	x	x	x	x	x	x	x	x	x	x
Purchase Order Processing linkages	x	x	x	x	x	x	x			
Value Network Analytics and KPIs	x	x	x	x			x			
Ad hoc situational analysis and optimization	x	x	x	x		x	x			
Automatic results achievement	x	x	x	x		x	x			
Decision Support	x	x	x	x		x	x			
Invoice reconciliation and discrepancies	x	x	x	x		x	x			
Automated invoicing & payment	x	x	x			x	x			
Shipping and receiving automation	x	x	x	x		x	x		x	x
Shipping and receiving auditing	x	x	x			x	x		x	x
Proof-of-delivery at final destination	x	x	x	x	x	x	x			
Pick & pack, sorting, break-bulk	x	x	x				x			
Cross-docking automation	x	x	x	x			x			
Dynamic warehouse material handling automation	x	x	x	x			x			
Intelligent Object' self-responsibility	x	x	x	x			x			x
Dynamic object routing	x	x	x	x			x			
Real-time shipment routing and re-routing	x	x	x	x		x	x		x	x
Real-time flow analysis and identification	x	x	x				x	x		
Advanced scheduling, bottoms-up	x	x	x	x		x	x		x	x
Dynamic order allocation, multi-variable	x		x	x		x				
Planning										
Demand-driven replenishment planning	x	x	x	x	x					
Advanced plan-o-grams	x	x	x		x					
Demand and supply planning	x	x	x	x	x	x	x			
Inventory optimization	x	x	x	x	x		x			
Process simulation and optimization	x	x	x				x	x	x	x
Reverse Logistics and Warranties										
Returns management			x	x			x			
Recycling & end-of-life disposal			x				x			
Spare parts inventory management			x	x		x	x			
Field-level equipment configuration analysis			x			x				
Manufacturer retail allowance management	x	x								
Illicit Activities Tracing and Deterrence										
Anti-counterfeiting and authentication	x	x	x			x	x	x		
Gray-market goods tracing	x	x	x	x		x	x	x		
Theft prevention and deterrence	x	x	x	x		x	x	x	x	x
Secure International Transports	x	x	x	x		x	x	x	x	x
Condition Monitoring										
Temperature	x				x					
Humidity	x		x		x					
Expiration Date	x				x					
Shock and Vibration			x	x						
Tampering	x	x	x	x	x				x	x

A value network is a community of interest that is focused on a common set of goals and objectives with the expressed purpose of sharing selected operational data in a secure manner.

Value networks have existed for a long time, and so has the exchange of information between members of such a value network in order to enable collaboration. With RFID, value networks and their members will have an exact picture about inventory at all levels of the network. Misallocation of inventory and bullwhip effects will be more easily detected, and mismatches of fulfilment and actual demand will be resolved or avoided altogether.

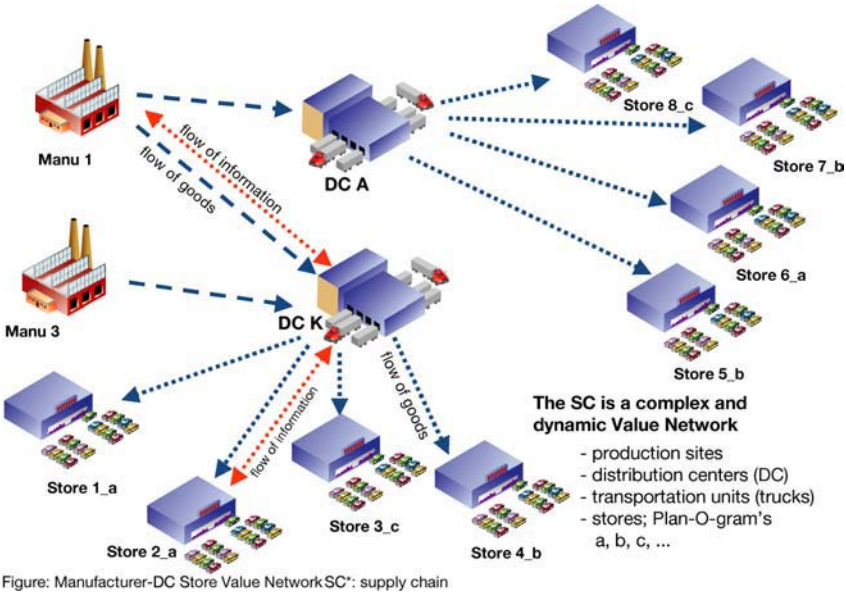

Fig. 3: Example of a Value Network in Retail and CPG Industries

In a CPG/retail value network, the retailer assumes the role of the value network master. In this capacity, the retailer determines the global service levels, which all entities of the value network have to comply with. These entities comprise the retailer's distribution centers and stores and his suppliers. A value network therefore organizes value creation across companies. Hence, some data will be shared and other data will be considered private. Value Networks handle complex business relationships. Across CPG/retail value networks, relationships are getting even more complex. A CPG manufacturer, such as Procter&Gamble has relationships with all big

retailers, and, similarly, all retailers have relationships with most CPG manufacturers.

Table 2. Process Metrics for CPG/Retail Value Networks

Store Process Metrics	**DC Process Metrics**	**Network Process Metrics**
SKU-level profit/cubic foot analysis	% SKUs cross-dock	Consolidated SKU-level Network Inventory
SKU-level SLA	% SKUs inventoried staple stock	Total network SKU margin analysis
SKU Out-of-Stock Index	$ SKUs DSD	Total network SKU cost allocation index
Store-Specific Network EOQ Modeling	Cartons/hour/DC headcount	SKU-level distribution cost performance index
SKU Process Responsiveness Index	Trailer cube capacity utilization	Private and common fleet cost / mile index
Store-level labor productivity index	DC-level labor productivity index	% of vendors with full demand and SC visibility
SKU-level velocity analysis	SKU-level replenishment SLA	Pallets reuse index
SKU-level forecast to actual sales index	Inventory investment/RDC applied revenue	SKU-specific transportation cost index
	% of conveyable SKUs	Private fleet round-trip utilization / cubic foot
	% of flow-through no-touch pallets	Trailer utilization 24x7 index
	% of flow-through no-touch cartons	
	% of store/aisle specific pallets	

Still, these many-to-many relationships work to date. Companies simply share information by exchanging documents. This loose, document-based, integration and co-operation has proven to be the right approach to managing these complex relationships. Tightly-coupled, point-to-point information exchange solutions would fail for reasons of cost and complexities of integration.

Standard electronic business documents such as waybills, purchase orders, bills of material, picking lists, advanced shipping notices, etc. are being accepted as input to a value network, and will generate electronic

documents for consumption by other systems and participants. RFID will not change these relationships, but improve processes through finer granularity and higher accuracy. More fruitful collaboration will be enabled by RFID signals, their translation into business events, and the subsequent combining of electronic documents with more event information.

Figure 3 illustrates a CPG/retail value network with its flows of goods and information.

Through RFID, value networks will become transparent and Key Performance Indicators (KPI) can be automatically measured. This will allow supply chain members to permanently monitor performance of individual entities of the value network (store and distribution center (DC)) and the performance of the value network as a whole. Network process metrics, such as consolidated SKU-level network inventory, will give a permanent picture about network performance (Table 2).

Furthermore, such metrics can be used to actively manage the behavior of parts of or the whole value network. Instantaneous analysis on business events, e.g. total network SKU margin analysis, will suggest appropriate action to exploit such business events.

The vision of a CPG/retail Yield-Management-System becomes real once SKU-level profit/cubic foot analysis can be conducted and appropriate action can be taken in real-time.

The subsequent table is a compilation of store-, DC- and network-level metrics, which will be critical for a Yield-Management system for CPG/retail value network.

4.3 Mastery of Data Overload and Complexity

RFID data signals and their transformation into business events require the value network to be event-sensitive. The question remains how such events can be exploited once they occur. The traditional operations research approach of applying a central optimization paradigm must fail given the decentralized nature of events and their resolution. Also, the interdependencies between nodes of a value network (store, DC, manufacturing site) and the fact that they may have different goals given that a value network comprises entities of separate companies, does not bode well for a central approach.

Instead, it is worthwhile adopting a distributed control paradigm. Distributed control will help master complexity. The farther the decision competence is away from an event, the more data and brainpower will be needed to process an event and the fewer local constraints can be considered. As an example, let's imagine a data noise at the receiving gate of a

warehouse, e.g. resulting from a reading error, which could easily be filtered out locally as the local context is known rather than passing it on to a central 'problem resolution' engine, where it is at best difficult to determine whether or not this is a relevant event or simply a noise. Distributed control mechanisms will result into more robust solutions.

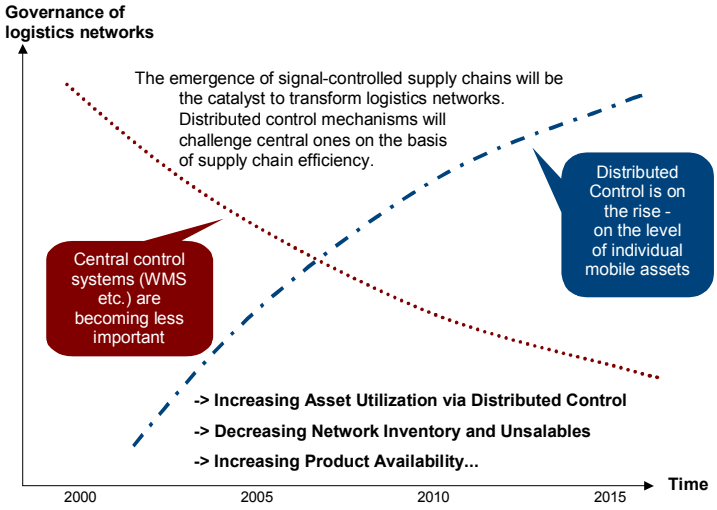

Fig. 4: Distributed control to increase supply chain efficiency

Distributed control is vital to RFID-enabled asset intelligence on two levels:

(a) Local capturing of signals and local pre-processing
(b) Process execution determined and executed by individual entities, i.e. contributors

RFID tags will put more information into mobile assets than ever before. Previously dumb items will deliver information that can be exploited in a local context only. Hence, central control systems like traditional warehouse management systems (WMS) will become less important over time, and render authority to local decision-making components. These can be local process controlling units and, in the future, RFID tags themselves will be equipped with processing power and will be able to make own decisions at a local level, e.g. a tagged product could notify its environment, when it is time to be shipped upon certain conditions. In fact, the first RFID tags of this kind are tags processing state information like humidity

and temperature. Rather than being governed top down, these products have bottom-up capabilities. In the future, these products are expected to pro-actively manage their destiny.

An example of a "bottom-up" organizational model is Kanban. Kanban has been widely adopted due to its flexibility, efficiency and adaptive event resolution. Local decision-making by context-savvy entities (work groups) is a key advantage of Kanban. Toyota and many other organizations have proven, that local decision-making and event resolution helps master complexity and run a more efficient business. Kanban's local control helps cope with uncertainty and external events, and complements forecasting and planning. Its pull-based behavior makes it demand-driven and enables the customer-driven organization.

The IT equivalent of a distributed control system that can manage a complex value network is an agent-based event-driven system. Such an agent-based system will sense, analyze and act locally while maintaining global service levels (Figure 4).

4.4 Right-time Event Intelligence in RFID-enabled Value Networks

IT and business people alike support the notion of real-time business. "Real-time" suggests that any event shall be spotted, analyzed and processed in nanoseconds, including its implications for back-end systems. While this desire is valid, and its fulfilment would greatly facilitate the world in which we live, we must determine what "real-time" really means in the context of a sophisticated value network and its processes. Fortunately, business processes tend to have a duration not measured in nanoseconds, but in days and hours. Also, value network members may determine whether an event is relevant for all other members (i.e. sent to systems of other members), or whether this event can be dealt with locally without jeopardizing expected service levels. In the latter case, notification to other partners is not necessary as action can be taken autonomously. In the case where events must be resolved in collaboration with others, "real-time" must be looked at in the context of actual process requirements. Thus in a procurement process "real-time" may be a 24-hour period in which a bottleneck situation has to be resolved. Hence, "right-time" is more appropriate a concept in this context. Most business processes comprise asynchronous elements, which have to be coordinated and acted upon in concert with a broad spectrum of information sources – the objective is therefore to ensure that this information is accurate, relevant and timely.

As mentioned earlier, a value network comprises heterogeneous entities and goes beyond companies' boundaries. Systems will never be connected in point-to-point solutions for reasons of complexity and flexibility and, as a consequence, for reasons of cost. Network collaboration will therefore continue to be document-based. Still, RFID-based collaboration will require a Business Systems Infrastructure upon which a range of processes will be synchronized.

The definition of this 'Business Systems Infrastructure' is:

- A globally applicable software layer,
- That sits above signal capture,
- That provides horizontal business application functionality, that both supports and augments enterprise applications,
- That integrates business events into heterogeneous business processes and legacy systems environments.

The figure below illustrates such a business systems infrastructure with its application functionality.

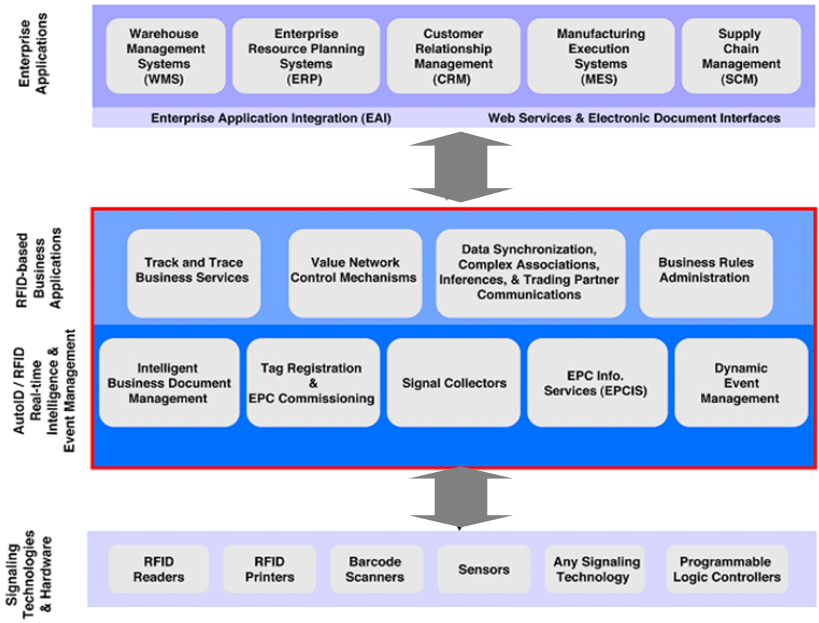

Fig. 5: Business Systems Infrastructure for RFID-enabled Value Networks

4.5 Data Privacy

Data privacy has to be viewed at the level of inter-company information exchange in value networks and at the consumer level.

Introducing the notion of access categories for information exchanged between companies greatly facilitates integration issues. There is private data which a company will not reveal, shared data which companies are willing to share with business partners only, and public data which is non-sensitive and available for broader audiences. Given the sensitivity of flow information, access to data will be classified as:

(a) private
(b) shared (accessible to individual partners)
(c) public (broad access)

The value network master will control access rights. Beyond an agreed shared database, members of the value network may determine which data they are willing to share, and which data will remain private.

If RFID is to become ubiquitous, all stakeholders in the RFID business must find answers to the concerns of consumers who fear that RFID may help intrude their privacy. Arguments of consumer advocate groups, such as C.A.S.P.I.A.N (Consumers against Supermarket Privacy Invasion and Numbering), must be taken seriously and data privacy issues must be addressed.

4.6 Auto-ID Managed Services and International Supply Chains

For value networks to be successful in leveraging RFID, the value network master and the members need a cost-effective solution to conduct their value network operations. In an emerging market like RFID, many companies are reluctant to invest in infrastructure given that product offerings are volatile and standards are just emerging. An alternative is to use a managed service.

- A managed service allows the vast majority of network participants to leverage a common networked Auto-ID/RFID service allowing value networks to be immediately enabled and cost-effectively organized into clusters that can migrate to open networks as Auto-ID/RFID standards mature.
- A managed service will realize critical mass quicker providing the support and maintenance of central and distributed Auto-ID/RFID equipment and software at a lower total effective cost and with materially more effective field support of hardware and software systems.

- A managed service allows the cost of learning and leveraging Auto-ID/RFID technologies to be spread over a large population of companies and users providing a lower total cost of ownership.
- Managed service providers have a critical mass of influence in which to help enable a more rapid maturation of Auto-ID/RFID standards.
- Companies that deploy Auto-ID/RFID hardware and software systems using a managed service provider experience lower total cash flow requirements.
- The managed service can be leveraged as a stand-alone or loosely 'light-touch' integrated solution that does not require costly integration and customization expenses.
- The managed service provider can provide a more secure, high performance environment that customers can trust.
- As an 'edge service' with significant value network characteristics across multiple participants, it logically makes sense to outsource part or all of the service to a shared managed service provider.
- Network service providers have existing networks that they can leverage at bundled service prices.

Supply chains increasingly become international in scope. Event-based end-to-end supply chain monitoring and optimization will therefore require end-to-end RFID networks. Affiliate managed service providers will enable end-to-end value chains to cost-effectively tag items in remote manufacturing facilities, and will provide the network visibility and the ability to track and trace services worldwide.

4.7 Commoditization

Today's RFID pilots still lack the key characteristics for full-scale rollout, namely that of significant economies of scale when rolled out throughout a value network. Standardization is a key to achieving economies of scale. This scalability and standardization requirement applies to all components of RFID delivery:

1. Hardware
2. Software
3. Professional Services

Both hardware and software will have to be commoditized before large-scale rollouts throughout value networks, i.e. 1,000s of RFID reading locations will become economically viable. Vendors must understand that current architectures, products and solutions will have to become simpler and cheaper before RFID will proliferate. The industry consortium created by major retailers - Carrefour, Metro and Tesco and the chip company Intel -

gives an indication of the need for accelerated standardization and commoditization.

In the emerging more commoditized RFID world, professional services will be required, not for integration of software systems, but for value-added business services directly related to the specific business.

5 Conclusions

While the market for RFID-based services in logistics and IT will grow substantially in the years to come, companies will be reluctant to commit significant resources upfront. Companies have to find out what is in it for them before investments are made. They will therefore try to source basic capabilities of their RFID services, and only build what really differentiates their services in the perception of their customers.

This sourcing strategy will be adopted throughout the different phases of RFID projects:

- Design and build
- Pilot
- Rollout
- Operation and Maintenance

By leveraging existing RFID services and capabilities, companies will be in a position to reap the benefits of economies of scale and achieve decreasing incremental cost, as soon as the market takes off.

A major example for this delivery model is a managed service. Managed services providers, e.g. logistics companies or telecom providers like British Telecom, will offer basic RFID services such as tracking and tracing for their customers. Customer-specific extensions will complement reusable basic capabilities, and result into customer-specific solutions at minimum cost. Providers of the basic capabilities (hardware and software) will tackle issues such as adoption of the newest standards, integration with ERP and other legacy systems and support of existing technologies, such as barcode. In this way, all applications deployed in such a managed service will be up-to-date as only the lower level layers need to be updated or upgraded in case standards change. Moreover, leveraging operational RFID capabilities throughout entire value networks is best achieved through a managed service with standardized operations.

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Shopping in the 21st Century: Embedding Technology in the Retail Arena

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1 Introduction

The emergence of new technologies such as wireless networks and Radio-Frequency Identification (RFID) tend to render the traditional retail processes faster, more transparent and effective. Indeed, processes such as procurement, order management, demand forecasting and inventory management will be greatly enhanced through the deployment of these technologies. Moreover, these emerging technologies introduce new opportunities for the retail sector stakeholders in order for them to accurately and promptly respond to consumers' needs with personalized services and promotion plans. This entails a dual benefit for retailers: optimized processes are leading to increased cost savings and an improvement of overall customer satisfaction.

Enhancing customer satisfaction has been a major objective for the retail sector for the past decade. In effect, ECR Europe has introduced a major project on consumer value during 1998-1999, which tackled this objective from three distinct perspectives: value measurement, value creation and value management. Recently, consumer value has regained its strategic importance for the retail sector mainly due to the sociodemographic changes of today'sconsumers, which have altered their demands and expectations. A recent survey presented by Accenture during the 2003 ECR Europe Conference, revealed that the so-called "traditional family" is dramatically declining. In effect, we are witnessing a gradual decrease in the average household size and the percentage of married couples, while, at the same time, the number of one person or lone parent households is continuously increasing. Moreover, the spending patterns of consumers are also changing: food is proportionally taking less of the "purse" compared to other retail products, such as clothing and home-related items.

Consequently, the extent to which retailers will be able to deliver a positive shopping experience will determine the degree of customer satisfac-

tion and customer loyalty that they engender, and, thus, will constitute the ultimate driver of improved sales and profitability. In today's challenging economy, the 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. In this environment:

- Customers are expecting and demanding value-added services and rich information.
- Increased competition in a saturated market (such as the retail industry) is not allowing retailers to sustain differentiated brands and value propositions.
- Rapid evolution and adoption of new technologies present both opportunities and risks for companies thriving to innovate.

This chapter aims to investigate the potential of information technology in the retail sector, focusing on the downstream side and, in particular, the retail outlet. Our research revealed that the deployment of emerging technologies in the retail arena enables retailers to meet consumers' needs even better than before. In the so called "store of the future", shoppers interact with a technologically-augmented environment capable of enhancing their total shopping experience in such a way that they feel understood, supported and, consequently, delighted.

2 What Is Affecting Consumers' Shopping Experience?

The shopping experience for consumers can be characterized as a circular process affected by a multitude of issues and situations before, during, and after they visit a store and buy something. It is from the total sum of multiple points of interaction that consumers form their opinions and overall attitudes about retailers. Over the past years, supply chain management researchers have performed endless studies in order to identify what frustrates shoppers most during their visit to the retail outlet. Several individual elements have been identified such as congested checkouts, out-of-stock products, misplaced items, and so on. In effect, these surveys revealed that the shopping experience is negatively affected by a number of store-related factors, which include – but are not limited to – ambience (temperature, scent, music and so on), service quality, store image, and

situational elements (such as crowding, time and budget availability by the consumers, and so on). All these lead to consumer dissatisfaction mainly in the form of increased levels of stress for the supermarket shopper, and may result in creating a new form of supermarket shopper: apathetic shoppers; people who have no interest in, or actively dislike, shopping, and appear to endure rather than enjoy the whole experience.

A shopping experience can be driven toward the maximization of efficiency or toward entertainment. As mentioned before, ECR has introduced two projects (Consumer Value Management and Consumer Enthusiasm) attempting to alert the FMCG value chain regarding these changing customer needs. These projects derived from the experience that profitable growth could no longer be generated by consumer satisfaction or consumer loyalty, but only by creating consumer enthusiasm. It is therefore imperative that the FMCG value chain actors jointly discover the actual consumer needs and implement new shopping experiences.

In 2003, Cap Gemini Ernst & Young, Intel, Cisco Systems and Microsoft worked with ORC International to conduct a pan-European study on the relative importance of factors and frustrations relating to the shopping experience. 2,500 consumers of different retail channels (grocery stores/supermarkets, discount stores, specialty stores, drugstores, department stores, and fast food restaurants) have been surveyed in five European countries: United Kingdom, France, Germany, Netherlands and Sweden. The survey uncovered a number of key findings that validate the aforementioned elements that affect the traditional shopping experience:

- European consumers expect retailers to help them save time, streamline the shopping visit and enhance the overall quality of service.
- European shoppers are frustrated with their shopping experiences, resulting in a negative impact on their shopping habits. According to the survey, the top in-store frustrations consumers face can be summarized in the difficulty getting through the check-out process quickly, out-of-stock or misplaced products, poor service quality in terms of (a) difficulty finding store employees to assist or answer questions, and (b) lack of employee knowledge about the products in the store, and, finally, poor visibility of product prices on shelves. These in-store frustrations tend to lead shoppers to shop less frequently, or even stop shopping from a particular shop.
- Consumers are willing to use technology-based solutions to facilitate and enhance their shopping visit. In particular, the survey respondents stated that they would most probably use the following service-oriented applications within the store: self-service terminals providing special

promotions/discounts, clerk-assisted check-out throughout the store, and self-service terminals providing information about products.

Another survey jointly performed by IBM and the National Retail Foundation with leading retailers in Europe and North America in October - November 2002, indicated that technology adoption is accelerating for both retailers and their customers, setting the stage for significant change in the near future. As consumers become more comfortable using new access devices and payment mechanisms over time, retailers expect them to be eager adopters of new technologies that will consequently satisfy them through efficiency and convenience, and build the necessary infrastructure to motivate them and convert latent desire to real demand. The key denominator in both surveys is that information technology may hold the key to providing enhanced services to the end-consumers, and, thus, constitute the differentiating factor that will leverage user satisfaction and overall service quality.

3 Embedding Information Technology in the Retail Outlet

3.1 Introduction

Traditionally, the retail sector has been very technology-oriented, constantly experimenting with new technologies promising to streamline and optimize core operations within the store or the warehouse. Indicative examples include the introduction of Electronic Data Interchange (EDI) to standardize the ordering process between the supplier and the retailer, and the introduction of barcode scanning at check-out. Nevertheless, recent developments in information technology in terms of:

1. supporting communicating technologies, such as wireless networking and automatic product identification,
2. customer interaction techniques offering access to rich store or product-related information and
3. mobile access devices enabling access to product location or additional information, sales suggestions, and optimization of the check-out process

have given modern retailers new tools for reaching their shoppers in ways unimaginable in the near past.

Indeed, retailers can use a multitude of technologies in order to offer fully personalized services to their shoppers during their visit to the store. Personal Digital Assistants (PDAs) and Tablet PCs embedded in the shopping trolley can be used by shoppers in order to facilitate their shopping

trip, and receive fully personalized information based on their distinct and individual shopping habits and consumption behavior; multimedia infokiosks can provide information on any product within the store, including information on sales promotions; multimedia monitors can display product advertisements and provide valuable suggestions; electronic price labels can constantly display the current price of products on the shelves and, most importantly, they can be dynamically updated based on the current inventory level or promotion plans; technology also provides the opportunity to embed multimedia attributes in the individual products or the store aisles in order to attract the attention of shoppers.

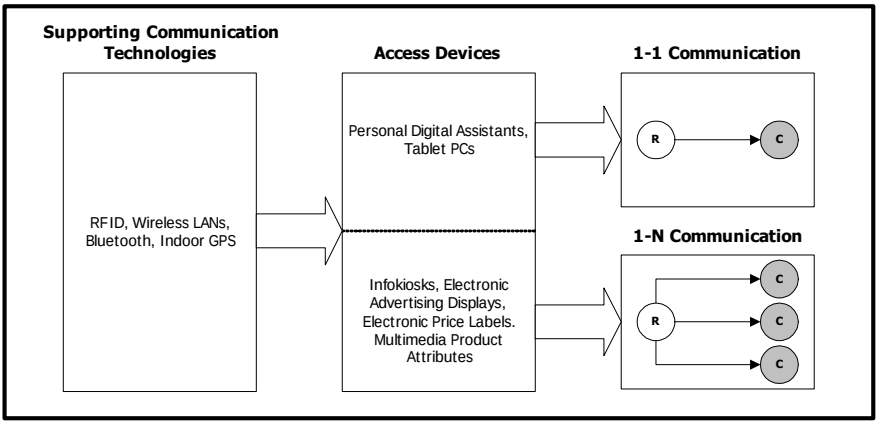

Fig. 1: Revisiting traditional retail communication channels within the store

Figure 1 illustrates how information technology helps retailers revisit the traditional communication channels within the store, and, depending on their strategy, select the most appropriate technical solution. It should be noted that many major retailers are already beginning to investigate the potential of embedding advanced information technology within the store. As a result, we are witnessing several isolated examples, the most important being currently the Metro Future Store Initiative, which will be briefly presented in the following sections.

3.2 Enabling the Provision of Pervasive Retail Services Through Wireless Communication Technologies

The provision of advanced and value-added services within the store is intimately related to recent developments in mobile and wireless infrastruc-

tures, which in turn led to severe decrease in implementation and installation costs.

Table 1. Overview of wireless communication and location identification technologies

Technology	Integration Requirement	Potential Typical Application
Automatic Identification		
Radio Frequency Identification	High	• Personal shopping assistant (continuous monitoring of the products in the shopping trolley) • Shelf management (elimination of out-of-shelf conditions)
Wireless Communication		
WLANs	Low	• Continuous communication with the retailers' legacy systems (enabling access to the current product catalogue, prices, and active promotions)
Bluetooth	Medium/Low	• Wireless communication of the shopping trolley with the cashier • Wireless communication of a shopper's PDA with information terminals within the store or embedded in the shopping trolley
Location Identification		
Indoor GPS	High	• Identification of the shopper's current location within the store • Identification of a product's current location within the store

The emerging technologies are characterized by three major features: electronic identification of physical products (consumer or otherwise), seamless communication of electronic devices using wireless infrastructures, and capability to identify the location of an individual person or product within the retail outlet. Electronic tagging, in particular, annotates physical artifacts with identification information, which can be used for tracking purposes, but also in order to associate particular characteristics or properties with a specific product. This capability generates a rich information source that can be utilized either in supply chain management applications or for enhancing the consumer experience. As a result, wireless infrastructures can be used to deliver a new class of information systems within

the store: pervasive retail information systems. This will create environments augmented with IT resources providing information and services when needed by shoppers in a fully transparent way. Table 1 presents an overview of potential applications supported by wireless communication technologies, including their integration requirements with retailers' backend systems or other IT resources within the store.

3.3 Radio-Frequency Identification: The Barcode of the New Millennium

The barcode, as an identifier of supply chain assets and products, revolutionised the retail industry 30 years ago; today over 5 billion products are scanned every day in 141 countries. Whilst it is clear to retailers and manufacturers that the barcode's relevance and importance to the industry will remain for years ahead, many in the industry are now looking to the business case for the "next generation of barcode" – Radio-Frequency Identification tags or, in short, RFID.

RFID falls under the umbrella of Automatic Identification (Auto-ID) technologies, along with technologies such as magnetic stripe, smart cards, voice data entry, touch memory, and so on. An RFID tag can be attached to a pallet, case, product, even an individual part or component. The tag consists of a microchip, in which relative information is stored, and an antenna. RFID tags communicate to RF-Readers (or "gates" in the case of warehouse management applications) as they pass along the supply chain from factory to store, supplying real-time information about the attributes or even the location of the tagged items along the supply chain. The cost of the tag varies according to the material it is made of and how much information needs to be stored on the chip.

RFID offers a more sophisticated kind of tagging compared to barcodes. Some of the improvements are summarized below:

- RFID tags can identify each item uniquely, providing the capability to have full supply chain visibility.
- RFID technology offers simultaneous reading of multiple tags – e.g. in a stock-room – without having to establish line-of-sight.
- RFID tags can withstand chemical and heat environments that would destroy traditional barcode labels.
- Barcodes contain static information that cannot be updated, unless the user reprints the code; information in an RFID tag can be dynamically updated.

The replacement of barcodes with RFID tags will enable companies to monitor product movement accurately and continuously, from manufacturing to actual consumption, in real-time. RFID benefits will also be apparent for shoppers, since they will be able to bypass checkout counters altogether, as their tagged purchases will be automatically debited to their accounts on their way out of the door, or they will have the opportunity to pay in cash without having to wait in queues.

Nevertheless, the tagging of individual products has raised severe concerns regarding the protection of consumers' personal information, especially in terms of monitoring their shopping behavior even after their visit to the store, since the purchased products will continue to be tagged. A possible solution to this problem is to automatically de-activate the RF-tag at the moment of purchase. Moreover, the tags should be placed on the product package (and not embedded in the product itself), they should be visible, and, most importantly, consumers should always be notified when they purchase an RF-tagged product.

4 Key Examples of Information Technology Augmented Environments

4.1 The METRO Future Store Initiative

One of the most notable examples of technology-augmented implementations in the retail environment is the Metro Future Store Initiative in Rheinberg, Germany. In April 2003, Metro, the German retailer, unveiled the "Future Store", a converted traditional supermarket embedded with emerging retail technologies aiming to make shopping easier and more comfortable for the shoppers. The initiative is a joint operation of Metro with IBM, SAP and Intel.

In the Metro Future Store, shoppers use a shopping cart equipped with a Tablet PC enabling them to scan the barcodes of items they select, and presenting them with valuable information. Moreover, intelligent scales and multimedia info-kiosks enhance their overall shopping visit. A wireless network ensures the unobtrusive communication with the backend system accessing the product catalogue and active promotional plans, while self-service checkouts make payments automatic. The technologies and applications employed include:

- *Streamlining the shopping trip by using the Personal Shopping Assistant (PSA):* The PSA consists of a small computer attached to the shopping trolley that facilitates individual shopping. Shoppers can scan the prod-

ucts by using the embedded barcode scanner, and all respective information is instantly presented in the computer's display screen. Shoppers initiate their shopping session with the PSA by using their personalized loyalty card (entitled "Extra Future Card"). The PSA also displays indications of active promotions and special offers, whilst also providing a navigation system enabling fast orientation and instant product location finding within the store.

- *Ad-hoc, real time in-store related information provision through infokiosks:* Infokiosks are information terminals located in the store for the customers' shopping convenience. Shoppers can scan a product and receive in-depth valuable information comprising ingredients, recipes, or even alternative or similar products.
- *Above-the-line marketing using Electronic Advertising Displays (EAD):* Electronic displays comprising flat screens are efficiently located in the store, and highlight current offers and promotions, or play short video sequences of product advertisements.
- *Comfort shopping using self-checkouts:* New, fully automated check-out systems accelerate the payment process. Shoppers can manage the checkout process themselves, since the total price of the products scanned with the Personal Shopping Assistant is transmitted to the check-out system via radio signals. Shoppers can pay with cash or credit card in the cashier.

4.2 The MyGROCER Project

Although the Metro Future Store constitutes the most renowned example of an IT-enabled retail environment, one of the first implementations of such a technology-augmented environment was an EU-funded research project (MyGROCER), which spanned two years (2001-2002), and developed and tested an innovative shopping scheme in a Greek supermarket by using cutting-edge technologies (namely RFID and wireless interconnectivity).

The business concept of the Greek pilot enabled the shopper to pick up a shopping cart equipped with a display device and an RFID sensor capable of scanning the contents of the cart. The shopping cart was wirelessly connected (through 802.11b) to the retailer's backend system, providing access to the product catalogue and active promotional plans. The shopper used his/her loyalty card to log in the system, which presented a reminding shopping list of products the shopper usually purchased. The shopper could then start navigating within the store as usual, picking up products and placing them inside the shopping cart. Each time a product was placed

in the cart, the display device showed its description, detailed information, price, and updated the total cost of the cart's contents. At the same time, the product was erased from the reminding shopping list. Moreover, at any time, the shopper could request additional information about a product (e.g. nutritional value, ingredients, and so on), be informed about the promotional activities running in the supermarket (fully personalized, based on the shopper's profile and past consumption patterns), and request for navigation assistance within the store. Finally, during check-out, the system transmitted the list of purchased products along with the total amount to the cashier that issued the receipt.

The initial approach was to install multiple RF-readers inside the shopping trolley in order to support full coverage of its total volume. Nevertheless, due to impervious technical and business difficulties (increased power requirements, RF-signal absorption by the material of the shopping trolley, and increased total cost), the project team decided to install just one RF-reader on top of the trolley. As a result, the shopper would have to place each product he/she purchases in the range of the RF-reader in order to have it "scanned". Although this solution resembles the existing self-barcode scanning mechanisms, it offers significant benefits both to the shopper (there is no requirement to search for the barcode label in order to have the product scanned) and the retailer (security / anti-theft precaution).

The in-field evaluation of the pilot spanned over a two-week trial during September and October 2002 (Athens, Greece – ATLANTIC supermarket). The aim of the trial was to understand how the new shopping method influences the shopping experience compared to the traditional supermarket environment. Members of the supermarket loyalty club were selected to take part in the study. Specifically for the trial, a corridor of the supermarket was modified, and a representative set of products was selected, which were equipped with RFID tags. The entire system infrastructure was installed in the back-end room. Participants were contacted over the telephone, and time slots were booked for each individual. Upon arrival, participants were demonstrated the system functionality, and then used it independently. The participants were able to perform part of their shopping trip within the specially modified corridor, and receive offers and promotions according to their profile. Finally, participants were asked to complete a questionnaire in order to evaluate the system services, express their views of their experience and compare it to traditional shopping.

Several aspects of the system received favourable responses, especially the features that help save time and money. In particular, minimizing the checkout time, and 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. Moreover, the navigation

features of the system were highly appreciated by the trial participants. In short, the perceived benefits of the system for the participants' "traditional shopping experience" involved conducting shopping faster, easier, and at better value for money. Specific features that proved to be more attractive included the following:

- Constant awareness of the total cost of the shopping cart contents, which offers the opportunity to accurately control spending during a shopping trip,
- On screen appearance of complete and accurate description of products,
- Ability to compare the value of similar products simply by scanning them,
- Personalized, targeted promotions fitting the shoppers' profile,
- The in-store navigation system, which appeared impressive and very practical in saving time from asking store employees to locate products,
- The smart check-out and the ability to bypass queues and reduce waiting time, which was the feature that received the highest appreciation by respondents.

Finally, one of the most striking responses was that the new shopping scheme has a high entertainment value, with the majority of participants stating that they found the experience enjoyable, while more that half considered the new shopping method an exciting activity. In addition to this, participants overwhelmingly considered that the use of such systems reduces their stress level and sense of time pressure while shopping. The Greek trial identified that modern technologies can help retailers meet the needs of consumers even better than before. In the "store of the future", customers may make use of a service tailored even more accurately to their specific wishes and expectations. Consequently, the technology-augmented environments make shopping more individualized, efficient and comfortable. Retailers will have a tool that enables them to "work with their consumers", making them an integral part of their operations, and *reaching* them in a way that they become a real stakeholder, part of the ECR vision for an optimized value chain.

5 Conclusions

Embedding advanced information technology in the retail outlet is no longer a vision, but over the past few years it has become a reality. This can be mainly attributed to recent technological advances, which have

made the deployment of pilot initiatives technically and economically viable. In effect, 62 leading retailers in North America and Europe have expressed their plans to deploy new IT-enabled convenience schemes for consumers (such as infokiosks, RFID enabled check-outs, navigation assistance, and so on) within the next 3-5 years according to a survey performed by IBM and the National Retail Foundation. The direct benefits for the retail value chain deriving from the incorporation of cutting-edge technologies in the traditional supermarket environment include among others:

- Real-time information provision regarding the products' lifecycle within the retail outlet, optimizing the forecasting process of future demand,
- Real-time information provision regarding the shopper's shopping trip within the retail outlet, identifying and modeling 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 information technology within the store is the creation of new shopping experiences and, consequently, enthusiasm for the consumers. The major challenge for retailers is to persuade their consumers to use the new information technology appliances. We expect that older consumers will be more reserved and conservative against new technologies, whilst younger consumers will be more eager and enthusiastic to adopt the emerging shopping schemes.

Certainly, the deployment of IT appliances within the store will transform the way consumers conduct their shopping. According to the 2003 survey performed by Cap Gemini Ernst & Young, Intel, Cisco Systems and Microsoft, information technology can have a positive impact on consumers' shopping behavior since they might buy higher quality products; be more informed; spend more time in the store during each visit; tend to spend more money; and, finally, it might increase their loyalty to the particular store that offers them such advanced facilities.

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Towards 'Smarter' Supply and Demand-Chain Collaboration Practices Enabled by RFID Technology

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1 Collaboration in the Supply and Demand Chain

The advent of e-business has created several challenges and opportunities in the supply chain environment. The Internet has made it easier to share information among supply chain partners, and the current trend is to try to leverage the benefits obtained through information-sharing (also called visibility) across the supply chain to improve operational performance, customer service, and solution development (Swaminathan and Tayur, 2003).

Since the early 1990s, there has been a growing understanding that supply chain management should be built around the integration of trading partners (Barratt and Oliveira, 2001). Bowersox et al. (2000) state that firms collaborate in the sense of "leveraging benefits to achieve common goals". Anthony (2000) suggests that supply chain collaboration occurs when "two or more companies share the responsibility of exchanging common planning, management, execution, and performance measurement information". He goes further by suggesting that "collaborative relationships transform how information is shared between companies and drive change to the underlying business processes". Research carried out by Andersen Consulting, Stanford University, Northwestern University, and INSEAD, as reported in Anderson and Lee (1999), recommends that industry participants "collaborate on planning and execution" of supply chain strategy to achieve a "synchronised supply chain".

Some scholars suggest using the term demand chain management (DCM) instead of supply-chain management (SCM) (Vollmann et al., 2000; Vollmann and Cordon, 1998). This puts emphasis on the needs of the market, and designing the chain to satisfy these needs, instead of starting with the supplier/manufacturer and working forward. The main stimu-

lus behind this has been the shift in power, away from the supplier, towards the customer (Soliman and Youssef, 2001).

In retailing, supply-chain collaboration has taken the form of practices such as Continuous Replenishment Program (CRP), Vendor Managed Inventory (VMI) and Collaborative Planning, Forecasting and Replenishment (CPFR). VMI is a technique developed in the mid 1980s, whereby the manufacturer (supplier) has the sole responsibility for managing the customer's inventory policy, including the replenishment process, based on the variation of stock level in the customer's main warehouse or distribution centre (Cooke, 1998; Frantz, 1999). VMI is probably the first trust-based business link between suppliers and customers (Barratt and Oliveira, 2001). CRP moves one step ahead of VMI and reveals demand from the retailers' stores. The inventory policy is then based on the sales forecast, built from historical demand data, and is no longer purely based on the variations of inventory levels at the customers' main stock-holding facility (Andraski, 1994).

Collaborative Planning, Forecasting and Replenishment (CPFR) can be seen as an evolution from VMI and CRP, addressing not only replenishment, but also joint demand forecasting and promotions planning, focusing on promotions and special-line items. CPFR is based on extended information sharing between retailer and supplier, including point-of-sales (POS) data, forecasts and promotion plans. Pramatari et al. (2002) further suggest a new form of CPFR, which they name Process of Collaborative Store Ordering (PCSO), addressing the daily store replenishment process. This process is supported by special IT infrastructure (collaborative platform), allowing for the daily online sharing of store-level information (e.g. POS sales data, store assortments, stock-level in the store, promotion activities, out-of-shelf alerts, etc.), sales forecasting and order generation, online collaboration of the trading partners, and, finally, order exchange and order status tracking. Any user connects to this collaborative platform through a secure Internet connection, using a simple Web-browser interface.

Based on these short descriptions, VMI and CRP are more about supply-chain collaboration, whereas CPFR puts more emphasis on the demand side. What makes the distinction in the evolution path followed by these collaboration practices is the amount of information exchanged between the trading partners, and the process(es) enabled by this information sharing. In this paper, we discuss the next generation of supply and demand chain collaboration practices empowered by the additional information that becomes available when the technology of Radio Frequency Identification (RFID) is used to identify product delivery units (e.g. pallets, cases) and/or individual items.

In the following section, we discuss the technology infrastructure that has enabled collaborative practices up-to-now, and current trends in this area. We then discuss the technology of Radio Frequency Identification and the processes that are enhanced by the new information that becomes available in this "smarter" context. In the fourth section, we describe the underlying infrastructure required to support RFID-enabled collaborative practices in the demand and supply side, and conclude with some closing remarks and future directions in this area.

2 Enabling Collaboration Between Trading Partners

Efficient information and data exchange is the most essential requirement for implementing the collaborative practices referred to above. In the traditional ordering process, retailers provided manufacturers with only data on quantities of goods required once a week (through ordering). VMI/CRP and CPFR dramatically increase the total volume of information transmitted between retailers and suppliers. Table 1 summarizes the evolution in increased information exchange, from pure ordering to CPFR, and the underlying technology supporting the exchange of information and collaboration between the trading partners.

In order to cope with this increasing need for extended information exchange, the retail sector has started moving away from EDI, to new ways of information exchange, mainly enabled by Internet-based communication platforms and retail exchanges (Sparks and Wagner, 2003), also referred to as electronic marketplaces (e-marketplaces). Such exchanges are characterised by the retailers' direct access to distributors and suppliers, enabling businesses to interact via a neutral intermediary (the exchange) in order to conduct either one-to-one or multiple transactions. Thus, suppliers gain access to more buyers, and buyers can contact many suppliers. Such exchanges also hold out the hope of a more efficient supply system, through better and more rapid communications, facilitating improvements in planning, deployment of transport fleets, warehouse management and procurement procedures (WWRE, 2000). Pramatari et al. specifically discuss the requirements of an Internet-based platform supporting information sharing and collaboration with the objective to streamline the store replenishment process. Although these could provide members with cost and service benefits in line with their global ambitions, they might also change the nature of some business relationships (Sparks and Wagner, 2003).

Table 1. Information exchanged and underlying technology from traditional ordering to CPFR

	Supply-Chain Collaboration Practice			
	Traditional ordering process	**VMI/CRP**	**CPFR**	**PCSO: Daily, store-level CPFR**
Information Exchanged	• Orders • Dispatch advices	• Orders • Suggestive orders • Inventory report (including store demand and warehouse shipments in CRP)	• Orders • Inventory reports • Aggregated POS data • Sales forecasts • Promotion plans	• Orders • Store inventory • Daily POS data • Store product assortment • Store promotion activities • Dispatch advices
Collaborative Business Processes	• Replenishment	• Central Warehouse (CWH) Replenishment	• CWH Replenishment • Store Replenishment • Promotion planning	• Store Replenishment
Technology supporting information exchange	• Paper • EDI • EDI over Internet (lately)	• EDI (mainly) • EDI over Internet (lately)	• XML/ ASCII files over Internet	• XML/ ASCII files over Internet
Technology supporting collaboration	• Internal ERP systems	• Internal specialized application (mainly) • Collaborative platform retail exchange (lately)	• Collaborative platform retail exchange	• Collaborative platform retail exchange

A recent investigation by Eng and Spickett-Jones (2002) reported that current Internet exchanges are more suitable for commodity-based products and services, and that key issues concerning collaborative planning, forecasting and replenishment have been impeded by short-term focus of transaction-based activities in e-marketplaces. Furthermore, the Internet has been so far confined to internal processes, and has not yet been used to exploit opportunities beyond the traditional ownership of supply chains, or has involved collaboration with external firms to reach new markets and synchronise product planning and promotional activities (Eng and Spickett-Jones, 2002).

Grieger (2003) argues that most of the work published on electronic marketplaces, both in research and practice, is biased towards e-commerce, sales and marketing, or is simply counting all sorts of possible values and cost savings. The supply chain dimension of electronic marketplaces is, for the most part, mistreated and handled insufficiently. He further describes how supply chain management can be examined by analysing different types of electronic marketplace relationships (transactional, information-sharing and collaborative). Retail exchanges are intuitively compelling, but it is still not really clear how they are going to affect retail industry competitiveness and the supply base (Sparks and Wagner, 2003).

However, the third-party operated e-marketplace is not the only option for operating an Internet-based collaboration platform. Sparks and Wagner (2003) report that suppliers are wary of further involvement in e-marketplaces. Disillusioned by pricing and other concessions, they are still waiting to see the promised volume and liquidity levels. On the other hand, they see the emergence of private exchanges, namely invitation only networks that connect a single company to its customers, suppliers or both. A few retailers e.g. Wal-Mart, have had the will and the finance to create priority supply chain information systems, and the power to force suppliers to adopt them.

Eng (2003) further identifies two main barriers to implementing strategic collaborative supply chain processes:

(1) technical uncertainty on the reliability of e-marketplaces, in that migration from EDI to an e-marketplace system requires technical support and integration of various supply chain activities in a company; and
(2) sharing of strategic information with other participant organisations is not a common practice. This hinders the extent of the types of collaborative and strategic supply-chain management activities that can be carried out in the e-marketplace.

These points raise several discussions as to what form the supply chain collaboration will take, especially when considering new types of information exchanged and new forms of collaboration among supply chain partners, such as those enabled by RFID, which will be discussed in the following section.

3 Enhancing Retail Business Practices Using RFID Technology

Radio-Frequency Identification Technology (RFID) falls under the umbrella of Automatic Identification (Auto-ID) technologies along with technologies such as magnetic stripe, smart cards, voice data entry, touch memory, and so on (Agarwal, 2001). RFID technology has been extensively used for a diversity of applications ranging from access control systems to airport baggage handling, livestock management systems, automated toll collection systems, theft-prevention systems, electronic payment systems, and automated production systems (Agarwal, 2001; Smith et al., 2003; Tierney, 2002; Wilson, 2001). What is more, recent advances have made possible the identification of consumer products using RFID.

Traditionally, the retail sector uses barcode as the main identifier for cases, pallets and products. Today, over 5 billion products are scanned every day in 141 countries. Whilst it is clear to retailers and manufacturers that the barcode's relevance and importance to the industry will remain for years ahead, many in the industry are now looking to the business case of RFID as the "next generation of barcode".

The technology uses radio waves to automatically identify individual items. In effect, RFID technology comprises two main parts:

- *The RF-tag,* consisting of a small, versatile and cheap (predicted to eventually be less than five cents by 2006) microchip attached to an antenna, which can be easily and invisibly embedded in most products packaging, clothing or parts. Tags can be characterised as active, semi-passive, and passive depending on whether they have a battery or draw power from the reader. Moreover, RF-tags can either be read/write or read-only. Read/write tags are useful in some specialized applications, but since they are more expensive than the read-only chips, they are impractical for identifying low-value items.
- *RF-Tag readers,* able to scan tags when they reach their range. Readers are usually connected to a computer, which in turn communicates with a back-end information system (e.g. a warehouse management system, a management information system, and so on). The antenna on the tag enables the microchip to transmit the identification information to the reader.

The prospects of RFID have attracted the attention of large retailers and suppliers. Over the past few years, we have witnessed several initiatives in the retail sector that have tried to field-test RFID in different application areas. Metro has launched the 'store-of-the-future' in Rheinberg, Germany,

a converted traditional supermarket that uses RFID technology as a means to enhance the shoppers' experience during their visit to the retail outlet (Wolfram et al., 2004). Moreover, Metro has installed RF-Readers at their distribution centre at Essen (Wolfram et al., 2004). By attaching RF-tags in boxes and pallets, and integrating the RFID infrastructure with its existing Warehouse Management System, Metro is able to accurately and automatically monitor which products arrive and exit the distribution centre, significantly reducing labour costs and receiving additional benefits, such as automated proof-of-delivery.

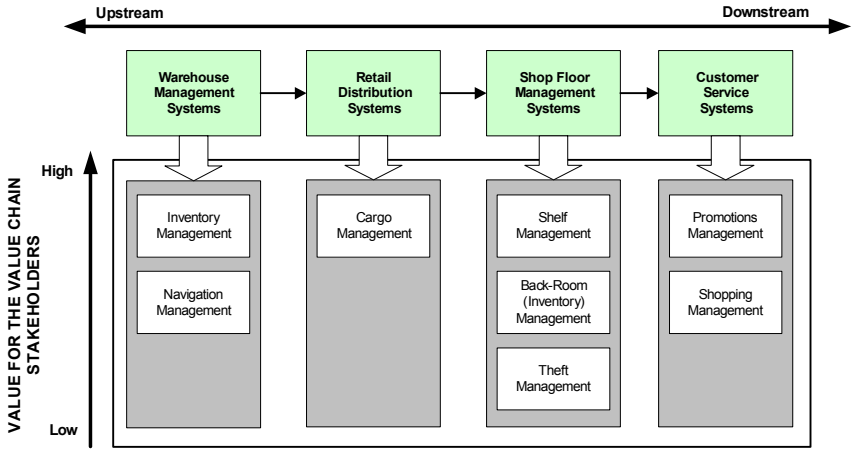

Fig. 1: A taxonomy of different classes of RFID-enhanced applications

MyGROCER, a European project in which Procter & Gamble and the Greek supermarket chain ATLANTIC participated, also investigated the potential of RFID in the downstream environment and, in particular, its effect on the traditional shopping experience (Kourouthanassis et al., 2002a). This was supported through an intelligent shopping cart equipped with a display device and an RFID sensor capable of scanning the contents of the cart. Shoppers could use their loyalty card to log in the system and receive the following facilitating services: continuous monitoring of the products that are currently in their shopping cart along with their cumulative value; a reminding list of products they wish to purchase during their shopping visit; a list of all available promotions, fully personalised based on their shopping behaviour and past consumption patterns; display of valuable information for each product (such as nutritional value, recipes, and so on), complementing or even extending the information available on the product

packaging; and advanced navigation capabilities (Kourouthanassis et al., 2002a).

Finally, Gillette investigated the potential of RFID in store management focusing on the elimination of out-of-shelf conditions (Cantwell, 2003). In particular, Gillette, in collaboration with the MIT Auto-ID Center and Metro, implemented a 'smart-shelf', where RF-Readers were able to monitor RF-tagged razor blades, and initiate replenishment and theft alerts, and proceed even to automatic re-ordering. The increased interest of the retail sector in RFID technology can also be deducedfrom Wal-Mart's decision to have its top 100 suppliers begin shipping tagged pallets and cases by January 2005 (Roberti, 2004).

RFID can thus enhance core supply and demand chain management operations, ranging from the upstream to the downstream side. Figure 1 illustrates a taxonomy of different classes of RFID-enhanced applications.

The taxonomy classifies the prospective RFID-enhanced applications across two axes: The first axis spans across the value chain, from the upstream side (referring to applications targeted to the supplier and intermediate distribution centres), down to the retail outlet, and finally, the end consumer. The second axis refers to the *perceived value* of the individual application for the interested stakeholder. This value derives from the nature of the application and its perceived benefits: high value applications introduce totally new means of operating a particular process, resulting, in most cases, in increased business effectiveness; low value applications simply automate or provide an alternative means to conduct a particular operation. The following table (Table 2) outlines the individual application types in terms of their typical operations and perceived benefits for the supply or demand chain stakeholder.

Table 2. A list of RFID-enhanced application areas

Type of Application	Typical Operations	Perceived Benefits
Warehouse Management Systems		
Inventory Management	RF-Readers (or RF-Gates) are installed at the entrance and exit of the warehouse automatically scanning cases, pallets, or individual products entering or exiting the warehouse	• Real-time information provision about current inventory levels • Reduced labour costs • Automated proof-of-delivery • Reduced order cycle times • More responsive production (for the supplier) • Eliminating stock verification • Real-time tracking of products • Better forecast accuracy • More efficient yard management

Type of Application	Typical Operations	Perceived Benefits
Navigation Management	RF-Readers are installed on forklifts communicating with the Warehouse Management System. RFID tags are attached on the floor of the warehouse at key locations.	• Instant monitoring and routing within the warehouse • Real-time tracking of product location (requires integration with a telematics application)
Retail Distribution Systems		
Cargo Management	RF-Readers are installed in the truck, enabling continuous monitoring of the products current status. The RFID infrastructure communicates wirelessly with a terminal device located near the driver.	• Real-time information provision about the products condition • Real-time asset management
Shop Floor Systems		
Shelf Management	RF-Readers are incorporated in the shelf, continuously monitoring the quantity of products on the shelf.	• Tracking and elimination of out-of-shelf conditions • Initiation of theft alerts • Real-time tracking of products and provision of the full product lifecycle • Efficient waste prevention management (tags report when products are reaching their sell-by date, so that they can be quickly sold or returned to the supplier) • Reactive Promotions Management (new promotions may be introduced for products near expiration)
Back-Room (Inventory) Management	RF-Readers (or RF-Gates) are installed at the entrance and exit of the back-room, automatically scanning cases, pallets, or individual products entering or exiting the back-room	• Real-time information provision about current inventory levels • Reduced labour costs • Automated proof-of-delivery • Reduced order cycle times • Eliminating stock verification • Better forecast accuracy for ordering • More efficient yard management
Theft Management	RF-tags have embedded a security mechanism that is de-activated when they are scanned by a Customer Service System. RF-Gates are installed at the exit points of the retail outlet monitoring for products that have not been scanned.	• Elimination of thefts

Type of Application	Typical Operations	Perceived Benefits
Customer Service Systems		
Promotions Management	Promotional rules may be embedded on the RF-tag or on dedicated servers within the retail outlet. Shoppers have access to personalised promotions based on the current contents of their shopping cart or even past consumption patterns.	• Personalised promotions management • Monitoring promotions effectiveness
Shopping Management	Shoppers use RF-enabled terminals to scan the products they purchase. An application running on the terminal offers personalised services to the shopper, such as continuous monitoring of the products that have already been scanned along with their cumulative value; display of valuable information for each product (such as nutritional value, recipes, and so on), etc. Alternatively, RF-readers may be embedded in the shopping cart.	• Fast check-out • Real-time information provision to the shopper • Higher quality of service to the shopper

Smith et al. (2003) characterise the integration of RFID technology in supply chain management operations as "an internet for physical objects", implying that the new technology will introduce significant changes in the way that companies conduct business. RFID does not simply embed new hardware and software in the retail arena. On the contrary, it is a major business undertaking focused on and driven by the retail sector. It is all about delivering innovation through enhanced business processes. Different forms of business collaborations will emerge, mainly in order to benefit from the rich information availability that will exist in the retail sector. The following section discusses an approach that tries to integrate the existing collaborative schemes that have been discussed at the beginning of this paper with the underlying RFID infrastructure.

4 Supporting RFID-Enabled Collaboration

The previous section presented a brief overview of the capabilities and potential application areas of RFID technology for the retail sector. Most of these applications refer to internal information systems, operating either in the retailer or the supplier, in order to streamline and automate internal business processes. However, RFID solutions need to be integrated with the existing back-end infrastructures of retailers and suppliers, and this re-

quires significant overhead, especially if we take into account that such infrastructures have been developed incrementally over a rather long period of time, and thus their current architectures have evolved rather than be designed. Still, this integration represents the initial phase in order for the retail sector to benefit from the rich information provided by RFID. In this phase, companies investing in RFID systems will reap the expected benefits by creating proprietary systems, owned and controlled solely by them.

Table 3. Characteristics of RFID-enabled collaboration

	RFID-enabled collaboration
Information Exchanged	• Products shelf position • Out-of-shelf indication • Accurate inventory information (including lot numbers, expiration dates, etc.) • In-store shopping route • Order and place of product selection •
Collaborative Business Processes	• Replenishment • Shelf management • Evaluation of promotion effectiveness • Promotion planning
Technology supporting information exchange	• XML/ ASCII files over Internet (expected)
Technology supporting collaboration	• Collaborative platform retail exchange (expected)

The second phase will require the creation of the necessary infrastructures that support *information sharing and collaboration* in the retail value chain. While the Internet has provided new means for retailers and suppliers to collaborate and share information using dedicated platforms, we argue that RFID will significantly enhance the *depth* and *quality* of the information exchanged over such collaborative platforms, leading to smarter forms of collaboration. Indeed, the capability to know on a real-time basis the current stock level at the warehouse or the shelf will lead to gradually eliminating out-of-stock and out-of-shelf situations. Similarly, tracking a product along the supply chain on a real-time basis, even within the retail outlet, will enable suppliers to effectively manage replenishment and product recalls, have better forecasting accuracy, and provide more tailor-made promotional plans. Table 3 gives an overview of the extended information that can be exchanged among trading partners in the RFID context, and the collaborative processes than are empowered based on this information exchange.

We expect that, in this context, information exchange and collaboration will be supported by an intermediate collaborative platform, either e-marketplace or private retail exchange, driven by the high amount of information to be exchanged, and sophistication of the collaborative processes. The new collaborative mediator will act as a hub that manages and integrates the information generated by the various sources, processes it, and uses it for offering value-added smart services to the entire business network.

The following figure (Figure 2) provides an integrated mapping of the applications mentioned in the previous section onto the revised smart business network.

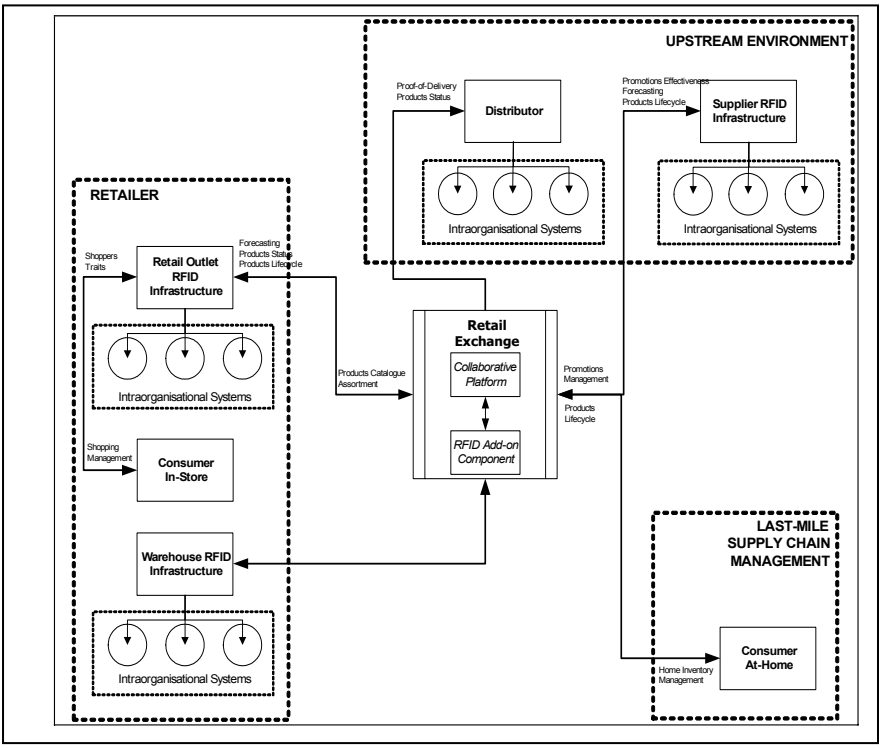

Fig. 2: RFID-enabled smart business networks

RFID technology can be ultimately embedded in our everyday lives. Fully aligned with the recent developments pertaining to 'smart information appliances' (Roussos 2003; Roussos et al. 2003b), RFID readers may be embedded in the last mile of the supply chain towards the consumer: the consumer's own household. In this scenario, the consumer can be fully

supported by a 'ubiquitous commerce' system, which is able to continuously monitor the home inventory, and generate 'out-of-stock' alerts when a product needs replenishment. Extending this scenario, the shopper can receive on his/her mobile phone (or other wireless device) the automatically generated alerts (accompanied by personalised promotion messages), and proceed, should he/she desires, to replenishment orders. Alternative scenarios pertaining to the deployment of RFID into our everyday activities have been extensively discussed in Roussos et al. (2003a). Ultimately, RFID technology can generate 'intelligent' supply and demand chains, where the product instead of the end user triggers the business process.

5 Conclusions

The previous discussion assumes that all the technical barriers regarding the application of RFID have been overcome, and that RF-tags have been introduced on all or a big proportion of consumer goods. However, this assumption is still far from reality, as technical barriers have not been totally overcome yet, especially when considering large-scale implementations, and standards are still evolving to support the wide adoption of RFID technology across the industry.

While research is progressing fast on the standards and technology front, there is an ever increasing concern about consumer privacy relating to the use of RF-tags on consumer goods, which has recently led companies like Benetton and Wal-Mart to temporarily shirk RFID-at-consumer-level pilots (McGinity, 2004). Analysts predict that while four or five years will pass before consumers are directly affected by RFID, privacy will be a major problem, if it isn't addressed up-front. These concerns, in combination with the lower costs associated with introducing RF-tags on product cases and pallets instead of consumer units, currently lead the industry to implementing warehouse applications in the first round. Eventually, privacy concerns will be overcome, as has happened during the initial introduction of barcode technology several decades ago, allowing companies to adopt advanced RFID applications and smarter collaboration practices. This perspective opens up many new directions for research and development in this area, relating both to technology and the many different business aspects associated with it. The work presented in this paper is a first attempt towards this direction.

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ECR *Hellas*

Efficient Consumer Response

The Association of Efficient Consumer Response (ECR) Hellas started its activities as a non-profit organization in October 1995 and it was the first ECR national initiative that included University Professors in its organisational structure. Today, a fifteen-member Board of Directors, comprised six Retailers (representing over 70% of the Greek retail sector), six Suppliers and three University Professors and Market Experts, runs ECR Hellas. Moreover, ECR Hellas has over 100 companies (suppliers and retailers) involved in its activities. The participating suppliers represent about the 90% of the Grocery Trade Business.

As a national initiative, ECR Hellas is an active member of ECR Europe and participates in the Executive ECR Europe Board with Mr. Nick Veropoulos and in ECR Academic Partnership with Prof. G. Doukidis.

During these years, ECR Hellas followed the two fundamental principles that guide all ECR efforts worldwide: 1) focus on shopper satisfaction and 2) setting retailers and suppliers work together in a more efficient and effective way. Along these lines, ECR Hellas focus on a) improvements related to Supply Side, and 2) efforts to address the challenges and opportunities associated with the Demand Side. As far as the Supply Side initiatives are concerned, the main projects accomplished from 1996 to 2003 are the following: Unit Load/Pallet Standardization, EDI, New Product Coding and Changes of Codes, Efficient Delivery in Central Warehousing and by Delivery Point, Transport Optimisation, Logistics Service Providers and Out Of Stock. The ongoing projects for 2004 are: Product Quality Assurance through the Supply Chain and the Key Performance Indicators in the Supply Side. On the other hand, under the umbrella of the Demand Side initiative started in early 1998, the accomplished projects until now are the following: CRP, Category Management, Light Category Management, Promotion Tactics, Collaborative Relationship Management, New Product Introduction and Shopper Research. The ongoing project for 2004 is the Coupon Management.

ECR Hellas through all these projects and activities tries to be close to the trade problems that occur in the Greek market and educate the related companies regarding the usefulness of adopting the ECR concepts. To that end, ECR Hellas regularly organizes special events and conferences.