Demand Management Opportunities in E-fulfillment: What Internet Retailers Can Learn from Revenue Management

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ERIM REPORT SERIES *RESEARCH IN MANAGEMENT*	
ERIM Report Series reference number	ERS-2008-021-LIS
Publication	April 2008
Number of pages	19
Persistent paper URL	http://hdl.handle.net/1765/12244
Email address corresponding author	mfleischmann@rsm.nl
Address	Erasmus Research Institute of Management (ERIM) RSM Erasmus University / Erasmus School of Economics Erasmus Universiteit Rotterdam P.O.Box 1738 3000 DR Rotterdam, The Netherlands Phone: + 31 10 408 1182 Fax: + 31 10 408 9640 Email: info@erim.eur.nl Internet: www.erim.eur.nl

Bibliographic data and classifications of all the ERIM reports are also available on the ERIM website: www.erim.eur.nl

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REPORT SERIES

RESEARCH IN MANAGEMENT

ABSTRACT AND KEYWORDS	
Abstract	In this paper, we explain how Internet retailers can learn from proven revenue management concepts and use them to reduce costs and enhance service. We focus on attended deliveries as these provide the greatest opportunities and challenges. The key driver is service differentiation. Revenue management has shown that companies can do much better than a one-size-fits-all first-come-first-serve strategy when selling scarce capacity to a heterogeneous market. Internet retailers have strong levers at their disposal for actively steering demand, notably the offered delivery time windows and their associated prices. Unlike traditional revenue management, these demand management decisions affect both revenues and costs. This calls for a closer coordination of marketing and operations than current common practice.
Free Keywords	E-fulfillment, demand management, revenue management, home delivery, marketing-operations interface
Availability	
Classifications	

Demand Management Opportunities in E-fulfillment

What Internet Retailers Can Learn from Revenue Management

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April 16, 2008

1. Introduction

Since the burst of the internet bubble, e-tailers have taken major strides towards improving the profitability of online distribution channels. Operations managers have increased the efficiency of fulfillment processes. Marketing managers have unveiled the purchase behavior of different customer segments. However, the coordination between operations and marketing remains weak - whereas they are closely interdependent. At the same time, information technology provides the means for an ever richer interaction with the customer. Exploiting these means to enhance the marketing-operations coordination represents a vast yet untapped potential for sustaining the profitability of online distribution. In this paper, we discuss how revenue management concepts can help achieve this goal.

Rebounding after the end of the initial hype in the late 1990s, Internet retail sales have been growing at a staggering pace over the last 5 years, and nothing indicates that this trend will change any time soon.[1] Datamonitor predicts global annual Internet retail sales will reach $1251 billion by 2011. The U.S. Census bureau estimates that e-commerce sales accounted for 2.5% of the total U.S. retail sales in 2005, and Business Monitor International estimates that online grocery retailing accounted for 1% of the 784 billion euros spent on food and drink grocery purchases in Europe in 2006. [2]

Internet retail channels have a great potential for increasing customer value by providing access 24/7 to a huge assortment right from the customer's home. However,

Internet retailing also requires a physical distribution structure, either in-house or outsourced to a third party, that fulfills these promises by promptly delivering the product to the customer. Inability to design cost-efficient fulfillment processes is widely recognized as a root cause of many of the failures of early online retail initiatives.

Cost-efficient fulfillment is particularly challenging in the case of attended home delivery, which is common for many types of products that cannot easily be delivered in the customer's mailbox, such as grocery (due to perishability), electronic equipment (value), or white goods and furniture (size).[3] In attended home delivery, the retailer and the customer agree on a delivery time window. The window choice gives rise to a cost-service trade-off. A narrow delivery window provides certainty to the customer but in general implies higher costs for the retailer by limiting the retailer's flexibility.[4] Internet retailers have learned from past failures to make this trade-off carefully. For example, most of today's Internet grocers use one to four hour delivery windows (see Table 1) rather than the aggressive 30 minute window offered by Webvan in the late nineties. At the same time, some Internet retailers will find out that their current delivery offering is too conservative. Many customers no longer accept half-day or even full-day delivery windows, for example for the delivery of home appliances.

Internet retailers have been improving their supply chain efficiency also in other ways. These include the "bricks-and-clicks" bundling of online and offline channels to leverage buying power, the incremental expansion of delivery networks instead of a rush to giant automated fulfillment centers, and the smart deployment of inventories across the delivery network to offer a large assortment while limiting the risk of overstocking.[5] However, these supply-side decisions cover only half of the supply-demand equation. Demand management has an equally strong impact on profitability, affecting both costs and revenues, and may hold a much greater potential for many of today's Internet retailers than further supply-side optimization.

Effective demand management requires a good understanding of customer preferences and the flexibility to tailor the product proposition to them. Internet retailers are in a unique position in both respects. Online transaction and click-stream data provides a wealth of information on customer behavior, and online communication allows close interaction with the customer.

Internet retailers have been very successful in using available data in their marketing activities, notably in customer relationship management (CRM), identifying and assessing a multitude of customer segments, tailoring communication to individual customers, and optimizing cross-selling.[6] However, in our discussions with managers, we found that few companies systematically link this information to their supply and fulfillment processes. Thereby they miss out on opportunities for enhancing efficiency and for deploying available delivery capacity for the most profitable customers. There is a vast potential for reducing costs and improving service in Internet retailing by establishing the missing link between marketing and operations through systematic demand management.

The prototypical example of demand management is revenue management. Revenue management originated in the airline sector but has since been adopted by many other industries, including hospitality, car rental, and advertising.[7] The goal is to maximize revenues for a given supply quantity. Pricing and inventory allocation are the main levers to achieve this goal. The core idea is to segment the market, differentiate the product offering in a flexible way, and to prioritize service to the most profitable segments.

In this paper, we explain how Internet retailers can learn from proven revenue management concepts and use them to reduce costs and enhance service. We focus on environments with attended deliveries as these provide the greatest opportunities and challenges. We proceed as follows. In Section 2, we review the e-fulfillment process of a large Internet grocer in The Netherlands. The example serves to illustrate the main supply chain processes of an online retail channel. In Section 3, we compare these processes to those in airline revenue management. We show that both settings share a number of characteristics, but argue that there are also important differences. Therefore, traditional revenue management concepts have to be adjusted to be effective in an Internet retailing context. We classify the resulting approaches based on two criteria: the demand management lever and the degree of time flexibility. In Sections 4 through 7, we discuss the four resulting solutions in detail. We highlight the specific benefits of each solution and explain how to realize them. Section 8 summarizes our findings and discusses implications for industries beyond internet retailing.

2. Illustrative Case: Demand Management at Albert.nl

To help make things concrete, we briefly sketch the home-delivery process of a specific Internet retailer, namely Holland-based e-grocer Albert.nl. The grocery sector is commonly recognized as one of the most challenging environments for successful e-fulfillment due to fierce competition, low profit margins, and logistically demanding products, such as fresh food. Not surprisingly, the sector has seen some of the most spectacular e-business failures. On the other hand, practices that work in e-grocery have a high chance of success with other Internet retailers.

Albert.nl is the Internet channel of Albert Heijn, the Netherlands' largest supermarket chain and a subsidiary of Royal Ahold, the retail multinational who also owns Peapod, one of the major U.S. e-grocers. Albert.nl offers about 10,000 SKUs, including fresh groceries such as meat, milk, and fruit, thereby corresponding with a mid-sized Dutch supermarket. The product prices are identical to those in the conventional Albert Heijn stores, plus a time-dependent delivery fee. Albert.nl has organized its warehouse and delivery operations in two shifts per day. It currently operates in all major urban areas in the Netherlands.

Upon login, the customer reserves a two-hour delivery window. The cut-off point for order placement is about 16 hours before the actual delivery. After that cut-off point, when all the orders for the given shift are known, the company plans the corresponding delivery routes. Subsequently, the orders are picked in the warehouse and grouped by vehicle before actually being delivered. A typical delivery route visits between 10 and 20 customers.

Zooming in on demand management reveals two main levers which the e-tailer uses to steer demand, namely the set of delivery windows offered to the customer and the corresponding delivery fees. To improve the capacity utilization of the delivery service, the company uses a differentiated delivery fee to balance the demand over the week as well as over the day. The delivery fee ranges from €4.95 to €8.95, based on the popularity of the time slot. As expected, this price differentiation smoothes the demand, reducing the ratio between the busiest to the least busy window in terms of number of customers visited from 3:1 to 1.5:1. The second demand management lever concerns the offered delivery windows. Albert.nl offers different sets of windows, dependent on the zip-code of the delivery location. This lever mainly serves to balance regional differences in demand volumes. Low demand areas receive fewer windows than areas with more customers in order to concentrate deliveries and achieve economies of scale. Moreover, Albert.nl takes into account the

proximity of different zip-codes in choosing the delivery windows in order to support efficient delivery routes without harming customer service.

Some of the above details are, of course, specific to Albert.nl. For example, Tesco.com, the world's largest e-grocer, uses store-based rather than warehouse-based order-picking. Others, like UK-based retailer John Lewis, outsource their entire fulfillment operation. However, the main steps of the fulfillment process - order in-take, routing, picking, execution – and the corresponding planning tasks are generic and apply to many other Internet retailers with attended home delivery and even to other delivery services. This includes parcel carriers such as FedEx and Velocity Express who are targeting the B2C delivery market with evening deliveries and more narrow time windows than in the traditional B2B market. [8]

The role of pricing and delivery windows as the main demand management levers is generic, as is their impact on both customer service and operational efficiency. In this paper, we will explain how to exploit these levers in a systematic way.

3. Learning from Revenue Management

Inspiration for effective demand management for e-fulfillment comes from the example of revenue management. In fact, revenue management *is* demand management. In order to maximize the revenues generated with a given amount of capacity, revenue management aims to exploit market heterogeneities. Therefore, the market is partitioned into different market segments with different price sensitivities and different preferences. In the airline case, the prototypical application of revenue management, the classical market segmentation is between business and leisure travelers. Business travelers tend to have a higher willingness-to-pay and value flexibility regarding late booking and cancellations. Leisure travelers have a lower willingness-to-pay but are more flexible in general. Each group also prefers different travel times, such as weekday versus weekend stays. The key insight is that capitalizing upon these heterogeneities allows companies to do better than simply selling the capacity first-come-first-served at a constant price. Segmentation as such is a classical marketing instrument. What is new about revenue management is the increased flexibility, which allows companies to adjust prices and volumes offered to different segments in real-time.

In Table 2, we compare airline revenue management with Internet retailing. For the sake of simplicity, we restrict ourselves to the case of a single-leg passenger flight, recognizing that today's airline revenue management systems address many additional complexities, notably the optimization of flight networks rather than single flights.[9] The table highlights key ingredients of revenue management structured around supply-side and demand-side elements.

In the table, we can see that the main conditions for revenue management also apply to Internet retailing. The Internet retailer serves a heterogeneous market with a delivery capacity that is relatively inflexible in the short run, and he can change prices and customer access relatively easily. This implies that also Internet retailers can do significantly better than offering delivery on a first-come-first-served basis for a constant price.

However, we also see significant differences between Internet retailing and traditional revenue management environments. First, Internet retailing concerns the combination of physical products plus a delivery service. Effective demand management needs to take the product dimension into account, notably through its effects on revenues and capacity. Second, demand management has a significant cost impact in Internet retailing, as the location of the customers impacts the costs of delivery, unlike an airline setting which fixes operations prior to order in-take. Consequently, demand management in Internet retailing translates to *profit management* rather than revenue management (Figure 1).

Next we examine how to transfer revenue management concepts to Internet retailing while taking these distinctions into account. Akin to traditional revenue management, we will distinguish between quantity-based and price-based solutions. The first concerns decisions on which delivery options, namely which time slots, to make available to which customers. The second focuses on the delivery fee as the main lever to manage customer demand. A retailer can apply both of these options, slotting and pricing, at different moments in the sales process, either off-line prior to the actual order in-take or real-time as demand unfolds. These distinctions leave us with four different types of demand management in e-fulfillment, as summarized in our framework in Table 3. We next address each of these options and explain its potential and its requirements.

4. Differentiated slotting

The first lever for managing demand concerns the delivery time slots offered to the customers. Many retailers express these in terms of a weekly schedule. The time slot offering

sets the conditions before the actual order in-take. As such, the collection of time slots forms the base of the demand management system in Internet retailing.

Obviously, the number, length, and selection of delivery slots impacts customer service. Preferences can vary for different customers and in different situations. The more choices, the more attractive the service offering is for the customer, which translates into higher expected sales. At the same time, however, the offered delivery slots directly affect the efficiency of the delivery operations through transportation costs. Limiting the number of delivery options in a given geographical area helps concentrate customer orders, thereby reducing the distance traveled per order. Furthermore, the timing of the offered slots to nearby customer areas (see Figure 2) impacts the routing efficiency. For example, increasing the number of orders delivered per visit in a relatively isolated customer area from one to two essentially reduces the distance driven for these orders by 50%. If these types of orders account for 10%, say, of the total transportation costs this means overall savings of about 5%.

An effective time-slot offering has to balance these effects. To this end, customers should first be grouped geographically (for example by zip-code). Secondly, the number of visits per week to each group needs to be determined. This involves gauging the sensitivity of demand to the number of delivery opportunities offered as well as assessing delivery costs as a function of the number of deliveries made per visit. Thirdly, the slots have to be allocated over the week. The allocation should reflect the different preferences of the different customer groups, such as assuring availability of evening slots in areas with many busy professionals. Given these constraints, the windows have then to be coordinated across customer areas so as to facilitate efficient delivery routes. Note that not all windows necessarily have to have the same length. Offering longer windows, e.g. in a rural area, increases the routing flexibility. Windows of different lengths associated with different prices also provide a means for segmentation (see Section 5).

In computer simulations, we found that optimizing the number of time slots offered per week per zip-code reduced delivery costs by about 10% compared to unrestricted delivery slot availability.[10] In the case of thin margins, as for example in e-groceries, these savings can have a huge impact on profitability. The specific savings potential depends on the customer density. Past Internet failures often made the costly mistake of over-servicing low volume areas. Thus, we recommend critically assessing the minimum demand required to justify the visit to an area, considering both the average margin per order and the future growth potential. While certainly not negligible, the exact allocation of the windows has a smaller

cost impact than the number of windows. The savings potential of a smart allocation depends on the nature of the delivery trips. The more customer areas visited per route, the more important the coordination of the delivery windows across these areas.

Standard routing software typically does not support the above slotting decisions explicitly. Therefore, companies are as of yet dependent on custom-made solutions. However, our research indicates that rough approximations already result in substantial savings. Even simple spreadsheet tools can be of significant value.

5. Differentiated pricing

Pricing is probably the most obvious demand management lever. In our context, this concerns the delivery fee charged for an order. As for any business, the appropriate pricing level has to strike a balance between increasing demand volume and decreasing revenue per order. However, pricing also provides means for differentiating between different delivery options offered to the customer. In that sense, pricing and slotting are complementary tools. Specifically, pricing can provide incentives for attracting customers to a particular slot.

Since attended delivery requires the customer to be present, some delivery times, for example in the evening or in the weekend, are more popular than others. From a marketing view, this alone suggests charging different prices for different delivery times. There is also an operations argument for this conclusion. Uniform pricing typically results in imbalanced demand. Given a relatively inflexible delivery capacity, this means either costly over-capacity or losing peak-load demand. Differentiated pricing, such as peak-load premiums and off-peak discounts, help counter the above effects by smoothing demand (see Figure 3). For example, assume that a discount of $1 on an off-peak day shifts 50 orders away from a peak day, thereby increasing off-peak demand from 200 to 250 orders. This shift is financially attractive if the unit value of the freed peak capacity exceeds $1 × (50 + 200) / 50 = $ 5.

Differentiated pricing is fairly intuitive and is commonly practiced by many businesses including hotels (weekends vs. weekdays) and package delivery services (Monday-Friday vs. Saturday delivery). The pricing schemes for several e-grocers are found in Table 1. The difficulty with differentiated pricing lies in determining the appropriate magnitude of discounts and premiums. Excessive discounts not only give away margins but also spoil the market's reference price. Systematic market research and small incremental price changes help avoid these dangers.

Furthermore, delivery prices may also impact the basket composition and corresponding revenues of Internet retailing. In order to stimulate sales, several retailers offer delivery fee discounts for large orders. Other effects may be less obvious. Albert.nl, for example, experienced that a lower delivery fee at off-peak moments attracted customers with a smaller basket size.

Pricing allows a differentiation not only between different delivery times but also between different lengths of the delivery windows. Peapod for example, offers the customer a $1 discount for choosing a delivery window of 3.5 hours instead of 2 hours. In this way, the Internet retailer can exploit differences in the customers' flexibility by offering windows of different lengths simultaneously, granting a discount for wider windows. In this case, the discount should not only reflect the willingness-to-pay of the different customer segments but also the e-tailer's efficiency gain due to greater planning flexibility.

6. Dynamic slotting

The previously discussed demand management approaches are purely forecast-based in the sense that they set conditions prior to receiving the actual orders. However, even richer opportunities arise for Internet retailers through their interaction with the customers during the actual sales process. Slotting and pricing decisions then provide a means for managing demand dynamically and in real time.

The most basic example of a dynamic slotting decision regards closing a time slot once the corresponding capacity is depleted. While some kind of capacity check is in fact a necessity for any Internet retailer, an accurate assessment of remaining available capacity is less obvious than it may look at first sight. Effective capacity involves the picking capacity in the warehouse, physical fleet size, and available driving time.[11] The latter depends on the clustering of orders into routes and thereby directly links slotting to transportation planning. Systematically assessing this interaction helps Internet retailers increase their capacity utilization.

The potential of dynamic slotting goes much further. The fundamental lesson from revenue management is that there is a smarter way than selling the capacity first-come-first-serve until its depletion. Heterogeneous markets call for more differentiation between orders. In the prototypical airline case, this leads to a trade-off is between selling a seat at a discount fare now versus reserving it for a potential full-fare customer later. Thus, in e-fulfillment it may be beneficial to reserve scarce capacity, i.e. busy time slots, for the most profitable

customers. Transportation costs add another dimension to the trade-off, namely whether to serve a customer in the given time slot or whether to try and convert him to another slot that allows for a more efficient delivery. In essence, revenue management shifts the focus from capability (*Can* we deliver this order at that moment?) to profitability (Is it *profitable* to deliver this order at that moment?).

Customers can be segmented in multiple ways. First, one may segment by order size, or more generally by customer value. Losing a large order from a regular customer is worse than losing a small order from an incidental customer. Second, the degree of customer flexibility is of importance. A busy slot is best used for the customer that is least willing to accept an alternative slot. The third segmentation is by delivery location. There are two potential reasons for wanting to keep a certain order away from a given slot. Either that order may be cheaper to deliver in another slot, or the capacity in that slot may be more valuable for another order (Figure 4).

We illustrate this last point in an example. Assume that more efficient routing increases the margin of order A from \$12 to \$15 if this order is delivered in slot Y as opposed to slot X. Also assume that there is a 50% chance of receiving a future order B whose margin decreases by \$3 if it is *not* delivered in slot X. Then withholding slot X from order A yields a financial benefit of $\$15\times(1-p_A) - \$12 + 50\% \times \$3$, where p_A is the risk of losing the order. This benefit is positive as long as p_A is below 30%.

There are many potential benefits of tailoring the delivery service to individual customers dynamically, rather than fixing everything up front. Our simulation studies indicate potential unit transportation cost savings of up to 20%.[11] In addition, dynamic slotting enables Internet retailers to offer shorter time windows without hurting their delivery efficiency. This not only improves customer service but also reduces the risk of failed deliveries, which are a significant challenge in Internet retailing. The specific improvement potential of dynamic slotting increases with the degree of customer flexibility, heterogeneity between customers, the variability of demand, and the tightness of capacity. Many Internet retailers face a significant market growth. Dynamic slotting enables them to increase the return on their current capacity, thereby postponing expensive capacity expansions.

In order to reap these benefits, companies need good visibility of customer behavior and delivery cost dependencies. Detailed transaction data provides a rich source for analyzing customer response to different delivery options. We see room for further improvement

through a better understanding of the customer choice models in the marketing literature.[12] On the cost side, the analysis of dynamic slotting is closely related with the planning of delivery routes. The difficulty lies in the fact that the cost impact of an individual request needs to be estimated before all orders are known. In addition, all real-time computations have to be very fast in order not to derail the customer's ordering process. Several vendors of commercial vehicle routing packages have started extending their software to support real-time scheduling (e.g. Paragon, Descartes, Sidewinder, ORTEC). For example, the Sidewinder real-time scheduling tool enabled Sainsbury's to reduce the number of failed deliveries and at the same time offer shorter time windows to the customer (www.sainsburys.com). As an easier yet beneficial starting point, we advise extending a well-designed static slotting schedule with a few simple dynamic rules, e.g. withholding a slot from an order that lies further apart than a certain threshold from all other (accepted or expected) orders in that same slot. The threshold is dependent on the margin of the order and on the risk of losing it.

7. Dynamic pricing

Dynamic pricing provides an even richer tool for real-time demand management. Pricing allows a much finer gradation of incentives than the yes-no type of decisions in slotting. In addition, pricing can provide incentives for pulling customers to a particular delivery option whereas dynamic slotting pushes them away from certain options.

Delivery-related price incentives can aim at many different goals. Traditional airline revenue management uses dynamic pricing as a means for segmenting based on customers' willingness to book in advance. Typically, prices increase as the departure draws nearer. In similar vein, delivery services often segment their customers based on their lead-time preferences, e.g. standard (5-7), two-day or next-day. As in the airline case, customers with different lead-time preferences and different willingness-to-pay then compete for the same delivery slots.

Another option is to use price incentives, namely discounts, to steer an order to a time when it can be delivered efficiently. The underlying economics are similar to those of dynamic slotting, involving the same trade-offs of delivery efficiency and customer flexibility. For example, discounts can be used for matching a delivery with a visit to a nearby customer, and for moving demand to temporarily underutilized delivery periods, thereby enhancing capacity utilization. The experience of Peapod indicates that even a small discount (e.g. $1) can change the customer's slot selection.[13]

One of the particular challenges of dynamic pricing is its appropriate communication to the customer. More than in the case of dynamic slotting, customers may perceive unexpected price changes as unfair.[14] The fierce criticism of Amazon's differentiated pricing experiments starkly illustrates these challenges.[15] However, the fact that it seems normal that our seat neighbors on a flight pay a different ticket price than ourselves illustrates that acceptance of dynamic pricing may be a matter of habituation. In order not to overstrain the customer, we see limited, well-targeted price discounts as more appropriate in Internet retailing to date than full dynamic pricing. To assure visibility of temporary price discounts, Internet retailers may approach target customers proactively, e.g. by means of SMS or e-mail notifications. Another challenge concerns opportunistic customer behavior. If discounts follow a regular pattern customers will learn to anticipate them and thereby limit the directive effect of the pricing tool.[9] This is another argument for a careful use of dynamic price incentives.

As with any price discounts, dynamic pricing in Internet retailing involves the danger of conceding margins without achieving measurable benefits. In principle, the right amount of discount is the minimum price reduction that achieves the intended customer reaction, as long as this amount is smaller than the resulting efficiency gain. Affecting customer behavior alone does not make a price incentive successful. The key question is whether the incentive is profitable. Therefore we advise to start by clearly identifying the exact objective of any discount and by carefully quantifying the achievable delivery cost savings. This assessment is closely interrelated with the planning of the delivery routes. While standard vehicle routing software is not currently supporting this analysis, an assessment of the cost of the detour associated with the delivery of the considered order can serve as an indication.[16] The second step then is to assess the customers' price sensitivity. We advise experimenting with small discounts first; if necessary these can easily be increased, whereas moving the opposite way is much harder if not impossible. The example of Ocado illustrates that even non-monetary incentives may suffice to influence the customer's delivery choice (www.ocado.com). The company is appealing to the customers' environmental concerns by indicating which delivery window would minimize the fuel consumption for their order.

8. Conclusions

To summarize, we have explained how active demand management can benefit the profitability of e-fulfillment services. The key driver is differentiation. Revenue management has shown that companies can do much better than a one-size-fits-all first-come-first-serve strategy when selling scarce capacity to a heterogeneous market. The same argument applies to e-fulfillment. Customers differ in their willingness to pay, their time preferences, and their flexibility. A smart strategy should recognize these differences through a differentiated service offering.

In contrast with classical revenue management, the cost side plays an important role in e-fulfillment. Delivery costs differ between customers and, for the same customer, between different delivery windows. These cost effects add a second dimension to demand management in e-fulfillment.

Internet retailers have strong levers at their disposal for actively steering demand. From a fulfillment perspective, the offered delivery time windows and their associated prices are of particular relevance. Internet retailers can use both of these levers off-line to manage systematic demand patterns, such as weekly demand peaks and regional demand clustering. Even more importantly however, they can adjust time slot offering and delivery fees real-time, based on actual orders, thereby tailoring their service proposition to individual customers. The future will allow even richer interactions, such as negotiations through software agents.

Close cooperation between marketing and operations is a prime prerequisite for successfully exploiting the great potential of demand management in e-fulfillment. While the importance of the marketing-operations interface is growing in many industries[17], its role in Internet retailing is pivotal since demand management decisions have an immediate and fundamental impact on delivery costs. Software developments that support an integrated demand management are encouraging. Several vendors of routing software have taken first steps towards extending their applications with demand management capabilities, notably regarding time slot management. Standard solutions, including dynamic pricing support, are yet to come.

The potential of demand management extends well beyond Internet retailing. In principle, the above arguments apply to any business that involves appointments with the customer. This includes, for example, delivery of furniture or kitchen appliances from a store

or visits by a repairman or a service engineer. The main differences with Internet retailing concern the pricing lever. Typically, customers do not pay separately for the delivery component in these cases. However, the time slot offering remains a powerful steering instrument. In particular, dynamic slotting provides a means for differentiation, thereby increasing service without compromising efficiency. The key revenue management lesson is to prioritize service to the most profitable customers. There is still a lot to be learned from this lesson in the context of delivery services.

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Tables

Table 1: Delivery Policies of E-Grocers in Europe and US

	Delivery Area	*Delivery Time Slot Length*	*Timing*	*Delivery Fee**	*Dynamic Incentives*
Albert.nl	~65% of Dutch households	2-hour	8am-2pm/ 4pm-9pm	€4.95-€8.95 (t)	
Sainsburys.co.uk	83% of UK postcodes	1-hour	10am-10pm	£5	
Ocado.com	~80 % of UK households	1-hour	6am-11pm	£3-£6 (t,s)	✓
Tesco.com	96% of UK households	2-hour	9am-11pm	£3.99-£5.99 (t)	
Peapod.com	Chicago, Washington D.C., Boston, Baltimore, e.a.	2 hour/ 3.5 hour	6am-1pm/ 4pm-9.30pm	$6.95-$9.95 (t,s)	✓
Albertsons.com	Seattle, Portland, San Fransisco, Los Angeles, San Diego, Las Vegas, e.a.	1.5 hour	10am-2.30pm/ 3.30pm-9.30pm	$9.95	
Safeway.com	Seattle, Portland, San Fransisco, Los Angeles, San Diego, e.a.	2 hour/ 4 hour	10am-3pm/4pm-9pm	$9.95 (s)	

* t = time-dependent / s = size-dependent

Table 2: Key Characteristics of Airline and E-Fulfillment

	Airline	**E-Fulfillment**
Supply		
Product	Travel service	Physical product + delivery service
Capacity	Number of seats: Fixed, perishable	Product inventory: Flexible Picking + delivery capacity: Inflexible, perishable
Costs	Sunk at order in-take	Variable, interdependent transportation costs
Booking	Up to months in advance, specific departure time	Days in advance, delivery time window
Demand		
Revenues	Fare	Product margin + delivery fee
Transaction size	Single seat	Varying order size + driving time
Customer heterogeneity	Willingness to pay, flexibility, travel time	Willingness to pay, flexibility, delivery time, order size, delivery location
Response to stockout	Lost, up-sell/down-sell, alternative flight	Lost, alternative delivery time, off-line store

Table 3: Classification of Demand Management

	Capacity allocation	Pricing
Static	***Differentiated slotting***	***Differentiated pricing***
Off-line,	Regional demand clustering	Demand smoothing
Forecast-based	Balance service offering	Increase capacity utilization
	and delivery efficiency	
Dynamic	***Dynamic slotting***	***Dynamic pricing***
Real-time,	Differentiate service	Counterbalance underutilized capacity
Order-based	Maximize contribution of congested capacity	Stimulate efficient routes
	Avoid inefficient routes	Segment on customer flexibility

Figures

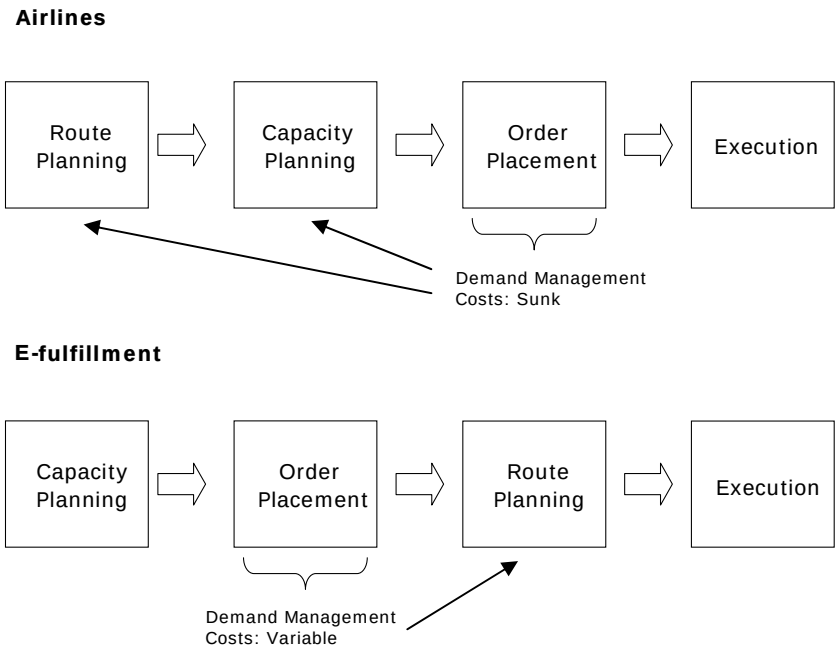

Figure 1: Planning Processes – Airlines and E-Fulfillment

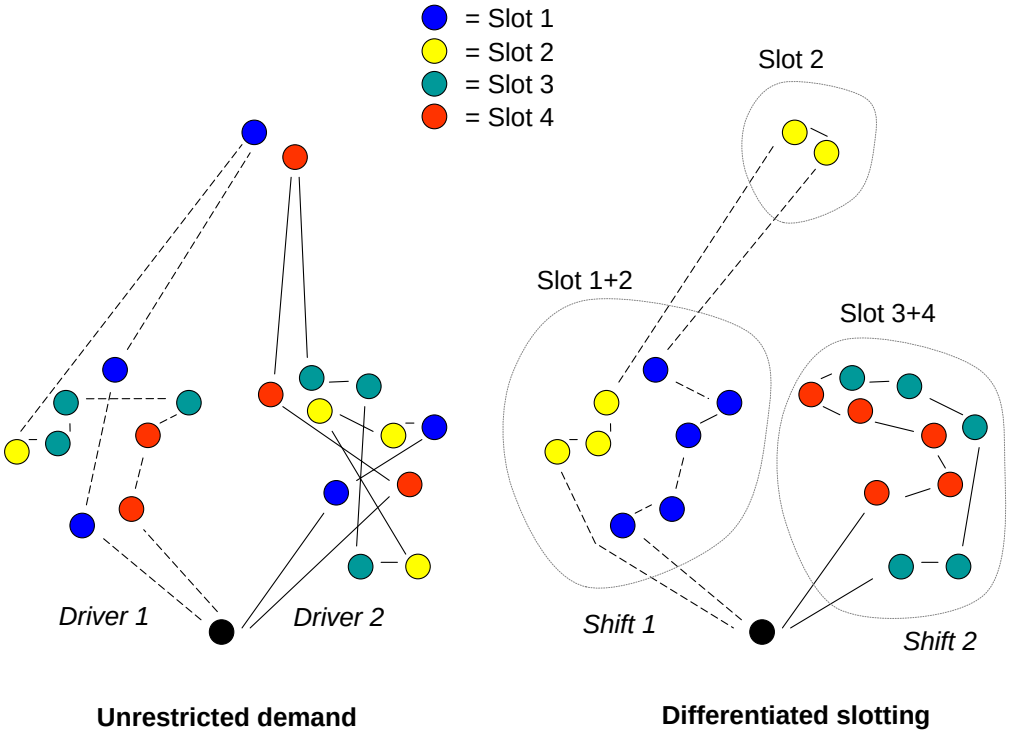

Figure 2: Differentiated Slotting

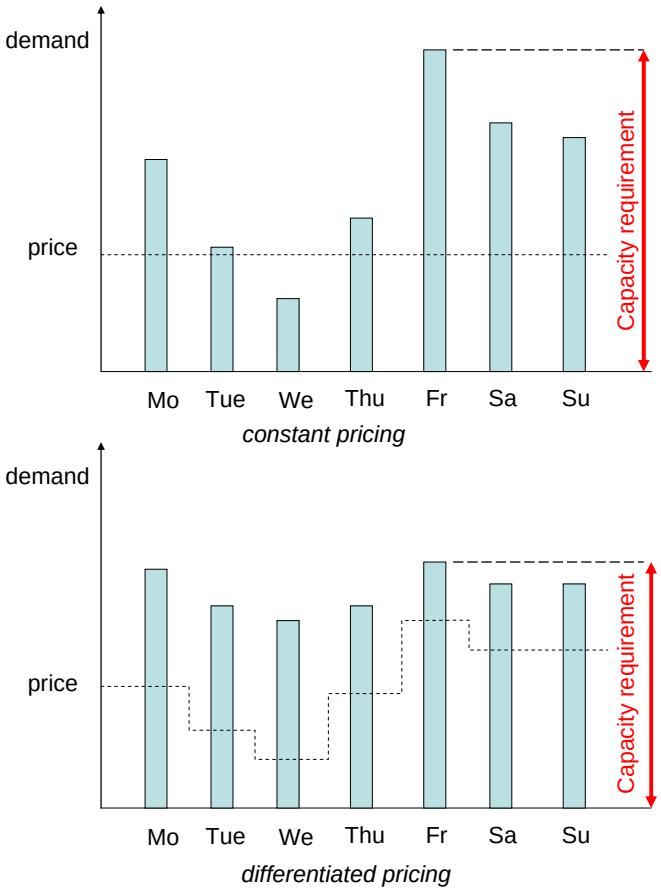

Figure 3: Differentiated Pricing

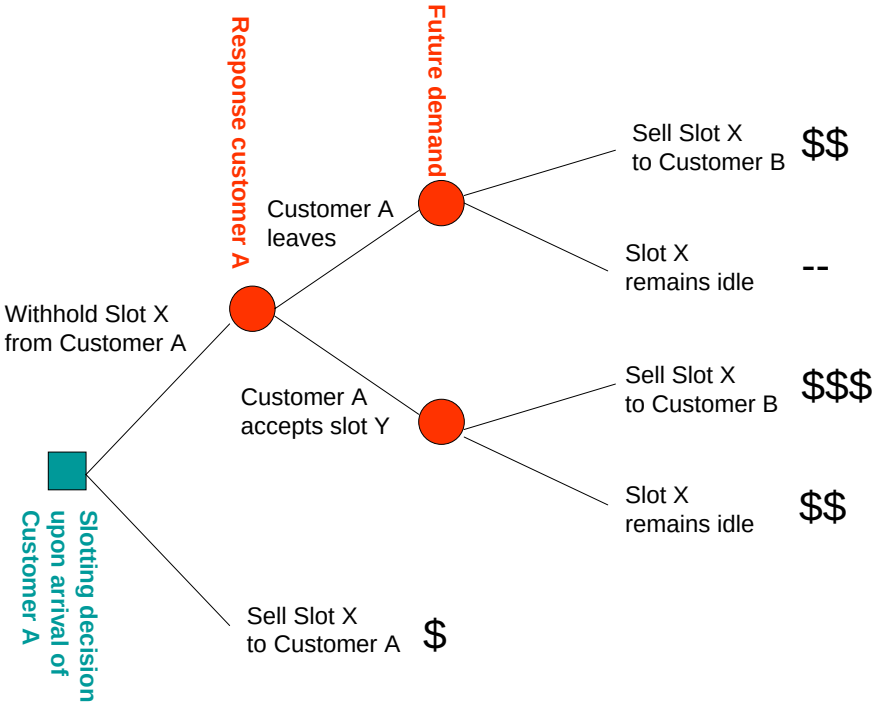

Figure 4: Dynamic Slotting

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