



A Comprehensive Guide
**To Retail
Out-of-Stock
Reduction**

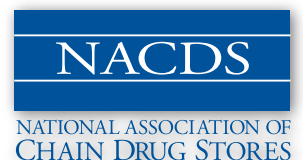
In the Fast-Moving
Consumer Goods Industry

P&G

A research study conducted by:

Thomas W. Gruen, Ph.D., University of Colorado at Colorado Springs, USA

And Dr. Daniel Corsten, IE Business School Madrid

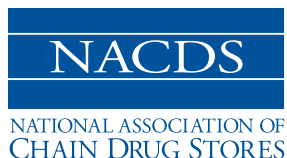


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Contact for permissions: tgruen@uccs.edu; dcorsten@london.edu

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A Comprehensive Guide To Retail Out-of-Stock Reduction In the Fast-Moving Consumer Good Industry

Executive Summary

OVERVIEW

This research report provides a comprehensive examination of the foundational knowledge, measurement approaches, and strategies used to reduce retail out-of-stocks (OOS) in the fast-moving consumer goods (FMCG) industry. Its objective is to provide a guide to FMCG retailers that seek to reduce their costs associated with OOS items, while simultaneously enhancing shopper satisfaction with sustained lower levels of OOS. As outlined in Exhibit A, this research report:

1. defines retail OOS metrics to resolve the confusion surrounding previously reported “OOS rates” and shows the total costs of OOS, beyond lost sales (Chapter 1);
2. compares the three basic approaches to the measurement of OOS, illustrates how OOS measurement can be directly linked to root causes, and shows where most OOS sales losses occur (Chapter 2);
3. systematically examines seven causes of OOS, from forecasting to merchandising, showing the impact on overall OOS levels of addressing each (Chapter 3); and
4. provides a flexible approach to reduce OOS that retailers can easily adopt, can be effective even with low initial level of resource commitment and can scale with increased resource commitment (Chapter 4).

Our extensive research shows that retailers can sustain OOS reductions below the industry average of 8.3 percent. The core requirement is the development of an effective measurement system – one that is accessible, timely, inexpensive, reproducible, and generally undistorted. Without this core ability, it is impossible to determine progress, assign responsibility for tasks, and maintain accountability for results. When the measurement stops, people go back to their old way of operating, and the OOS return to their previous levels.

Out of Stock Definition is Clarified

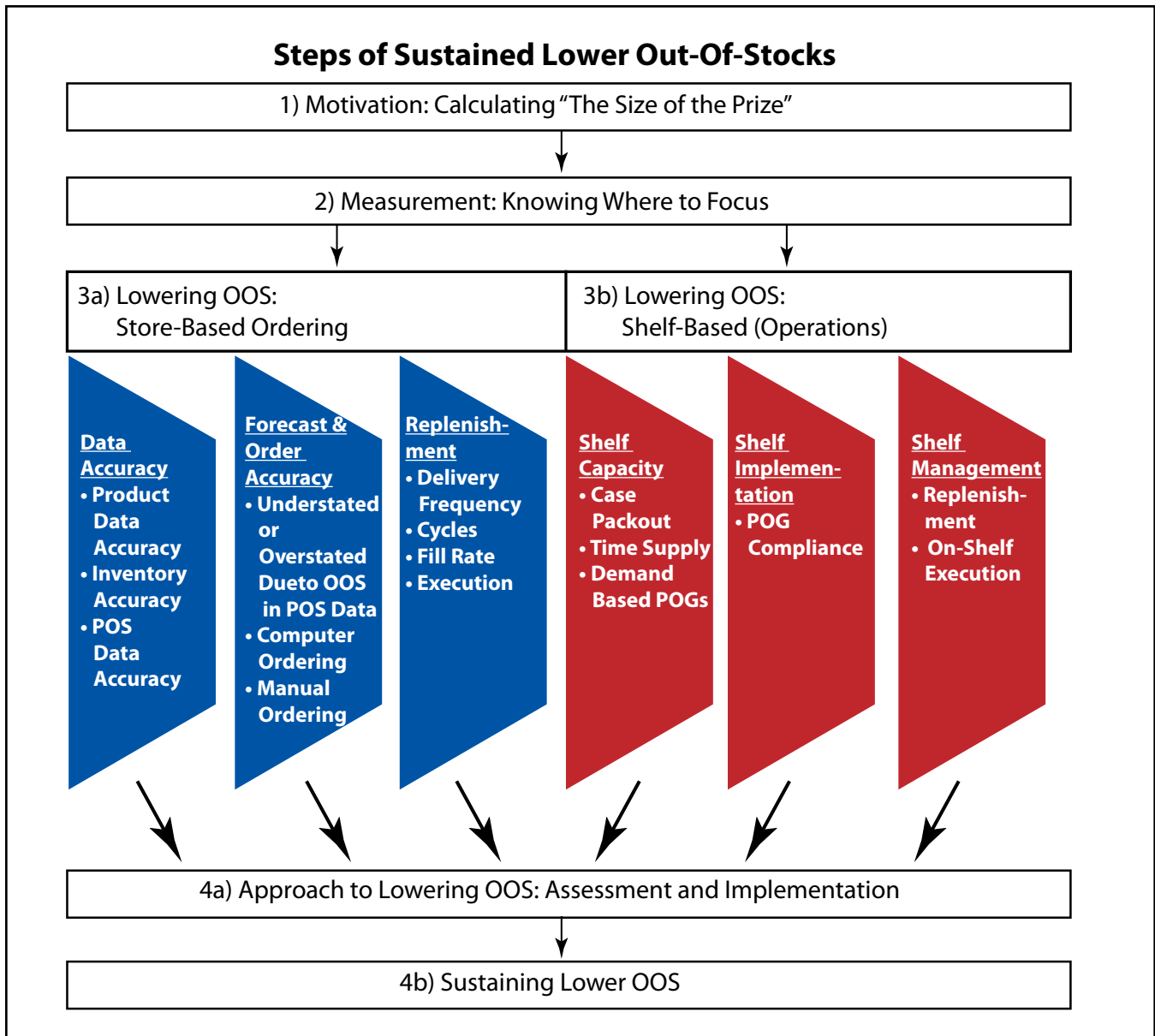
This report catalogs the meaning of various “out of stock rates” that have been reported in previous studies. We hope to avoid further confusion caused by vague reporting of the data collection and calculation methodology used to establish the rate. The three common types of measurement— (1) audit of physical inventory, (2) analysis of point of sale data (POS), and (3) use of perpetual inventory data (PI)—each measure different aspects of OOS, and thus report different OOS rates. Further ambiguity arises from differences in what is counted – (a) instances, (b) units sales losses, or (c) monetary sales losses. Generally, audits count *instances* observed at a point in time (when the audit took place). PI data is typically used to count *instances* over some time interval (perhaps a week). POS data analysis can yield a broader set of measurements including each of (a), (b), and (c) above.

We make a clear delineation between an OOS event (an instance of an item being unavailable for sale as intended), and the attributes of the OOS event, and statistical descriptions of collections of OOS events (expressed as an OOS rate). These attributes include: 1) number of occurrences over time, 2) number of simultaneous occurrences, 3) duration, 4) shelf availability, 5) lost unit sales, 6) lost monetary sales, and 7) number of customers impacted.

Store vs. Shelf OOS Perspective is Established

One of the keys to efficiently reducing OOS is a clear delineation between types and their distinct underlying causes. From the retailer perspective, the three main OOS types are the distribution center OOS, store OOS, and shelf OOS. While much of the industry is focused on distribution OOS, this report focuses on store and shelf OOS types.

Exhibit A: Overview of the Report



A store OOS occurs when the store is completely out of inventory. Excessive store OOS arise from mistakes in ordering, demand forecasting, or supply chain. Shelf OOS occur when there is inventory in the store, but the item is not on the shelf. The root causes of excessive shelf OOS are usually store processes, especially shelf space allocation, restock frequency, and ongoing monitoring of shelf stock for promoted items. Thus store and shelf OOS each have a different set of associated solutions. Understanding the difference and specifically addressing the root causes of each type will yield major reductions in overall OOS rates because most OOS events are at the retail shelf or the store. In other words, the distribution center could have supplied, or did supply the item – but there was a problem in retail store processes or execution.

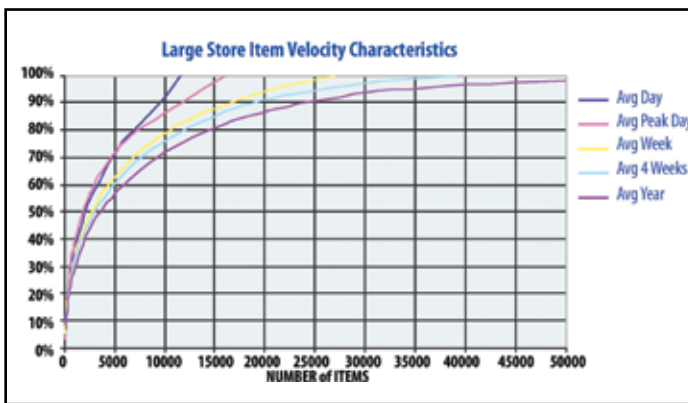
The Total Costs of Out-of-Stocks are Examined

The impact of OOS extends well beyond the lost sales of the OOS item alone. A variety of strategic and operational costs apply to both retailers and suppliers including decreases in store and brand equity and attenuated impact of promotions and trade promotion funds. OOS creates a ripple effect by distorting demand and leading to inaccurate forecasts. Retailer costs also include the time employees spend trying to satisfy shoppers who ask about a specific OOS item. For a typical U.S. grocery store, the cost amounts to \$800 per week. The corollary for shoppers is the amount of time spent waiting for resolution that could be spent more productively for the retailer in shopping—an estimated 20 percent of the average time for a shopping trip.

The Relationship of Volume on Out of Stock Rates

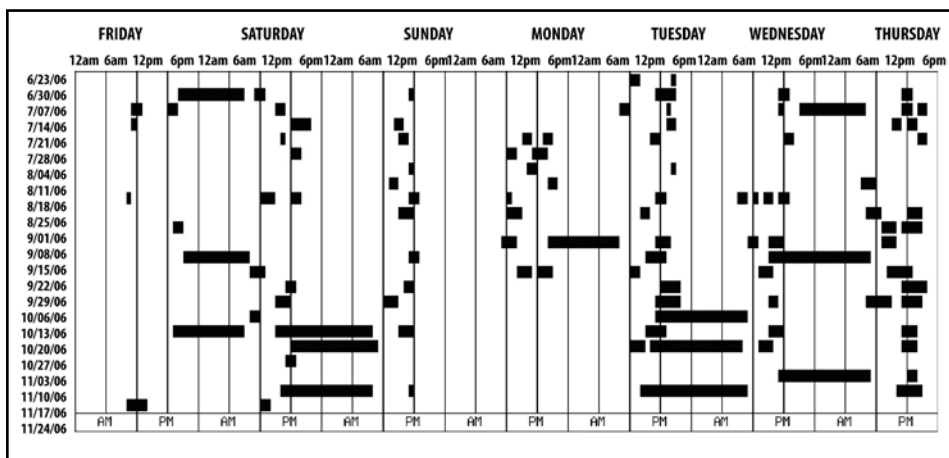
In this study we examine the relationship between sales velocity and OOS sales losses. Not surprisingly, fast moving items incur proportionally greater OOS sales losses, but the degree and concordant lost sales were surprising. As shown in Exhibit B, the classic 80/20 rule applies for item sales (20 percent of items comprise 80 percent of the total store sales in an average week). On the busiest day, 65 percent or more of the items did not sell at all, and on an average day, 75 percent or more of the items do not sell at all. Regarding

Exhibit B: Daily, Weekly, and Annual Item Unit Sales



Credit: Standard Analytics, 2006

Exhibit C: OOS Patterns Indicating Inadequate Replenishment Schedule



Credit: Standard Analytics

the relationship of the sales volume to out of stocks, the high demand items had almost six times the levels of lost sales from the out of stocks they encountered than did low demand items. These findings provide clear evidence that focusing on a relatively small number of SKUs can be an effective strategy to lower OOS sales losses.

Measurement Must Point to the Root Cause

Regardless of the measurement system used to track OOS— manual audit, POS data estimation, or perpetual inventory—it must be sustained, and it must point towards root causes. Due to their high expense and difficulty to scale, manual audits are usually not sustainable, and they do not provide a measure of sales loss. However, they can be effective when targeted at the most crucial products (either high velocity items or strategically important items such as “never outs” or preferred private brands), and when a second level of analysis is incorporated that links each OOS event to its likely root cause. A systematic means of assigning each identified OOS event to a set of pre-determined root causes can be implemented at a relatively low initial cost. However, it is costly to scale to a large number of items.

The use of point of sale (POS) data is a viable measurement method for many store formats. There are a number of companies that have developed algorithms to estimate OOS from POS data, and some retailers have developed their own in-house systems. POS measurement systems can be sustained, scaled and are able to deliver sales loss and duration measures. The accuracy of estimating OOS using POS data is 85 percent or greater, which is equivalent or greater to the accuracy of manual audits (where human error is present). One recent development of using POS

data calculation is the ability to discern visible patterns in out of stocks and thereby point directly at possible root causes and potential solutions—all done electronically. Exhibit C shows one of several patterns that have been identified as typical out of stock patterns. The pattern here shows that the OOS period occurs nearly the same week after week. Most likely, there are two deliveries a week, but four deliveries are needed. Alternative, the store could increase the safety-stock of this item. This approach shows enormous promise in reducing OOS due to its intuitive nature.

A third approach to measurement, perpetual inventory (PI) measurement systems can also be sustained, scaled and deliver sales loss and duration measures. However, PI systems suffer from the lack of on-hand accuracy necessary to make them consistently good measures. Algorithmic approaches to estimating and improving on hand inaccuracy

are being developed and implemented, and a best practice approach of manual techniques for improving PI accuracy is provided in this report.

Root Causes and Solutions

Moving from left to right across the trapezoids shown in Exhibit A, we researched seven key, different root causes and solution areas.

1. **Product Item Data Accuracy.** Product data inaccuracy creates an unstable foundation for ordering and forecasting. Commonly referred to as “data synch,” there are clear impacts on out of stocks when product data issues are excessive. The primary recommendation focuses on collaborative synchronization of data between suppliers and retailers using a third party vendor. We also show how the use of a parent-child product relationship system can enhance product data accuracy.
2. **Ordering and Inventory Accuracy.** We identified a variety of store issues that create PI system inaccuracy (especially on hands). The level of PI inaccuracy was stunning, as PI accuracy (where the PI exactly matched the on-hands) ranged from 32 percent to 45 percent in the four studies we conducted or examined. Exhibit D shows the distribution of PI accuracy for the best case we encountered. Phantom inventory (when PI system on-hand is greater than true physical product on-hand) is a major cause of OOS, particularly store OOS, because the reorder system does not recognize how low store inventory levels are. For the retailer shown in Exhibit D, items with correct on-hands had OOS event rates of 4.1 percent and had a rate of 8.9 percent where on-hands were not accurate.
3. **Demand Forecasting Accuracy.** Ideally a demand forecast should be the same as a sales forecast, however they invariably differ, largely because of the impact of sales variances caused by OOS. Whenever a shopper does not buy or shifts their buying pattern due to an OOS, it adjusts the demand history away from the sales history and no one can see the true demand history. Merging POS lost sales history with the sales history can more closely represent true demand and lead to better demand forecasts. When we further examined the impact of individual store managers adjusting merchandising quantities from suggested computer assisted ordering (CAO) quantities, we found that store personnel underperform even imperfect CAO demand forecasts.
4. **Store and Shelf Replenishment.** Using the POS measurements we were able to identify patterns that showed when store replenishment (from the distribution center or by DSD vendors) was too infrequent. We also found a positive relationship between backroom inventory and OOS, and thus recommend matching delivery schedules to meet the demand on the shelf, rather than maintaining backstock (except for promotional and other specific items).
5. **Shelf Space Allocation.** We found that 91 percent of the SKUs are allocated shelf space based on case pack size, and that 86 percent of the inventory on shelves is in excess of seven days supply. Given that the shelves are crowded, and that the fast moving items have six times the lost sales due to OOS than their slower moving counterparts, there is a strong case to be made to reallocate additional shelf space to the small number of faster moving items using demand-based planograms.
6. **Planogram Compliance.** We found that a 10 percent change in planogram compliance resulted in a 1 percent change in the level of OOS. Thus, categories that have high planogram compliance levels (90 percent or better), this would be a low priority. For retailers with low compliance levels, addressing planogram compliance can be a good way to lower OOS. The report also provides a best practice methodology for measuring planogram compliance.
7. **Item Management.** We examined the stocking practices that would affect manual ordering systems. We focused on three well-known links to OOS: 1) covering holes, 2) hiding product, and 3) shelf-tagging accuracy. In a new study we found that simple adherence to these practices had a huge effect on out of stocks, reducing OOS levels by about 40 percent, as shown in Exhibit E. While most retailers have policies for these practices, many were not enforced.

Exhibit D: Audited PI Accuracy of U.S. Retail Chain

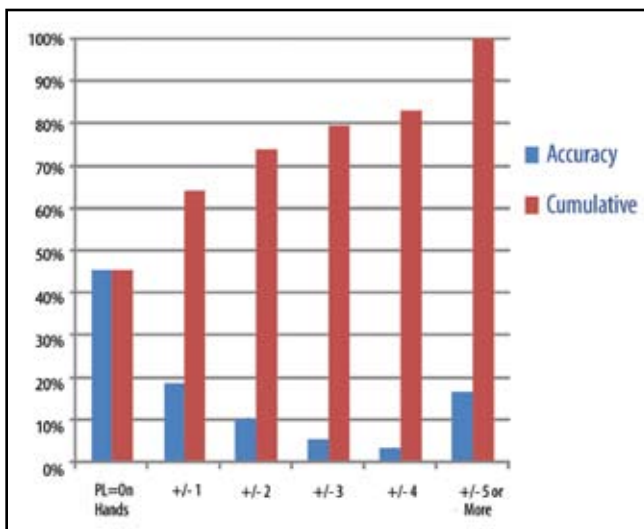
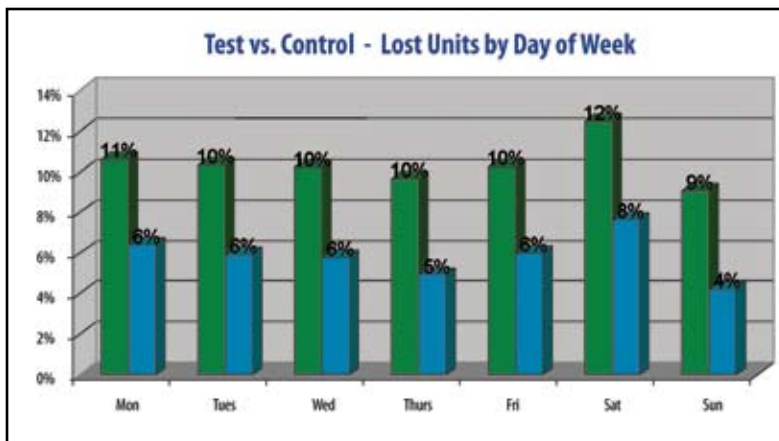


Exhibit E: Impact of Disciplined Shelf Management Practices on OOS Sales Losses

Credit: Data Ventures

RFID Technology and Shelf Out of Stocks

Due to technological and financial reasons, most radio frequency identification (RFID) applications have been limited to tags on pallets and cases and have not descended to the individual item level, where RFID shows great promise to address shelf OOS. However, at the case and pallet level, RFID applications can track when the cases are delivered to the store's backroom, and when they move from the backroom to the store floor and vice versa. As a result, RFID has been shown to reduce shelf OOS for high velocity items that require that the store hold large levels of backstock. RFID applications can enhance sorting of cases coming off a delivery truck. Items that are known OOS get identified quickly for immediate stocking, while items that are still available to the shopper but have room on the shelf for a full case get secondary attention. Cases that are backstock remain in the backroom, rather than being taken to the sales floor and returned. RFID requires disciplined shelf stocking practices. A case that cannot be completely stocked on the shelf becomes a problem when returned partially full because the RFID does not recognize a partial case in the backroom. In addition, RFID is being effectively applied to recognize shrink at the case level, where the impact of unrecognized shrink can have a large effect on OOS due to its large impact on inventory inaccuracy.

A Methodology to Get and Keep Low Levels of Out of Stocks

A simple three-step approach can be applied to address OOS. This approach is completely flexible based the amount of resources that can be devoted to addressing OOS and the desired amount of OOS reduction.

1. When assessing OOS, create both a product ranking and a store ranking, i.e., which products have the highest

level of lost sales due to OOS (or which items have been strategically identified on other criteria to have higher availability levels), and which stores have the highest level of lost sales due to OOS.

2. Define the targeted amount of OOS reduction desired, and then allocate the amount of gain to be achieved from product-based OOS reductions (store or ordering types of solutions) and from store-based OOS reductions (shelf or operations types of solutions). For example if a goal of \$500,000 lost sales reduction has been established, determine how much of the goal will be obtained from ordering type solutions such as PI data accuracy and how much should be gained from store type solutions (such as demand-based planograms). In this example, it may mean focusing on the top 300 products

and the worst 24 stores to get them to their target rate. The point of the recommendation is that this approach can be implemented by any retailer, and the degree of implementation can vary based on the available resources

3. Apply the identified solutions in the assessment specifically to those products (across all stores) and those stores (across all products). This will provide an estimate of the resource level needed to achieve the goal, and the degree to which adjustments can be made based upon the available resource. This targeting will keep work and disruption to a minimum. Once the solutions are implemented across these products and stores, a greater level of resources could be applied to additional products and stores.

There are a few important things to keep in mind with this methodology. First, both products and stores should be addressed, not exclusively one or the other. Working in one provides synergy to the other area, and increases the overall solution effectiveness. Second, some of the product gains will come in the targeted stores, thus are not fully additive in their impact. Finally ongoing and permanent measurement should be built into the process in order to sustain the gains in OOS reduction.

FINAL CONCLUSIONS

1. Out of stocks CAN be reduced on a sustained basis.
2. Measurement lays the foundation to be able to focus resources where losses are the most critical.
3. Selecting and maintaining a focus is crucial for success.
4. There are proven solutions for many identified root causes.
5. There is a simple, yet workable plan to achieve results.

Introduction

OVERVIEW AND OBJECTIVES

In 2002 we published a study on retail out-of-stock (OOS) levels of fast-moving consumer goods (FMCG) products that included many key findings including that the overall level of OOS in developed countries world-wide to be 8 percent, that 75 percent of the cause was due to retail store practices (opposed to up-stream supply issues), and that on average 30 percent of the items that were OOS were purchased at another retail store. The implications of our study suggested that retailers on average lose 4 percent of their annual sales due to OOS items, and that lost sales due to OOS items on average cost manufacturers \$23 million for every \$1 billion in sales.

These findings have been distributed, recognized and published widely, and they have become the basis for numerous academic and industry research studies, as well as for many business projects that have addressed on-shelf availability. These various studies and projects have focused on new ways of measuring OOS, identifying and analyzing root causes, and examining ways to increase on-shelf availability. Individually, each of these studies and projects enlightens various aspects related to OOS, and there is now a need to bring these issues together and provide the FMCG industry a guide for collectively addressing OOS problems and systemically increasing retailers' ability to offer shoppers increased levels of availability.

That is the purpose of this report. In it, we share the results of several studies we have undertaken since 2002, as well as bring together the best knowledge generated by many others who have been addressing OOS issues and who have agreed to partner with us in this endeavor. In our 2002 report, we provided baselines and benchmarks for understanding and measuring the extent, consumer responses, and root causes of OOS. In this report, we bring the discussion full circle, providing baselines and benchmarks for measurement and identification of OOS, as well as providing a guide to those responsible for addressing OOS — those organizations interested in increasing and sustaining higher levels of on-shelf availability.

After spending three years studying approaches to lowering OOS levels, our collective thinking led us to organize the general approach to addressing OOS that is shown in Figure 1. Contained in this relatively simple set of steps is a series of hypotheses and studies that test each hypothesis, reading and assimilating study after study of others who have been doing research in this field, meeting after meeting with expert consultants, suppliers and retail personnel, hours and hours on the sales floors and back rooms of countless retailers in the USA and Europe, and enough air miles to keep the authors platinum.

A Few Key Findings

So what did we learn from all of our efforts? Here are a few findings:

- New retail support technologies, such as RFID, have changed our thinking about OOS as a single problem, to separating OOS examination to “not in the store” and “not on the shelf.”
- An examination of SKU sales frequency shows that only a small portion of items make the big difference. This has implications for identification, ordering, and shelf-space allocation.
- There are new methods of measuring OOS that don't take much labor, and need to be implemented.
- Regardless of the method used, measurement and identification of OOS can point directly to the root cause, and thus the solutions become obvious.
- Accuracy of data—product data, inventory, and point of sales data—is the foundation for keeping product in the store and on the shelf.

What are Out-Of-Stocks?

Previous studies of OOS have used a variety of definitions, and this has resulted in confusion regarding what is being measured and what an “OOS rate” actually means. We have identified several related measurements, and there are two fundamental concepts that need to be understood:

Concept 1: The “*OOS event*” refers to what an “out-of-stock” is (i.e., how we know one when we see one). An OOS event occurs when, for some contiguous time, an item is not available for sale as intended. If the retailer

intends an item to be for sale, but there is no physical presence of a saleable unit on the shelf, then the item is deemed to be OOS. The OOS event begins when the final saleable unit of a SKU is removed from the shelf, and it ends when the presence of a saleable unit on the shelf is replenished.

Concept 2: The *attributes* of the OOS condition refer to aspects of the OOS event(s) that can be measured and that can be calculated as an OOS rate. There are multiple attributes that describe OOS events, and thus there are multiple OOS rates that are calculated and reported. Each attribute can be expressed as a rate over a given measurement period. OOS attributes include:

- 1. Number of occurrences over time:** *“Item OOS event rate.”* This is typically measured as the simple number of OOS events for an item over a given unit of time, for example, “six times per month.” This measurement is useful when comparing the rate against benchmarks or among items in a category.
- 2. Number of simultaneous occurrences:** *“Category OOS event rate.”* For this measure, the number of items in the category that are OOS at the time the measurement is taken are summed and expressed as a percentage of the total number of items intended for sale. For example, if the category has 50 items intended for sale, and at a given time there are five items that are OOS, then the *Category OOS event rate* is 10 percent. *This is the most commonly reported rate* because it is easy to calculate when taking a manual audit of the category.
- 3. Duration:** *“OOS duration rate.”* Over a given period of measurement, the *OOS duration rate* is calculated as the total time that the item is OOS divided by the total selling time available of the measurement period. For example, if a store is open 24/7, and if during a given week of measurement an item was OOS for 20 hours, then the *OOS duration rate* would be 12 percent (20 OOS hours/168 possible selling hours). It is important to note that the OOS duration over a given period may (and typically does) consist of multiple OOS events, and duration of each event is summed over the measurement period. *The OOS duration rate* measures the lost selling time for the item.
- 4. Shelf Availability:** *“Shelf Availability Rate.”* This is directly related to the *OOS Duration Rate*, which refers to the probability that shoppers will find the item when they enter the store. This is calculated as 100 percent - *OOS Duration Rate*. Thus, for the previous example, the *shelf availability rate* for the item would be 88 percent, meaning that the item was available for sale during 88 percent of the time the store was open.
- 5. Lost Sales:** While understanding and measuring OOS occurrences and duration is important for assessing supply chain and store merchandising effectiveness, *the most important attribute for providing diagnostic direction for OOS attenuation strategies* is the lost sales caused by an OOS. A lost sale occurs each time a shopper who wants to buy an item that is listed for sale in the retail store cannot find the item in its expected place and thus cannot purchase the item. If the item tends to be a fast mover, there will likely be multiple lost sales during a single OOS event. If the item is a slower mover, there may be no lost sales that occur during the OOS event, especially if it is a short duration. There are two primary measures of lost sales, both the units and the sales monetary volume. A related measure is the number of customers that are impacted.
 - 5a. Lost Unit Sales:** *“OOS lost unit sales rate.”* Over a given period of measurement, the OOS lost unit sales rate is calculated as the total number of estimated sales unit losses due to OOS divided by the total number of sales units sold plus the estimated sales unit losses.
 - 5b. Lost Monetary Sales:** *“OOS sales loss rate.”* Over a given period of measurement, the OOS sales loss rate is calculated as the total estimated sales volume (dollars, Euros, or other monetary unit) losses due to OOS divided by the total sales plus the estimated dollar sales losses. Derivative loss rates can be calculated using the relevant measure, such as gross margin. However, most loss rates are calculated on gross sales volume. Unless specifically specified, lost monetary sales calculations do not consider the impact of shoppers switching to other products. Thus the actual monetary loss to the retailers will be less than the summed estimates of the OOS of each individual item.
- 6. Number of Customers Impacted:** *“OOS Customer Impact Rate.”* This is measured as the number of shopping baskets that an item would have appeared had the item been always available throughout the measurement. It is mathematically determined as: $1 - \frac{(\text{the number of estimated baskets the item would have appeared} - \text{the actual number of baskets the item appeared})}{\text{the number of estimated baskets the item would have appeared}}$. For example, if during

a typical week an item—if always available—would be estimated to appear in 100 shoppers' baskets, but it actually appeared in 95 baskets due to the item being OOS, then the customer impact rate would be 5 percent. The customer impact rate can theoretically be equal to the OOS lost unit sales rate, but it is normally lower, as it accounts for multiple unit sales per customer.

SUMMARY OF OOS RATES

1. Item OOS Event Rate:

The number of OOS events for an item over a given unit of time

2. Category OOS Event Rate:

The number of items in the category that are OOS at the time the measurement expressed as a percentage of the total number of items intended for sale

3. OOS Duration Rate:

During a given measurement period, the total time that the item is OOS / the total selling time available

4. Shelf Availability Rate:

100 percent - OOS Duration Rate

5. OOS Lost Unit Sales Rate:

The total sales unit losses due to OOS / (the total number of sales units sold + the total sales unit losses)

6. OOS Sales Loss Rate:

The total monetary sales volume losses due to OOS / (the total sales + the estimated dollar sales losses)

7. OOS Customer Impact Rate:

$1 - [(the\ number\ of\ estimated\ baskets\ the\ item\ would\ have\ appeared - the\ actual\ number\ of\ baskets\ the\ item\ appeared) / the\ number\ of\ estimated\ baskets\ the\ item\ would\ have\ appeared]$

KEY DISTINCTION OF OOS EVENTS

Shelf OOS: Describes OOS events where a salable item is physically somewhere in the store, but not readily available to the shopper because it is somehow hidden from the shopper in its expected place; i.e., it is not found in the back room, it is in the wrong location, it is hidden behind other products or otherwise. Store OOS: Describes OOS events where the item is not physically in the store, as a result of forecasting or ordering inaccuracy, ordering practices and delivery processes.

GUIDE TO USING THIS REPORT

This report is based on insights and solutions that will assist managers in decision making and resource allocation to improve on-shelf availability. The report is organized into four chapters, following the steps in Figure 1.

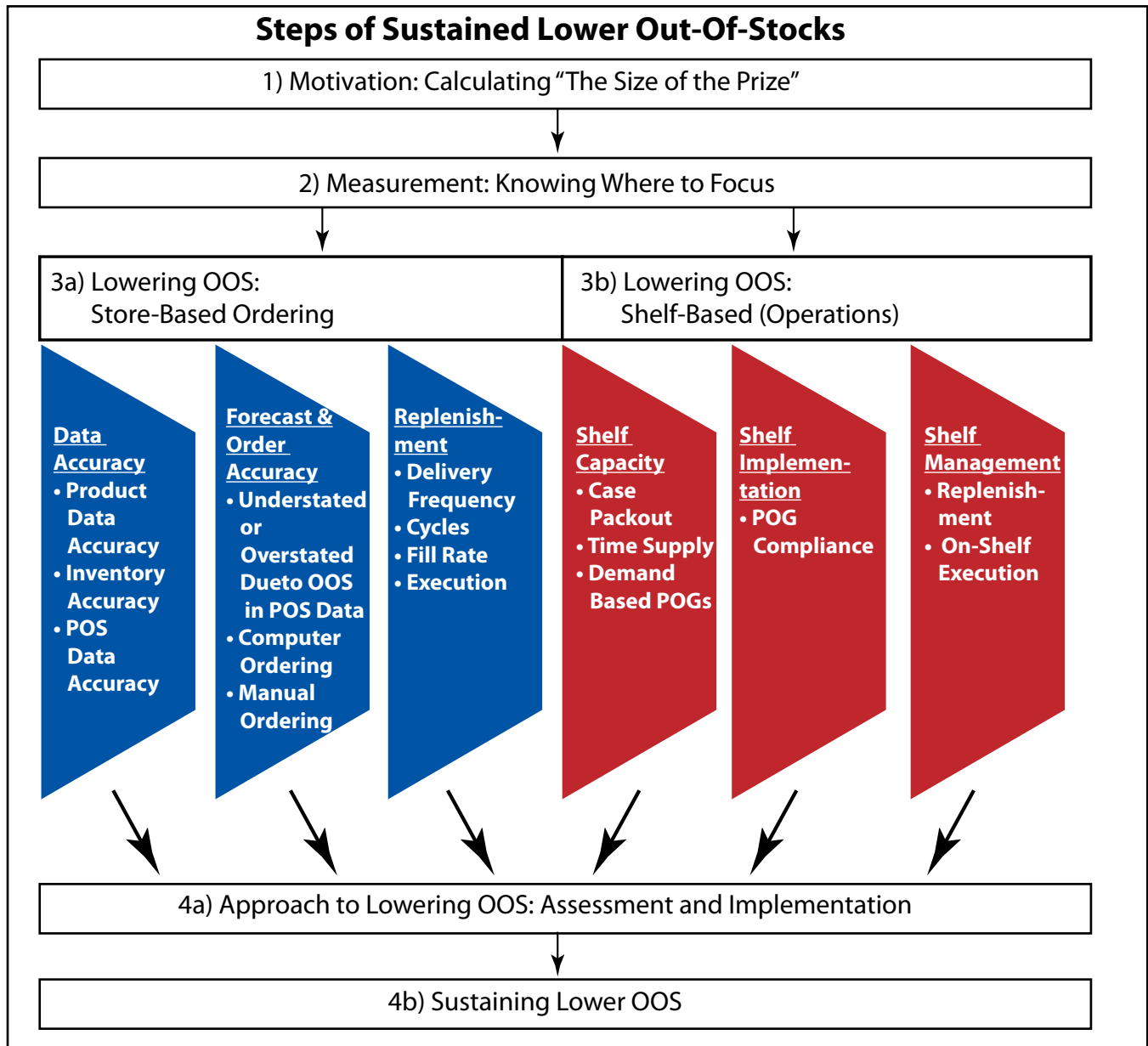
Chapter 1: Understanding the total cost of OOS

This chapter makes the business case for addressing OOS from both an operational and a strategic level. Discussion of the rationale, conclusions and summary of solutions at a high level are included in the body of the report, while detailed descriptions of the solutions appear in the appendices. This chapter starts where our previous study left off. It takes the basic cost of lost sales due to OOS that was determined in our previous study, and it goes forward to show how the complexity of the effects of OOS results in other previously undocumented cost areas that are incremental to the immediate costs incurred by lost sales. For example, employee time costs, shopper inconvenience costs and continued inaccurate ordering by retailers who must forecast in the presence of unknown demand. One focus is on a recent distinction in addressing OOS, separating store vs. shelf issues, a distinction becoming increasingly emphasized by those using RFID to address OOS.

Chapter 2: Understanding OOS through measurement

To know where one wants to go (lower OOS), one needs to know where they are. In this study we compare the primary ways that OOS are measured, and we show how measurement needs to point towards root causes and solutions. New light in understanding OOS is revealed through aggregate item movement in the store, where the analysis shows that a relative small number of items can be considered “fast movers.” Once attention is focused on these items, the chapter moves to examine different ways to measure OOS—both electronic and manual. Other attributes such as duration and frequency are addressed, as various measurement methods explore the attributes. New attributes of OOS are presented, including OOS patterns that can be identified. In all types of measurement, the emphasis is on using measurement to identify root causes, which can then be applied to solutions to reduce OOS.

Figure 1: Overview of the Chapters of This Report



Chapter 3: Lowering OOS rates—our hypotheses and related studies

Building on the enhanced understanding of OOS as presented in Chapters 1 and 2, Chapter 3 systematically examines efforts to address OOS starting with the initial steps of accurate data all the way through to daily replenishment practices. We delineate a series of hypotheses and demonstrate the proposed effect on OOS levels, providing the available supporting evidence through our own studies as well as from others’ studies. For two of the studies,

perpetual inventory accuracy and planogram compliance, we also share best-practice methods that were developed for each study.

Chapter 4: Assessment and implementation to get and keep lower levels of OOS

While each of the components to addressing OOS levels have been addressed systematically in the two previous chapters, this chapter provides a systematic approach for managers to address their OOS levels. This serves as a guide

where managers can methodically diagnose and assess their most serious OOS malady, and then apply the appropriate protocol to address it.

This chapter concludes with a vision for what a retailer could realize when a culture of continuous quality improvement is merged with the various technologies to provide a seamless, accurate, informational base that will assure that the products shoppers want are available when they want to buy them.

RFID FEATURES

Radio frequency identification (RFID) has been viewed as a technology that can support and enhance efforts to reduce OOS. With the use of electronic product codes (EPC) on palettes and case-packs, RFID readers can greatly enhance the ability to track products as they pass through designated thresholds. Special call-out boxes in this report feature the impact RFID can have in the quest to increase on-shelf availability.

Understanding the Total Cost of OOS

1

1-1. INTRODUCTION: WITH ALL THIS NEW TECHNOLOGY, WHY ISN'T AVAILABILITY HIGHER?

In 2002 we published a study, *Retail Out-of-Stocks: A Worldwide Examination of Extent, Causes, and Consumer Responses*, that established the worldwide average level of OOS in retail in the FMCG industry to be about 8 percent. This report clearly showed the industry that the problem of OOS items was caused primarily by retail practices, and estimated that OOS was costing the industry billions every year.

Is 8 percent good or bad? It's bad. From a shopper perspective, this means that for every 13 items one wants to buy, one will be out of stock. From a management perspective, our 2002 study showed that OOS cost retailers 4 percent of sales, and this translates to a similar 4 percent reduction in the average retailer's earnings per share. What was also interesting about the 8 percent figure was also that it had not changed from a major study published seven years earlier (Coca-Cola Research Council 1996). In fact nearly every report among the hundreds we have read and reviewed that deal with retail out-of-stock levels in the FMCG industry continue to converge on that 8 percent number, as if there was some DNA in the industry that predisposes retailers to this level of service.

We thought those findings would make retailers wake up to the fact that one of the easiest ways to improve earnings would be to simply get and keep goods on the shelf. And it has. Over the past three years, we have read or reviewed studies conducted by many retailers who seek to reduce OOS levels, and many have been successful at reducing OOS levels. Moreover, retailers have been able to use new technologies that incorporate point of sale (POS) data to better understand demand. Inventory systems have been implemented to keep better track of inventory in the store, on order, and in transit. RFID technologies are now being used on pallets and cases which help retailers better know what they have in the store.

With all of this attention and technology thrown at increasing retail product availability, why do shoppers still face unacceptable OOS levels? Overall, technology improvements have been offset by process complexity, such as

more complex promotions, and increased SKU proliferation. In sum, there are a variety of reasons, but we have identified the primary reasons:

- Demand forecasts are made with incomplete information, and thus often under-estimate demand;
- Inaccurate data from inventory systems provide incorrect ordering information;
- Traditional retail practices such as using only case-pack size to determine shelf allocation (86 percent of the dollar inventory on the shelf represents more than 7 days of supply) prevail, choking shelf space from the relative few fast movers, without consideration of time of supply;
- Item/SKU (stock keeping unit) proliferation—suppliers battle for shelf space by introducing “me-too” items, and are constantly changing UPC / GTIN (universal product code / global trade identification number) information and thereby contribute to inventory database inaccuracy;
- Promotional proliferation, generally at the urging of suppliers;
- Consolidation among retailers that bridge information systems containing inaccurate legacy data;
- Pressure to reduce personnel cost resulting in inadequate labor supply.

With so many drivers of OOS levels, managers need to know where to begin addressing the component that will have the most impact. And in order to know this, we have to have a better understanding of OOS and how they affect the business of both suppliers and retailers.

1-2. A GENERALLY UNRECOGNIZED PROBLEM: THE COSTS OF OOS > LOST SALES

It has become abundantly clear to us over the years that we have been studying OOS, that the direct sales loss, which we estimated to be up to 4 percent—substantial as it is for both retailers and suppliers—is only one part of the expense OOS items produce. Figure 2 provides an overview of several additional effects of OOS. The total costs are both operational and strategic, and these affect both suppliers and retailers.

- From a services delivery perspective, an OOS item indicates that a number of service failures have occurred,

and these service failures point to lowered customer satisfaction, decreased store and brand loyalty and increased shopper costs.

- From an operations and supply chain management perspective, OOS distort inventory information that is required for ordering and replenishment of the store and shelf. In addition, treatment of OOS items requires extra process steps that could be avoided if systems were in place that would eliminate OOS.
- From a marketing and sales forecasting perspective, the presence of OOS items distorts the baseline on which demand forecasts are made. Since true demand is unknown due to OOS items, some items are under-forecasted, while other items are over-forecasted.

Estimate of Aggregate Personnel Lost Time Cost Due to OOS Items

The following spreadsheet calculator shows how to make an estimate of the actual time spent on tracing OOS by personnel. This only looks at the cost of looking for items when asked by a customer. While OOS does not directly drive additional cost of this labor, this labor could be deployed to productive efforts of the store.

	Large Volume Example	Small Volume Example
Avg \$ volume/week (000)	298	60
Avg \$ transaction	\$27.34	\$15.00
Avg # customers/week	10,900	4,000
Shoppers encountering 1 or more OOS	40.0%	40.0%
# shoppers encountering OOS	4,360	1,600
% times shoppers involve store labor	10%	10%
Avg minutes spent by store employee	6	4
Avg. Hourly wage rate	\$18.00	\$18.00
Avg Cost/week/store	\$785	\$192
# stores in chain	100	100
Weekly cost labor in chain	\$78,478	\$19,200
Annual cost labor in chain	\$4,080,878	\$998,400

average weekly sales are approximately 20 percent of that of the large volume format, the average transaction size is slightly more than half the large volume size, and that the employee only spends four minutes on average per customer request.

Figure 2

	Manufacturers	Retailers
Operational	<ul style="list-style-type: none"> • OOS lowers the potential impact of promotions and trade promotion funds; • OOS distorts true store demand, thus category management and related efforts are less accurate and effective; • OOS increases overall costs of the relationship with the retailer (increased post-audit activity, irregular ordering) 	<ul style="list-style-type: none"> • OOS distorts true shopper demand thus decreases forecasting and ordering accuracy; • Operational costs are increased through personnel looking for OOS items in back room, providing “rain checks” to shoppers, unplanned restocking, etc. (Note: an example of how personnel costs might be estimated is provided below)
Strategic	<ul style="list-style-type: none"> • Direct loss of brand loyalty and brand equity; • OOS encourages trial of competitor brands; • Lowered overall effectiveness of Sales Team resources 	<ul style="list-style-type: none"> • Direct loss of store loyalty; • Decreased customer satisfaction; • OOS encourages shopping at competitor stores; • Permanent shopper loss to competitors (shopper switch rate is still undocumented, but annual cost is US \$1 million per every 200 shoppers)

In the large volume store example, the weekly cost per store is about \$800 per week, and for the smaller volume store, the cost per store is about \$200 per week. When these figures are annualized across all stores in a chain, the total costs are substantial.

In both the large and small volume examples, these conservative estimates quantify a typically non-documented cost caused by out-of-stock items, where they redirect scarce store labor away from productive activities. Retailers can construct this simple spreadsheet to match their specific situation

The following examples, for the large volume store, we use the Food Marketing Institute (FMI) average transaction size (US \$) of \$27.34, estimate that 40 percent of the shoppers will encounter at least one OOS (consistent with a 10 item list), conservatively assume that only one of every 10 will contact an employee about the OOS, and the average wage and benefits cost for the employee is \$18.00 hourly. The average weekly sales volume for supermarkets (FMI) is slightly under \$300,000, and we estimate that the store employee will spend six minutes on average searching for the requested item. In the small volume store example, the

OOS and Increased Shopper Costs

This study has not made any direct measures of shopper costs, but OOS events clearly increase the total shopping trip cost to the shopper. The measurement of the aggregate shopper costs in terms of increased transaction costs, lost time, increased decision making requirements, and a host of other social and psychological costs (for example the lower confidence of having to use an untested substitute) has never been calculated—nor are the total effects understood. If we consider the “flip side” of the examples shown in the previous

section, in a single large volume grocery store OOS add some amount of increased shopping costs to more than 4,000 shoppers weekly, or more than 200,000 shoppers annually.

The costs to each shopper vary. The shopper who makes a quick decision to substitute a similar size and priced item in a category will incur low time and costs, and depending on the item, it can have low psychological costs as well. Alternatively, the shopper who is pressed for time may purchase a more expensive substitute if the psychological substitution costs are high. A customer with high substitution costs will go to another store to get the product, and this is a very expensive proposition for the shopper.

Shoppers who ask store personnel to locate an item waste time in their shopping trip, having to find personnel as well as waiting to see if the item is available. With the average shopping trip being 28 minutes, a six-minute wait represents more than 20 percent of the entire shopping trip time, precious minutes that the shopper might spend examining a new item or attending to other merchandising efforts of the retailer. In short, while the shopper is actually in the store, the presence of an OOS forces the shopper to allocate minutes to activities other than those that retail management would most prefer them to engage.

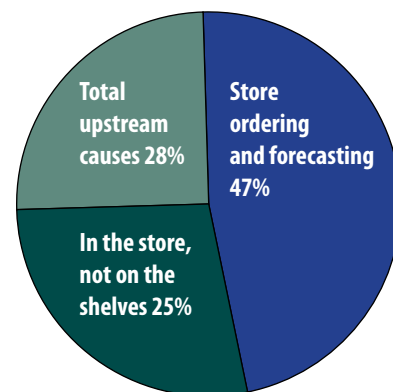
In an age of increased consumer understanding of the cost of time, and the availability of the internet as an alternative channel, retailers need to consider ways to make shopping as convenient as possible (or at least eliminate the unnecessary inconveniences). Shoppers not only have alternative stores for shopping, but now also have entirely new alternative shopping channels.

1-3. ROOT CAUSE ANALYSIS DRIVES A DISTINCTION OF STORE VS. SHELF OOS CONDITIONS

As we have been examining OOS over the past several years, a new focus on approaching OOS on two levels has begun to emerge: separating issues pertaining to store OOS as opposed to shelf OOS. One can attribute the causes of store OOS to forecasting, ordering, delivery and upstream supply problems. In our 2002 study, there was little information available on the impact of inventory inaccuracy in perpetual inventory (PI) systems. We now know (and report later in this study), that PI systems are often inaccurate, and that the presence of “phantom inventory” is a major contributor to the 47 percent store ordering root cause.

In our 2002 study, we identified that on average 25 percent of OOS were *shelf OOS*, when the product was actually in the store, but simply not on the shelf at the time the shopper wanted to purchase the item.

Figure 3: Root Causes of OOS



Credit: Gruen, Corsten, and Bharadwaj 2002

OOS Causes Worldwide Averages

Subsequent studies have confirmed our findings that a substantial number of products that are actually in the store are not found on their intended shelf. There are multiple primary causes for shelf OOS. These include:

- a breakdown of in-store processes that are designed to move back-stock (excess inventory kept in the back room of the store to cover for periods where sales are expected to be greater than the amount of shelf space allocated to the item for the regular delivery cycle) to the shelf;
- labor availability (not enough store stocking labor available);
- labor training—store stockers do not have a system for getting OOS “holes” filled first;
- the “hole” on the shelf is filled with another item, thus not identified as OOS;
- a lack of ability to know when restocking the shelf is required;
- item is located in multiple locations in the store and is out in one area while still available in another location; and
- too much product in the backroom—previous studies show a positive correlation of backroom inventory and shelf OOS.

This situation is particularly frustrating since the order forecast may have been correct, and the supply and delivery functions executed appropriately. However, due to execution in the store, for some reason the product didn’t make it the final 50 meters so it could land in the shopper’s cart.

RFID AND SHELF OOS

The advent of the use of RFID in the industry has brought increased attention to shelf OOS. Most RFID technology is limited to tags on pallets and cases, and—due to technological and financial reasons—has not descended to the individual item level. Thus RFID is limited in the ability of the technology to address shelf OOS. The major application for reducing shelf OOS is to understand what inventory exists in the backroom and to locate it, where hidden items are a continuing problem for store stockers.

RFID applications are focused on knowing when the cases come into the store’s backroom, and when they move from the backroom to the store floor. It can also identify when a case is returned from the floor to the backroom. As such this has implications for store stocking practices. For example, this suggests that a case that cannot be completely stocked on the shelf becomes a problem because the RFID does not recognize a partial case in the backroom.

Alternatively, RFID applications can help dramatically when sorting cases coming off a delivery truck. One might consider a sort of “triage” (borrowing from emergency medical care where the worst-case patients get the first attention). Thus items that are known OOS get identified quickly for immediate stocking, while items that are still available to the shopper but have room on the shelf for a full case get secondary attention. Cases that are back-stock remain in the backroom, rather than being taken to the sales floor and returned.

Backroom Inventory Correlates Positively with OOS Levels

While dominant logical thought would consider larger levels of backstock to reduce OOS levels, our research (as published in the 2002 study and as updated in Chapter 3, Section IV in this report) has found the opposite to be true. The reason this occurs is that the back room of the retail store should only store items where there is known demand beyond what can be kept on the shelf until the next delivery from the DC will be made (for example promoted items). Any inventory in addition to this that is kept in the back room effectively creates a second storage point, which is costly and inefficient by definition.

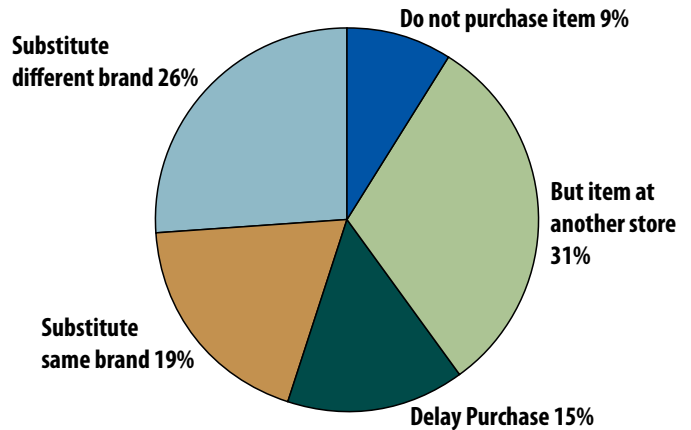
1-4. WE KNOW HOW CONSUMERS RESPOND TO OOS CONDITIONS

Reactions to OOS items

In general, our knowledge of how consumers respond when facing an OOS item is well-known. Our 2002 study, based on 72,000 shoppers, published overall worldwide benchmarks that have been generally accepted, and these are

shown in Figure 4. At minimum, the cost to manufacturers on average is 35 percent of intended sales, and the cost to retailers is 40 percent of intended sales. And from what was presented earlier in the report, the total cost is much higher than the lost sales.

Figure 4: Consumer Responses to OOS Events



Credit: Gruen, Corsten, and Bharadwaj 2002

Worldwide Consumer Responses to OOS Events Average across 8 categories

We also know how responses to OOS vary based on the type of product. A group of Dutch and Belgian researchers have provided a useful theoretical model to examine the shopper’s opportunity cost, transaction cost, and substitution cost (Campo and Gijsbrecht 2002). 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 transactions cost is high (the time and effort to purchase later or elsewhere), the consumer will either substitute or cancel purchase. Each individual cost component is limited in its ability to explain the consumer response, however, different reactions can be robustly explained by the interaction of the three components.

Another group of Dutch researchers examined a comprehensive set of antecedents to shopper OOS reactions (brand related, product related, store related, situation related and consumer related). They found that the brand and product related antecedents had the greatest influence on shopper reactions. From the results, they recommend OOS reduction strategies based on the equity of the brand and the way the product is used. While the overall conclusions are

Figure 5: Shopper Cost Components and OOS Behavior

When the Opportunity Cost is...	And the Substitution Cost is...	And the Transaction Cost is...	Then the Customer will...
High	High	Low	Buy item at another store
Low	High	Low	Delay purchase
High	High	High	Substitute—same brand
High	Low	High	Substitute—another brand
Low	High	High	Not purchase item

Credit: Gruen, Corsten, and Bharadwaj 2002

generalized to entire categories and require refinement to be diagnostic, the overall approach is enlightening and provides good general guidance (Sloot, Verhoef, and Franses 2005).

There are still some critical things we don't know about consumers. Most importantly, we don't have empirical evidence of how OOS affects store choice, either initially, or over the long run. We do know that when a shopper has to go to another store to get an item that was OOS at the preferred store, that the other store has been given an opportunity to win additional business besides the OOS item. Over time, business will erode due to OOS items, but we do not know at what rate this occurs.

CONCLUSION

Our knowledge of consumers gives management plenty of reason to consider reduction of category assortments and reallocation of shelf space to faster moving items. Such efforts result in fewer OOS as well as lower labor costs, as faster-moving items do not need to be stocked as frequently. The only surprise at this point is why this conclusion is not being implemented. In Chapter 3, we present our research on demand-based planograms, and this provides an initial approach and rationale for retailers to provide optimal assortment, as opposed to the widest assortment.

Understanding OOS through Measurement

2

2-1. UNDERSTANDING THE MEASUREMENT AND IDENTIFICATION OF OOS

Defining OOS to Measure the Impact of OOS: Events, Rates and Lost Sales

In order to address OOS, one must know what they look like, and thus be able to recognize and describe an OOS. How does one describe an OOS? How does one calculate the extent and interpret the degree to which OOS has affected their company?

In the introduction, we provided a detailed definition of an OOS, and we also provided a comprehensive list of the attributes that are typically measured to determine one of several OOS rates. In this section, we provide additional detail on OOS attributes, with a particular emphasis on how each type of measurement of the attributes can be used to detect the root causes behind the OOS.

In our research we came across a variety of indicators used to describe OOS, and the differences depended on the ways that the OOS were measured. The definition of what makes an OOS also affected the extent that has been reported in studies. Thus, for this study, we took particular care to clarify the definition that would allow us to measure OOS in a way that would provide adequate understanding to move towards solutions.

Events and attributes. To begin, most will agree about the meaning of an “OOS event,” referring to whether the product was or was not on the shelf in a salable condition, as we discussed in the introduction. This is the starting point. However, simple identification of OOS events does not provide adequate diagnostic understanding that will lead us to finding the root cause and a solution. With the identification of each attribute of the OOS event, we find that we can better identify the root cause and more efficiently and effectively apply a solution to the OOS. To review the attributes listed in the introduction, we note that the attributes are viewed in a specific measurement period (day, week, month, year), and from this we can derive various rates that are typically expressed as a percentage. Here are the relevant attributes we identified:

1. the frequency that events occur over the measurement period;
2. the length or duration of each event within the measurement period, and the total cumulative duration during the measurement period, and the inverse of this which is the availability, which is the probability that a shopper will be able to find the item on the shelf at any given moment;
3. the intensity, or the loss to the organization due to OOS, which has multiple related components including the lost unit sales, and the lost monetary sales. Other derivative measures of intensity include the net sales loss due to OOS (after consideration of substitution), the gross margin net sales loss, and the number of lost shopper baskets (a measure of number of customers that are dissatisfied), accounting for multiple sales loss to a single customer; and
4. the breadth (number of stores with simultaneous pattern), which indicates the likely location of the root cause (individual store, supply chain, manufacturer).

Best Practice Recommendation: These attributes must be measured to determine the overall impact of OOS. This approach to identifying and measuring multiple OOS attributes should be adopted as a best practice for the industry.

The “OOS rate.” As we showed in the Introduction, the notion of an “OOS rate,” which we determined in our 2002 study to be approximately 8 percent worldwide, is a function of the occurrence of the measured attributes over the measurement period. It is worth reiterating that the traditional “OOS rate” that has been reported in most studies, has been measured through manual audits, and thus indicates the number of items that are OOS at a given point in time. This measurement has little regard for the duration of the OOS, or the degree to which the OOS impacts the retailer. As such, we recommend that whenever the term “OOS rate” is used, that an adjective that indicates the attribute being measured also accompany the term.

BEST PRACTICE RECOMMENDATION:

When referring to an “OOS rate,” the industry should adopt as a best practice the use of our clarifying terminology of the various rates explained in the introduction.

Sales losses due to OOS. While understanding the frequency and duration of OOS rates is a critical starting point, understanding of the sales losses provides the diagnosticity required for addressing solutions that lower OOS in an efficient manner. Some OOS are more costly than others, and a focus on reducing the more costly OOS will lead to greater return on investment to lower OOS, than simply lowering the overall rate without regard to which OOS make a bigger difference. As this chapter demonstrates, OOS of fast moving items encounter greater lost sales than do OOS of slow moving items.

Lost sales occur when a product is not available at the time a shopper wants to buy it and as consequence shopper behavior is altered so that the intended item is not purchased, purchased at a later time, purchased at another outlet, or substituted with another item. Even when the item may be somewhere in the store or otherwise be hidden from the shopper, if the shopper is not able to purchase the intended item, it is considered to be a lost sale due to OOS. When an OOS event occurs, the item does not incur a lost sale unless it cannot be replenished to the shelf before affecting the next shopper that wants to buy the item. Alternatively, a single OOS event can result in multiple lost sales. The approach of examining the sales loss has major implications on how retailers prioritize and address OOS.

BEST PRACTICE RECOMMENDATION:

When seeking to address OOS, the OOS should be prioritized based on obtaining some understanding of the losses associated with each OOS event.

General Approaches to OOS Measurement

When examining OOS, there are three general alternative approaches or methods of measurement:

- A. manual audit method;
- B. POS sales estimation; and
- C. perpetual inventory aggregation.

Each method has its advantages and disadvantages, and—when used effectively—can direct managers to root causes of OOS.

A. Traditional Audit-Based Measurement of OOS—Looking for Holes

The first is a manual auditing method where periodic checks are made of the shelves or other merchandise displays in selected categories. This method formed the base of most our findings in our 2002 study. The auditor counts the number of “holes.” A “hole” is defined as an item that has a shelf tag or otherwise should have inventory on the shelf according to the planogram for that category, but there is no inventory for that item on the shelf visible to the shopper. If the item is placed in the wrong location or hidden behind another item, that also counts as a hole. The total number of holes that are found in that given period are then divided by the total number of items in the category to provide a percentage of items that are OOS.

In the traditional and most commonly used 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 total number of items that the store usually carries but are not available. Normally, the OOS rate is reported for each category individually and then the categories are averaged to create and report an overall OOS rate.

There are four primary advantages to this method of measurement:

- The method has been used for many years and there are reliable benchmarks available for comparison.
- The method also produces results that are believable, i.e., seeing is believing.
- In the aggregate, in the manual method, the OOS rate will approximate the lost sales rate due to the complementary errors where lost sales are over-estimated for slow movers and under-estimated for fast movers, and therefore they balance each other out. Based on our research and comparison of this method with others, the overall averages of OOS levels measured this way tend to approximate the overall lost sales for the retailer.
- It provides a cost-effective way to address on-shelf availability in a known problem area of the store.

The limitations to this approach to measurement include the following:

- all holes are counted as equal, even though some may be for much faster selling items or may have much longer durations;
- the audited OOS rate does not measure either the lost revenue or consumer impact of each OOS despite often substantial differences between them;
- the selection of the categories is often unbalanced, being influenced by a supplier who sponsors the audit;
- the frequency and timing of the audits, generally determined by the overall budget provided for

measurement and availability of staff, often misses peak business hours and weekends and produces biased OOS rates – audits are often performed first thing in the morning when the shelves are more likely to have been restocked;

- the duration of the audit (typically a week, again determined by budget) is often too short to measure the true average OOS rates because of normally large daily and weekly variations in OOS rates;
- the audits are very labor intensive and can interfere with routine store operations;
- the accuracy is diminished by unavoidable counting and other human errors due to inattention and fatigue of the auditors – especially if auditing goes on for an extended;
- when a “hole” is filled with another product and the shelf tag removed (for items the retailer intends to have in distribution), then the OOS cannot be identified, and thus OOS are underreported;
- when the shelf is filled with the wrong item even when the tag is present, the OOS may not be identified if the auditor relies only on visual inspection (but scanning the item’s UPC could identify the error);
- the overall cost is prohibitive for sustained measurement—the total cost is function of the frequency and duration of the audit; and
- this method is not feasibly scalable to a large number of categories or a large number of stores.

This final limitation is crucial to any effort to lower lost sales due to OOS. While the audit method provides reliable averages of the OOS rate that—when consolidated at the store level tend to provide an overall measure with reasonable accuracy—it assumes that each OOS item is equal in its effect, and thus does not provide the diagnostics necessary to address OOS reduction efficiently. A slow moving item that has no inventory on the shelf, but may not have a shopper come to purchase it for several days is counted as a single OOS event, while a faster moving item that may have multiple shoppers intending to purchase it in a single day is also counted as a single OOS event.

Given all the limitations, the manual method can still be valuable to the retailer by pointing towards major root causes of the OOS. Often, addressing a root cause will lower the OOS event rate of all items that were affected by it, regardless of the sales losses. For example, OOS items that are identified through a manual audit can be compared with the perpetual inventory (PI) data for those items. If the PI for the OOS shows a large number of the items to be on-hand, i.e., they are “phantom inventory,” then the PI inaccuracy would be the likely root cause for those items. Improvements in PI accuracy will then increase the overall

shelf availability for all items (this is further addressed in Chapter 3).

BEST PRACTICE RECOMMENDATION:

When conducting a manual audit of OOS items, retailers should seek to associate the findings with likely root causes. This can be done by comparing the items that are found OOS with PI data, items being advertised or otherwise promoted, items kept in multiple locations in the store, delivery frequency, shrink, ordering amount, etc.

B. Data-Driven Measurement: Estimates Based on POS Data

Instead of relying on physical audits, the second approach is measured through the use of models that estimate lost sales from OOS using store scanner and inventory data. This approach to measuring OOS directly estimates the number of times a consumer actually intends to purchase 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. Variations on this measurement estimate the lost sales quantity and/or the lost sales revenue. This view provides the advantage of determining the extent that OOS affects the retailer and the upstream supply chain members. Moreover, the data used to make the estimates also provides the duration and frequency of OOS. And, it enables a much more detailed root cause analysis because the start and stop time of day and day of week are identified for each OOS event.

This method of measurement using POS transaction-level data has been shown to identify true positive OOS at an accuracy of 85-90 percent when validated by manual audits. That is, 85-90 percent of the items identified as OOS were in fact either OOS or had a shelf tag error. Because each OOS event is individually identified, OOS losses can be aggregated to brand, category, department, store, or any other level of management interest, at the same degree of accuracy (80-95 percent). One disadvantage is the higher (but currently unmeasured) false negative rate – i.e., the number of items actually OOS but not detected as being OOS. Because of the way these data-driven methods estimate OOS, false negatives tend to be items where the losses are small.

- The major limitations of this method include: the OOS rates are estimates based on historical sales patterns, and when the past is a poor predictor of the present, accuracy is a problem;

- it does not work well for SKUs that sell slowly (thus are restocked without ever being detected as OOS);
- the method depends on accurate POS data;
- initial cost to set up; and
- the estimates are not immediately trusted by store management, since they have been mathematically estimated instead of physically observed.

In spite of these limitations, much work is going forward using this method. It overcomes most of the limitations of the manual audit method, by focusing retail managers on the OOS items that are impacting their shoppers the most, and by taking away the labor intensity and human error of measurement. Furthermore, while there is an up-front cost for the method for the retailer, the variable cost of analyzing additional categories or longer periods of time is much less than physical audit methods.

How does POS Estimation Technology Work?

A variety of methods have been developed by commercial ventures, consultants, and academics that use mathematical algorithms to estimate lost sales based on historic patterns of sales of the item. Each method that we reviewed has its own nuances, advantages, and disadvantages over other methods (in terms of its sensitivity, cost, accuracy, etc.) However, each mathematical algorithm tends to address OOS by the following general steps:

1. The algorithm examines each item’s historic sales velocity (normally requires a year).
2. It sets parameters for expected future sales velocity

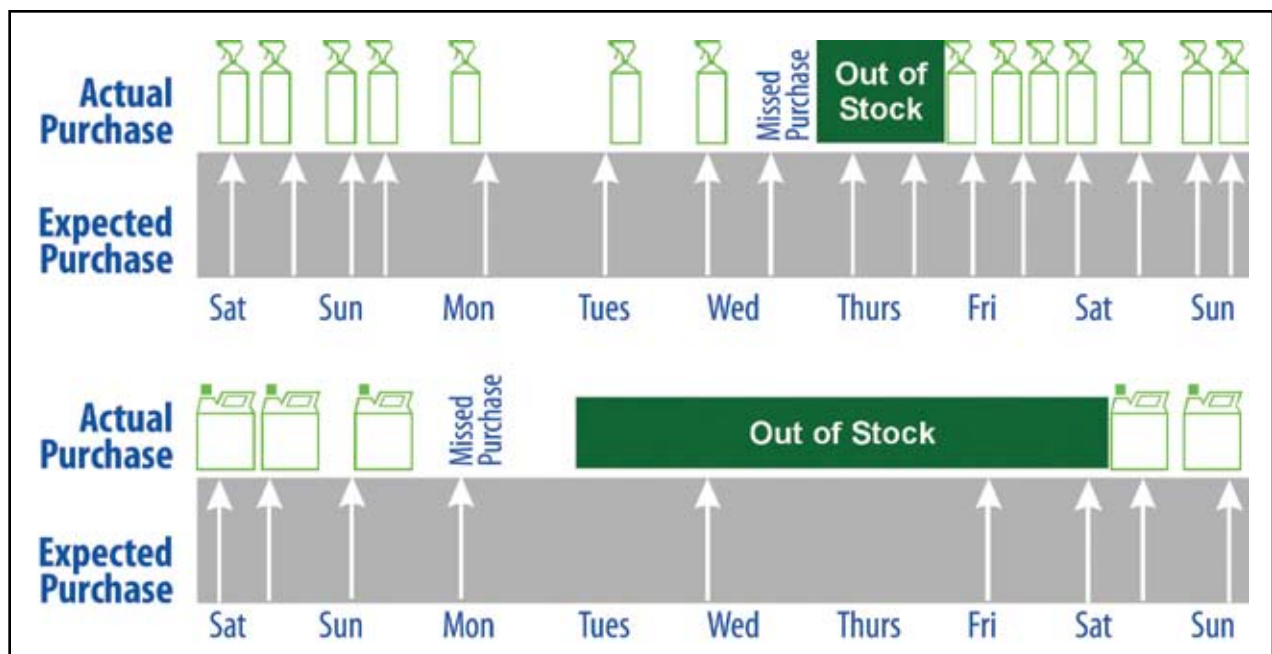
(taking into account a variety of variables including sales, prices, seasonality (time/day/week) as well as changes and variances to these.

3. When an item’s purchase cycle (expected velocity) is interrupted beyond a calculated threshold, that item is deemed “OOS.”
4. The item is reviewed to determine the likelihood for “false positive” identification (estimated OOS when it is actually in stock).
5. After the next actual sale of the item occurs, the total number of lost sales is calculated.
6. The lost sales and relevant OOS rates (events, duration, lost unit sales, lost monetary sales) are then aggregated into a managerial report.

Figure 6 illustrates with two examples how the estimation process works. The first example shows three lost sales (the first occurring when an expected purchase is missed followed by two additional expected sales), and the second example shows four lost sales (the first occurring when an expected purchase is missed followed by three additional expected sales).

POS estimation holds the greatest benefit for retail outlets where there are a large number of items where the product movement is faster than the typical replenishment cycle. While OOS can be detected for slower moving items, these may be detected more quickly and efficiently through other methods.

Figure 6: Two examples of OOS Estimation Using POS Data



Credit: Data Ventures

OOS Duration

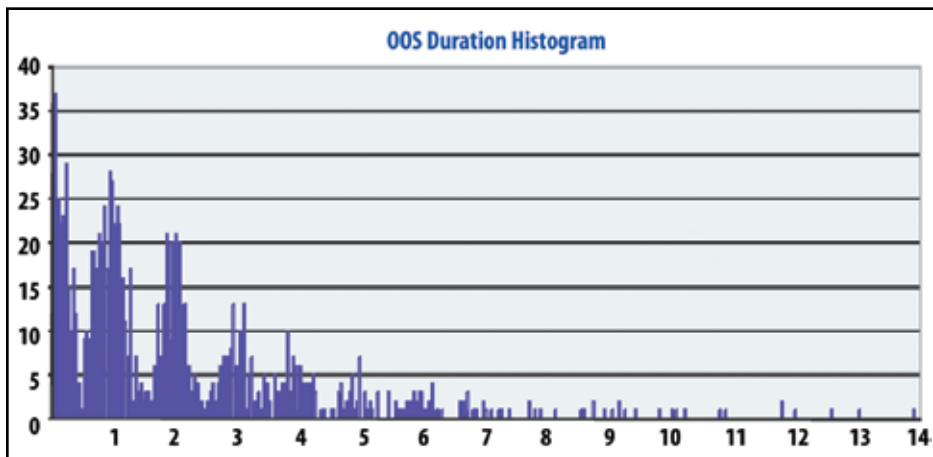
One attribute calculated by the POS measurement method is the duration for each OOS. Figure 7 shows the distribution of 1,084 OOS events on the 200 fastest moving store items that were detected for a U.S. retailer over a 14-day period. These duration measures include the hours the store is closed. Figure 8 provides the cumulative perspective of these events. This shows that 40 percent were one day or less, and an additional 20 percent lasted two days. Particularly troubling is the fact that almost one-quarter lasted three days or more.

Examining duration distribution patterns helps point to likely causes. It also helps understand losses from OOS, since the loss from an OOS is a total of the lost sales for that item over the period that it is OOS. Rather than waiting to

receive historical reports, some retailers are working with OOS identification vendors to obtain real-time notification of OOS as they are identified. POS data on the faster moving items is continuously analyzed to determine when an OOS has occurred, and the retail manager can immediately address an identified OOS event. This also provides a way to validate the algorithm used to identify the OOS: how many times is an OOS that is identified by POS data actually appearing as an OOS (i.e., a hole) when store personnel go to address it? The objective of real time notification of OOS is to reduce the OOS duration

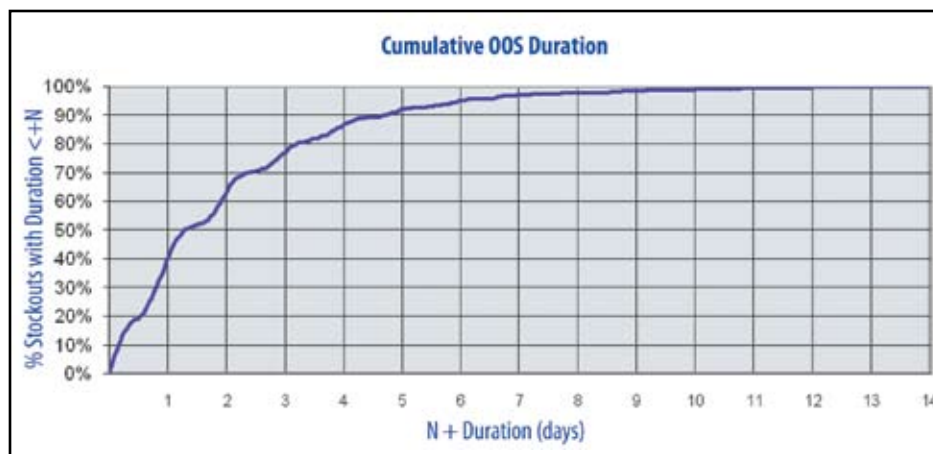
Figure 9 shows OOS duration in a study looking at 12 months of data for 100 products in 24 stores. For this retailer, the duration of these OOS items has a very different pattern than shown in Figures 7 and 8. The red bars (left bar in each cluster) identify the percentage of OOS that lasted for that particular period, while the blue bars (right bar of each cluster) identify the cumulative OOS.

Figure 7: Duration of 1084 OOS Events



Credit: Standard Analytics

Figure 8: Cumulative OOS Duration from Figure 7



Credit: Standard Analytics

For example, about 6 percent of OOS last three days, while 10 percent last three days or less, and about 25 percent last four-to-six days, while 35 percent last six days or less. There is a marked impact from OOS episodes with duration of one week or longer. This data indicates the opportunity available to this retailer for these 100 items: if store operations could simply identify and correct all OOS occurrences lasting seven days or more, then this would reduce overall OOS rate by more than 60 percent.

Differences in the duration patterns between the two retail formats suggest that the root causes and thus the best solutions will be different for each format. As the overall theme of this report suggests, the key is to be able to get good measurements of the OOS attributes, link these measurements to the likely root causes, and then address the root causes with focused resources.

C. Measuring OOS Using Perpetual Inventory (PI) Data

The third method for measuring OOS is using PI data. PI systems track sales, and when sales = 0, the item is OOS. While retail formats with faster moving items will benefit for POS estimation methods, lower volume store formats with a preponderance of slower moving items, may benefit by measuring OOS using PI data. The major limitation with this method that is described in Chapter 3-3 is that PI accuracy is generally below 50 percent. Thus a manual process for checking PI accuracy and potential OOS items that are not indicated by the PI system must be implemented simultaneously. Also PI data usually applies only to store OOS and not shelf OOS, so it cannot directly indicate shelf availability.

2-2. FOCUS ON THE ITEMS THAT RESULT IN THE MAJORITY OF OOS: THERE REALLY AREN'T THAT MANY FAST MOVERS

New analyses of POS data provide us with a clearer picture of product movement across time. The conclusion: a relatively small number of items constitute the majority of the store's total sales.

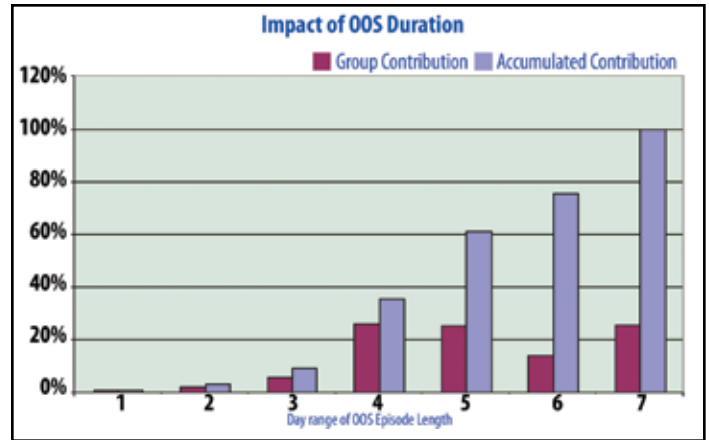
Our analysis of product movement shows that in a typical day, large volume U.S. grocery stores carrying more than 50,000 items (SKUs) will sell approximately 12,000 different items. This is pictured in Figure 10. On the busiest shopping day of the year, the store will sell about 16,000 unique items. In a single week, a store will sell about 27,000 unique items.

Looking at the chart from another perspective, even on its peak day, only 5,000 items (about 10 percent of the total SKUs carried by the store) accounted for over 70 percent of the store's sales. For a typical week, the classic 80-20 rule applies: 20 percent of the store's items (about 10,000), account for 80 percent of the store's sales).

This same pattern is even more pronounced for stores with lower overall sales volume (Figure 11). In this case, only 5,000 unique items are purchased in a single day, and on the peak day, about 7,500 unique items sell. In a week, 15,000 unique items are purchased, and 7,500 items constitute 80 percent of the store's sales.

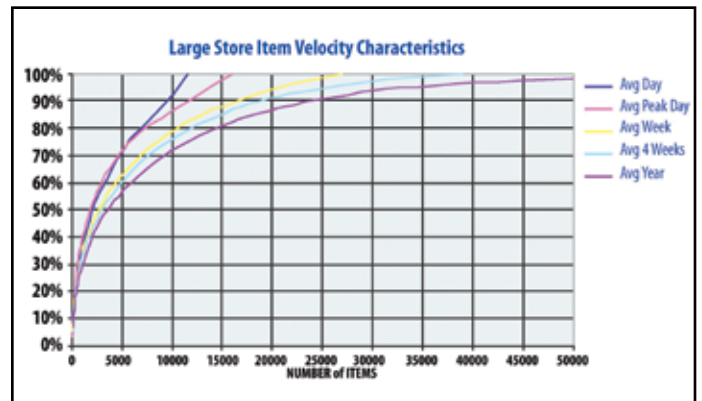
This general pattern shown here has long been recognized by stores, but this new data analysis clearly demonstrates the extent to which a relatively small number of items influence the overall store sales.

Figure 9 – Another View of OOS Duration



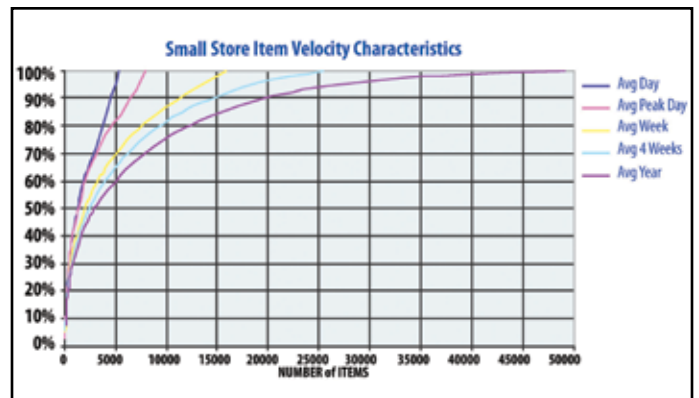
Credit: T3Ci

Figure 10



Credit: Standard Analytics, 2006

Figure 11



Credit: Standard Analytics, 2006

Previous research has shown that OOS rates correlate strongly with item sales velocity. Thus, the faster moving items (including promoted items) constitute a disproportionate share of OOS volume sales loss. Therefore, for the highest impact, the focus for reducing OOS needs to be on the SKUs that make up 70-80 percent of the store's sales.

The relationship of product movement to lost sales

Since a relatively small number of items account for most of the store's sales, the next question involves the linkage between the sales velocity and the number of lost sales. To answer this question, we analyzed the movement of items in a single store. We selected all the packaged items that had appeared in a minimum of 180 baskets in the year, and that had scanned in at least 12 different weeks of the year. This was 11,407 items of the nearly 70,000 unique items that had scanned at least once during the course of the year. We separated the items into three groups. The first group was the constant high demand items, packaged items appearing in at least 70 baskets per week in at least 12 weeks of the year analyzed. The second group was the temporary high demand items, packaged items scanning in at least 12 weeks of the year analyzed, and with a lift of at least four-times above their average weekly velocities in a given week. This group is mostly promoted items. The third group was all other items meeting the minimum inclusion criteria, but not moving fast enough to be included in the high demand groups.

Figure 12 shows that there is a clear linkage between product movement and lost sales. While the combined high

demand groups account for only 3 percent (363) of the items, they account for 17 percent of the total lost sales (\$50,094). Additional detail of the analysis and charts that show the relationship between sales velocity and lost sales are provided in Appendix 1.

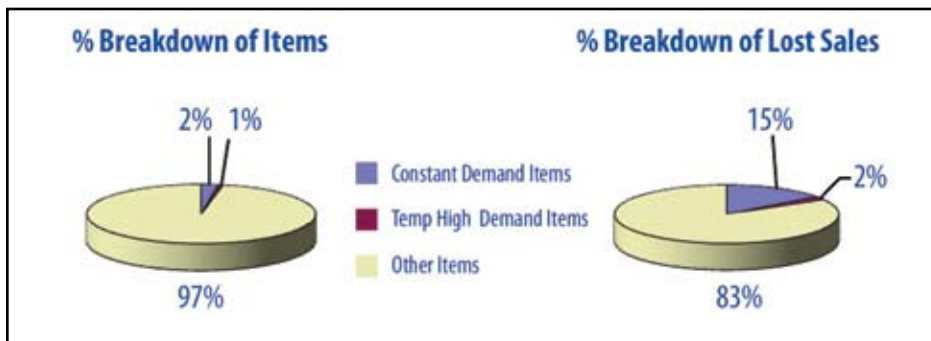
Why is this understanding of product movement important to the study of out-of-stocks?

The relationship between product movement and lost sales can have implications on forecasting, inventory (ordering and keeping backstock of fast moving items), and merchandising (allocation of shelf space to faster moving items). Moreover, this has specific implications for suggested solutions to OOS once the fast moving items have been identified. Strategies and solutions for reducing OOS levels for the fast-moving items should be different than the strategies and solutions for slow moving items. Sales rates of the identified fast moving items need to be matched with ordering and delivery cycles. For example, this analysis would indicate that a single weekly delivery should be adequate to keep the vast majority of SKUs available on the shelf (without the need for safety stock), while there is a small number of items that need more frequent deliveries (or significant safety stock).

Another implication of this analysis is that a retailer can not be ignorant of which SKUs are the most important. Several retailers we studied understood this to some degree, and they have instituted "never out" lists, or some sort of special identification on shelf tags. However, the solution is to understand the SKUs that are selling and accounting for most of the sales, and as a result for most of the lost sales.

One example might be a "SKUs never out" strategy employing the peak demand multiple identified in Chapter 3. Once these are addressed, the majority of lost sales from OOS items have also been addressed. A secondary strategy for addressing the OOS of slower moving items can then be implemented after the primary strategy for lowering OOS from the fast movers have been in place.

Figure 12: Number of Fast-Moving Items and the Corresponding Lost Sales



Credit: Standard Analytics, 2007

2-3. VIEWING OOS PATTERNS

Beyond Measurement to Finding Patterns

Our previous research showed that OOS tend to form patterns such as day of week (for example see our 2002 study, p. 14). These patterns can be identified through traditional shelf audit methods of measuring OOS. The research we have conducted for this study using POS measurement methodology has confirmed these same patterns day of week as well as time of day, and provides pictures of these patterns in distinct detail (see the appendix for examples of this measurement).

Using these simple patterns, managers can fashion strategies to address these known OOS patterns. For example, knowing that OOS will increase on Saturday and Sunday, stocking labor can be reallocated to increase frequency of stocking during these periods. Similarly, additional back-stock can be maintained to cover lack of weekend deliveries to the store.

Given recent progress in estimating OOS from POS data, it is possible to take the measurement to additional level of detail, and find additional patterns in the data using the attributes of OOS of frequency and duration. By plotting the duration of each OOS event on a weekly calendar (as shown in Figure 13), one can obtain a visual representation of the OOS pattern. This approach provides a new and effective way to address OOS by identifying behavioral patterns that may OOS tend to form.

Identification of OOS and Linkage to Root Causes

Analysis of OOS using this weekly calendar as a template has shown that there are some general patterns that OOS tend to form. Each pattern suggests a likely root cause (or causes), and thus the identification of the OOS pattern points to a likely fix (or fixes). Four of these patterns are featured below.

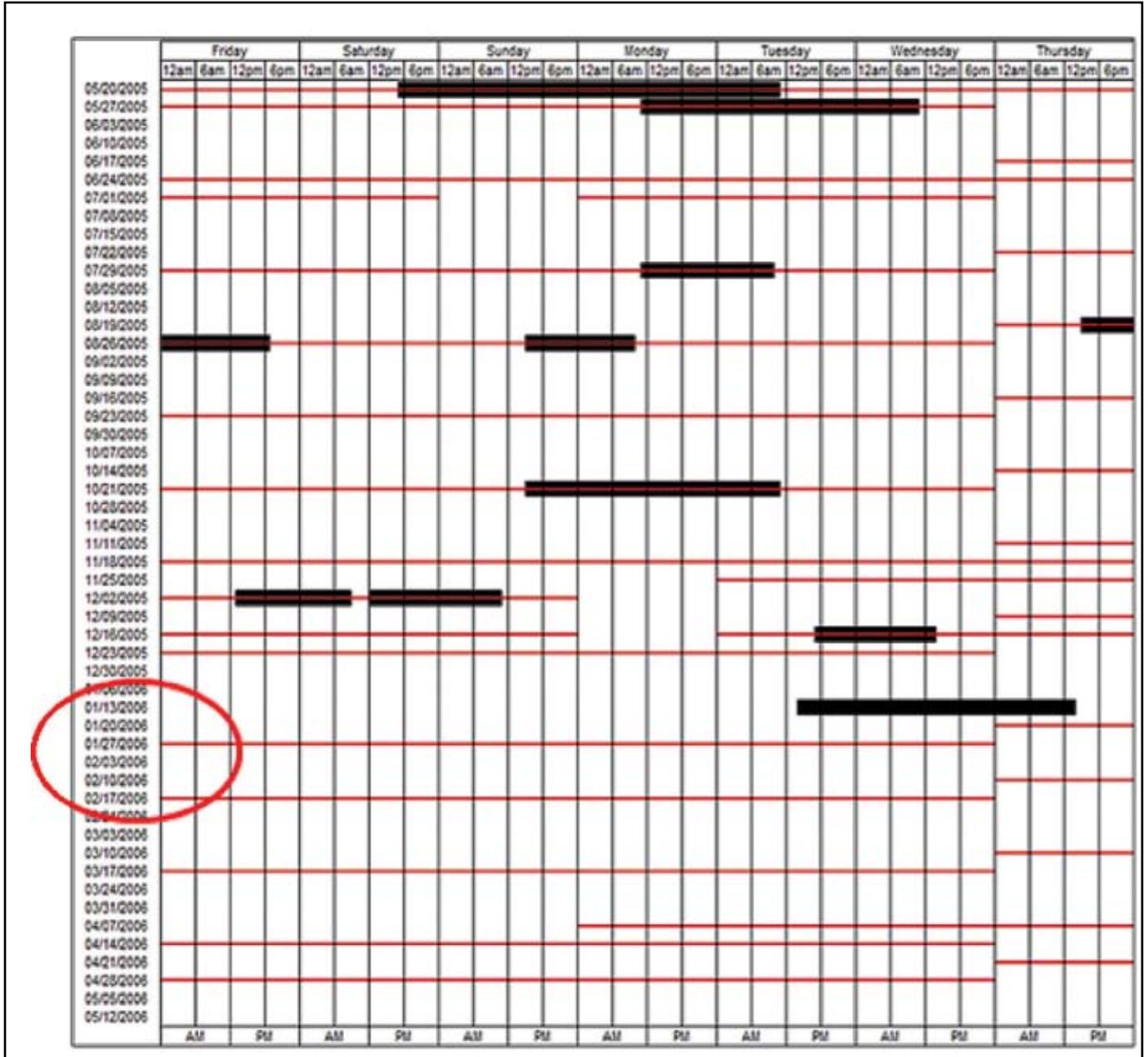
Utilizing patterns to address OOS:

The general theme of this report is that sound measurement of OOS needs to point to root causes, where resources can then be directly applied as a solution. As the examples in this section show, identifying patterns of OOS items provides an intuitive way to link solutions with OOS items. This approach is clearly a breakthrough in the identification and solution to OOS.

Pattern 1: Promotional Velocity Underestimated (Figure 13)

The first pattern shows annual sales by week of a fresh packaged good that is promoted (price) about one time every month. Promotional periods are indicated by the thin (red) horizontal lines, and periods where the item is OOS are indicated by the thick (black) horizontal line. Over the past year, the item has only experienced OOS during promotional periods, and then normally for one or two days in duration. Through understanding the specific OOS events during the promotional periods, the retailer adjusted order sizes, and after January, the OOS events ceased.

Figure 13: Promotional Velocity Underestimated

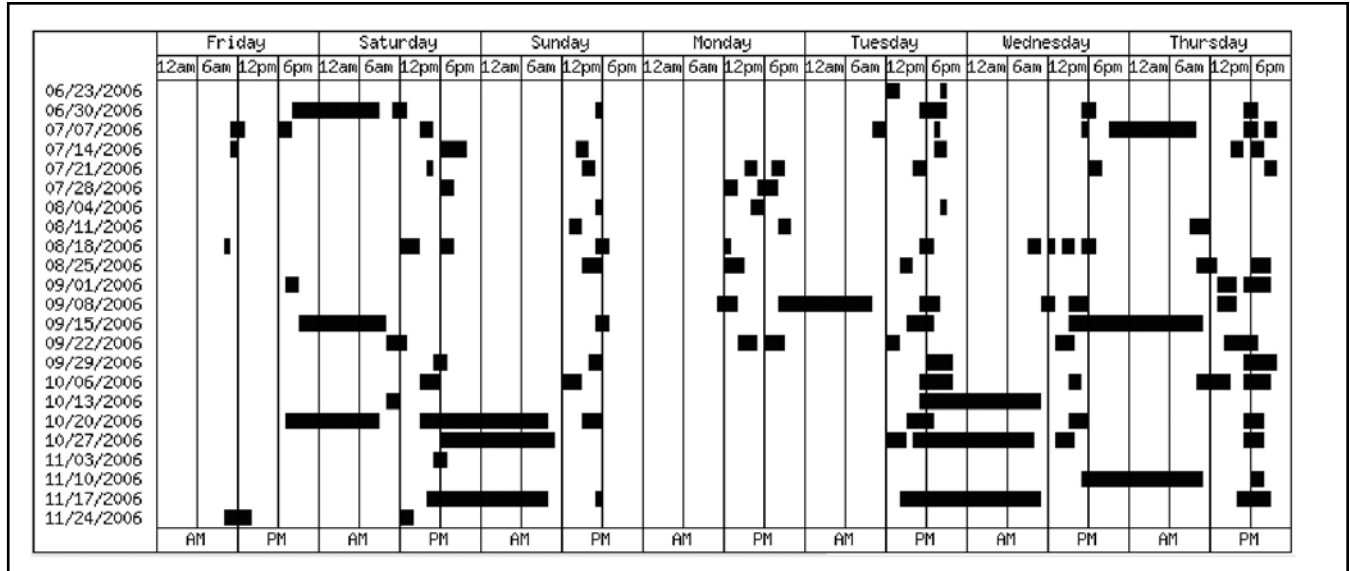


Credit: Standard Analytics

Pattern 2: Inadequate Shelf Restocking Frequency (Figure 14)

This pattern shows a series of short OOS occurrences that can occur any day of the week. This pattern shows that the item is in the store, but not always on the shelf. To address this OOS pattern, the store needs to add shelf space and check the stock more frequently and restock the item more frequently.

Figure 14: Inadequate Shelf Restocking Frequency

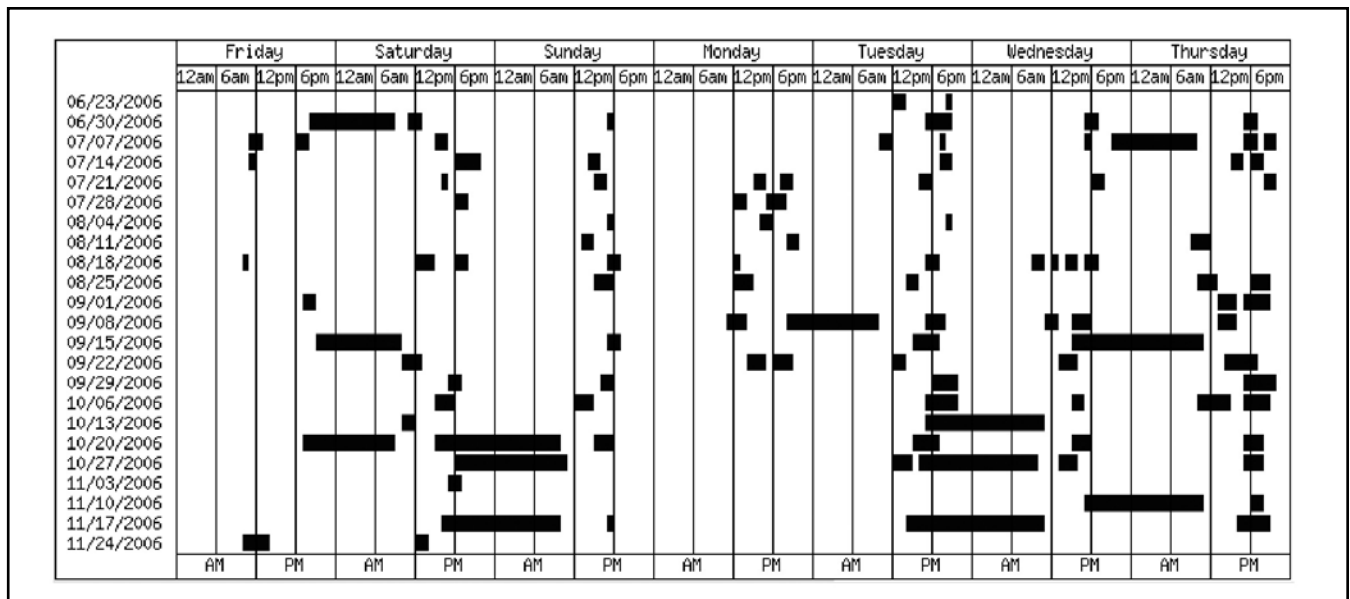


Credit: Standard Analytics

Pattern 3: Inadequate Replenishment Schedule (Figure 15)

The pattern here shows that the period of OOS occurs nearly the same week after week. In this case it looks like there are two deliveries a week, but four deliveries are needed. As an alternative, the store could increase the safety-stock of this item.

Figure 15: Inadequate Replenishment Schedule

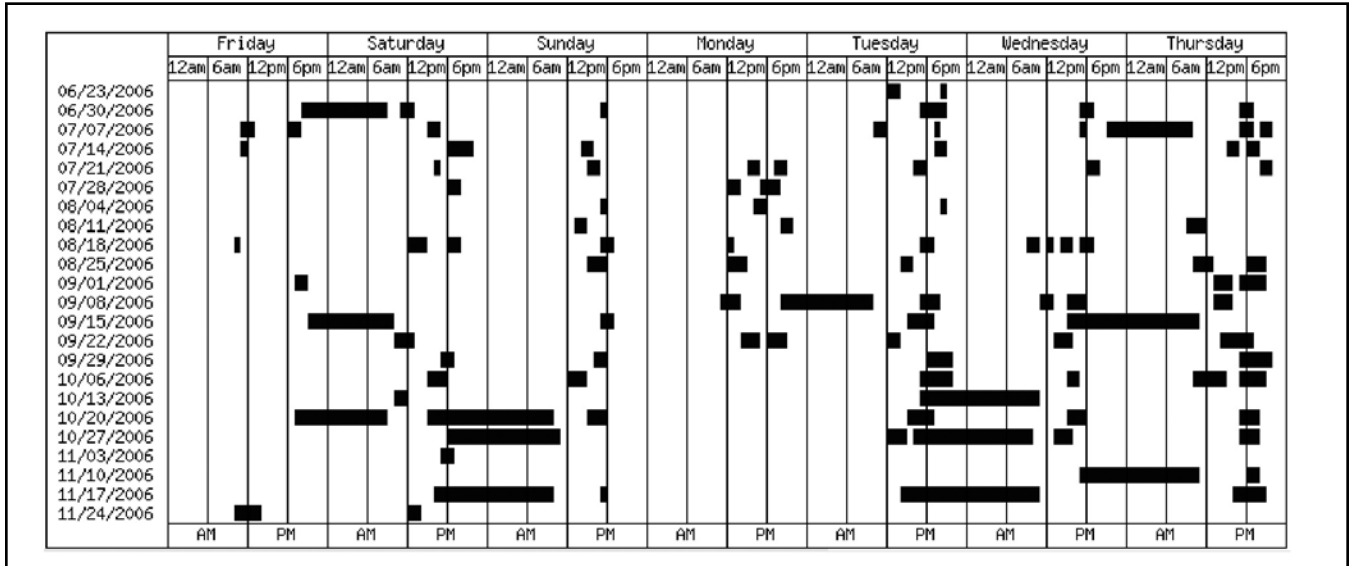


Credit: Standard Analytics

Pattern 4: Inadequate Shelf Stock for Daily Demand (Figure 16)

Here the item is OOS almost every day, indicating that inadequate space on the shelf has been allocated to this fast-mover. The solution is to substantially increase the stock on the shelf as well as checking the item multiple times during the day.

Figure 16: Inadequate Shelf-Stock/Shelf Space for Daily Demand



Credit: Standard Analytics

Lowering OOS Rates: Our Hypothesis and the Related Studies

3

OVERVIEW

In our research, we focused on seven general areas that are outlined below. For each of these we developed multiple hypotheses regarding their impact on levels of retail OOS. Our previous research suggested that each would have an effect, and in this study, we sought to find the degree each had an impact, and in what situations each would play a greater or lesser role.

In this chapter we present the findings of our proprietary studies, others' studies and additional evidence, and it is organized in the following seven sections:

3-1. PRODUCT ITEM DATA ACCURACY

Evidence from GCI studies and Data Synchronization

3-2. DEMAND FORECASTING ACCURACY

The self-fulfilling prophecy
Accounting for last sales in forecasts

3-3. ORDERING AND INVENTORY ACCURACY

The impact of accuracy of perpetual inventory
Other studies' evidence of the impact of perpetual inventory accuracy
Best practice for addressing PI accuracy

3-4. REPLENISHMENT

Frequency
In-store processes

3-5. MERCHANDISING: SHELF-SPACE ALLOCATION

Demand-based allocation vs. Case-Pack allocation
Theory

3-6. MERCHANDISING: PLANOGRAM COMPLIANCE

Theory-Hypothesis
Measuring POG compliance—best practice
Findings from study of four categories

3-7. MERCHANDISING AND SHELF MANAGEMENT

Item Management
Findings from study

3-1. ORDERING WHAT YOU NEED WHEN YOU NEED IT: THE CASE FOR ITEM DATA ACCURACY

In this section we examine the degree to which the actual items tracked in the inventory and ordering information database of the retailer matches the items that are actually for sale in the store. (Note that section 3-2 examines the degree to which levels of inventory of each item in the stores does not match the level of inventory in the store's database.) In general, one should expect that the level of OOS will be lower the more that the product item data in the retailer's database accurately matches the data of manufacturers' current SKUs.

A. Which Supplier and Retail Practices Lead to Item Data Inaccuracy?

Data inaccuracy in retailers' inventory databases comes from a variety of causes including:

- Merging previously independent databases; inaccuracy occurs due to mergers and acquisitions or due to the joining of previously separate data systems.
- Introducing new or discontinuing old products; new item information is not correctly recorded in or deleted from the database. Also, manufacturers regularly make minor changes in many of their items (e.g., down-counting, which is the manufacturer practice of removing a small portion of the product in the package, such as reducing a 100 tissue box to 95 tissues). Most of these changes are subtle with one very similar item replacing an existing item. Replacing the old with the new UPC/GTIN code for what is essentially the same product is sometimes forgotten.
- Managing seasonal or temporary products; manufacturers often introduce temporary product changes, such as bonus packs with a new UPC/GTIN code, and then revert back to the old UPC/GTIN. This can lead to data errors in the database.

B. What is the Effect of Improving Data Synchronization?

Small differences can have a large effect. Even a single digit that is incorrect in a product code or description can cause a mismatch that will lead to not making an order a necessary product, or making an order for an item that does

not exist. These errors are costly to track and fix because they incur substantial labor costs which would often justify investment in a solution.

Third-party vendors have evolved to facilitate collaboration between retailers and manufacturers. They function as a clearinghouse for the data, matching retail databases with product lists provided by the manufacturers. This collaborative effort between supply chain partners has been facilitated by the industry group, the Global Commerce Initiative (GCI).

The effects of data alignment on lowering OOS can be substantial as the following two pilot studies reported by Capgemini/GCI 2005 show:

- Johnson & Johnson and Wal-Mart have eliminated all OOS of J&J products that were caused by data integrity. This represents a 2.5 percent reduction in OOS.
- In Latin America (Mexico, Guatemala, and Columbia), The Procter & Gamble Company and several retail customers reduced purchase order errors from 3.6 percent to 0.8 percent, and this resulted in a decrease in OOS items from 8 percent to 3 percent.

C. Using Parent-Child Relationships to Eliminate Data Synch Errors

One method of eliminating data synch errors is to establish parent-child relationships. SKU's that are temporarily replaced by a package with a different UPC may be tied together using the retailer's item code. If a retailer has an item code that is six digits long, the first five might be the base number with the last digit a zero for the base SKU and different numbers to indicate a temporary pack. So, for example, if a Crest Toothpaste has an item code of 21342-0, that code would be the base item. The same Crest Toothpaste as a bonus pack of 25 percent free product might then have an item code of 21342-1 and a second bonus pack with a trial size Scope attached might be 21342-2.

Using this system all the sales for the SKU can be captured and aggregated into a single SKU code number. This system would not work for down-counting where an item permanently changes from a 100-count box to a 95-count box.

D. Conclusion

Industry initiatives that address data accuracy through data synchronization show that the industry can address OOS through a coordinated collaborative effort. Manufacturers and retailers need to participate in this initiative to achieve the benefits.

UPC TO GTIN

January, 2005 was the industry "sunrise" date for manufacturers and retailers to be "GTIN Compliant" meaning that products should carry GTINs and store scanner systems were required to be able to read 14-digit GTINs (Global Trade Identification Number). Previously they were only required to be able to read 12-digit UPC codes. The purpose was to create a unifying bar code identification number readable in all areas of the world. Many different standards exist in different countries of the world, and the GTIN was designed to be technically inclusive of all the standards. Thus, where the USA had a 12-digit UPC and Europe had a 13-digit EAN (European Article Number), both could be included in a GTIN. The newer standard allows manufacturers to sell items around the world without maintaining separate inventory with each of the regional identifiers, thus simplifying trading dramatically.

RFID VERSUS EPC

RFID is the broad term for the technology where a reader identifies (reads) tags as they pass in close proximity to the reader. The most public display of the technology is at the exit of stores where they are used for theft deterrence and if a powered tag passes through the portal an alarm goes off. Tags can be passive (i.e., the tag has no power and only responds when the radio signal hits it) or active (i.e., the tag can send a signal on its own).

EPC is the set of standards established by GSI and its subsidiary EPCglobal for multi-industry use. The format of the tags and the fields of information they carry are all standardized under EPCglobal governance so that all tags will contain the same data in the same format. The parallel would be where UPC is a standards-based format of a bar code used for the FMCG business (and others). There are other formats of RFID tags, just as there are other formats of bar codes in other industries.

An EPC tag is a unique identifier for the individual item the tag resides on. Thus, each package of Pampers can be uniquely identified as opposed to a UPC code where all packages of the same SKU have the same UPC, and the packages appear all the same to the UPC reader.

3-2. ORDERING WHAT YOU NEED WHEN YOU NEED IT: THE CASE FOR INVENTORY ACCURACY

In this section we examine the degree to which levels of inventory of each item in the store match (or do not match) the level of inventory in the store’s perpetual inventory (PI) system. (Note that section 3-1 examined the degree to which the actual items tracked in the inventory and ordering information database of the retailer matches the items that are actually for sale in the store.) In general, one should expect that the level of OOS will be lower when the actual level of inventory of each item in the store accurately matches the level of inventory of each item in the PI system.

A. How accurate is inventory information?

Inventory record inaccuracy is a substantial problem for retailers using automated inventory management systems. Overall we found in our research that inventory records match actual inventory on-hand at a surprisingly low rate. In spite of large investments by retailers in perpetual inventory (PI) systems that link to POS systems, physical audits consistently show that PI data are typically accurate for less than half of the items in the store.

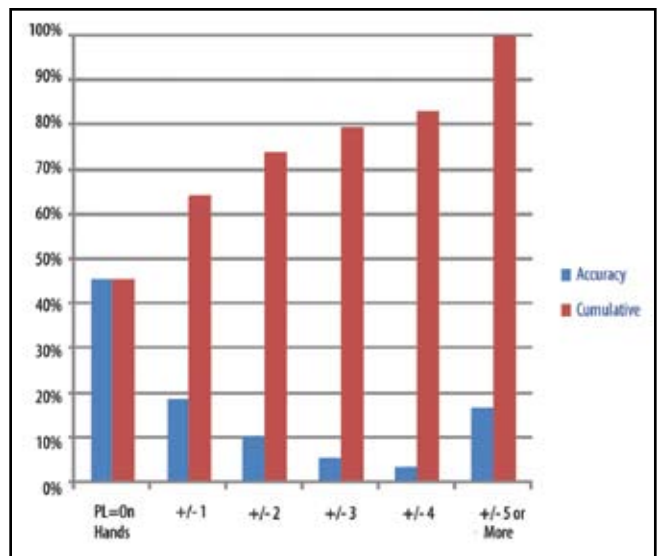
Accuracy can work two ways, with the actual on-hand inventory exceeding the recorded inventory level, or the actual on-hand inventory lower than the recorded inventory level. The physical audits show that about half of the time the PI shows more inventory to be in the store than is actually on-hand (referred to as “phantom” inventory), and that about half of the time the PI shows less inventory to be in the store than is actually on-hand (referred to as “hidden” inventory). Thus inventory accuracy is typically recorded as +- 1, +-2, +-3, and so on, reflecting the presence of both phantom and hidden inventory. There are several sources for inventory inaccuracy. Some of these include:

- Improper scanning of items at checkout. Improper scanning of a single item results in a double error in PI, with one item too low and another item too high.
- Unknown (e.g., theft) or unrecorded (damaged merchandise that wasn’t recorded) shrinkage
- Store stocker ability to make changes to “on-hands” in the PI system
- Incorrect audits and adjustments
- Product lost in the backroom
- Mislabeling of cases at the DC
- Improper handling of master data for promoted and alternate products

The example shown in Figure 17 shows the results of a physical audit of 166 items (sampled from a total of 25,000 items per store) in 121 stores (sampled from a total of 3,000

stores in the chain) of a major U.S. retailer. Of the total audit of more than 20,000 items, PI was accurate only 45.4 percent of the time, while 18.8 percent of the time it was +-1 unit, 10 percent +-2 units, and 25.8 percent it was off by 3 or more units. These findings are in line with published research from a group of academics from University of Chicago and the Harvard Business School. They examined nearly 370,000 inventory records of a large retail chain and found that only 35 percent of all inventory records equalled on-hand inventory (Raman, de Horatius and Ton 2001).

Figure 17: Audited PI Accuracy of Major US Retail Chain



B. What is the effect of PI Accuracy on OOS?

The Effect of Phantom Inventory

As we expected, the effect of phantom inventory on OOS was found to be substantial. In this study, when the PI matched the actual inventory, OOS levels were 4.1 percent. However, for the remaining items where the PI did not match the actual on-hand inventory, OOS levels were 8.9 percent. Thus OOS levels were about 2.2 times greater when PI did not match the on-hand inventory.

It is important to note that the measurement of OOS in this example is the physical absence of inventory on the shelf, and not necessarily reflective of the lost sales. For the retailer in this study, the vast majority of items are slow movers, where the average non-promoted sales rate is 0.3 units per week. Thus including a factor for promoted items and considering typical ordering and delivery cycles, the estimated lost sales at a 4.1 percent OOS level is more likely to be about 2.1-2.2 percent, not accounting for substitution.

Does this mean that lower volume outlets with slower moving items have less at stake than higher volume outlets with a higher number of faster moving items? It depends on the degree to which the PI does not match the actual on-hands, the capacity of units on the shelf, the reorder point set for the item, order and delivery cycle, and the rate of sales.

Consider, as an example, a slow moving item that sells once every two weeks (weekly sales rate = 0.5 units), the order and delivery cycle is once a week, the normal shelf capacity is two units, and the reorder point is one unit. The item can be reordered in single units. Such items can be reordered in single units with specialty retailers. If the on-hand inventory = 1 unit, and the PI shows 3 units available, when the one available unit sells, it will be OOS and the PI will show 2 units available. Thus the product will not be reordered by the ordering system, and could be out of stock for several weeks. This situation will continue indefinitely until a physical check of the shelf shows the item to be OOS. Thus correction and reordering of the item will depend on a physical process, triggered as a regular shelf check, or by a customer who asks for the item.

Alternatively, consider an example, *a faster moving item* that sells 1 unit a day (six -- seven units per week), has an order and delivery cycle two times a week, shelf capacity of 18 units, the reorder point is 6 units, and is ordered in a case of 12 units. (Note: this is typical of a 1.5 casepack shelf inventory system used by many grocery stores.) If the on-hand inventory is six units and the PI shows 10 units available, when four units are sold, the PI shows six units which triggers an order for additional case (12 units). The actual on-hand inventory is still two units, which would mean that with the bi-weekly delivery, that at most the item will be OOS one day. In this situation, an order would not be triggered only when the PI inaccuracy is greater than the minimum reorder point, in this case six units. Thus for this item, PI inaccuracy of one or two items is of less concern than for slower moving items.

The Effect of Hidden Inventory

The effect of hidden inventory on OOS is not as damaging as phantom inventory and is indirect. In this case, the PI system will trigger orders for additional product when there is adequate supply in the store. Thus it is unlikely that the store will run out of the item. However, the presence of unneeded inventory in the store not only includes the cost of the inventory, more importantly it requires extra labor costs to bring product to the shelf (which will often not have the physical space for the additional inventory), and then return it to the back room (plus related costs of storing and tracking inventory and additional shrink). Regardless, given that hidden inventory carries substantial costs, it increases the justification for additional investment in PI accuracy.

C. Conclusion: the Effect of Inventory Accuracy on the Level of OOS is Substantial

Our research shows a very strong effect of PI accuracy on OOS levels (this is consistent with other studies examining this effect, e.g., ECR-Europe 2003). The data we received from multiple retailers show that overall PI accuracy is surprisingly low, and thus there is a very large opportunity to lower OOS by improving the degree to which PI aligns with on-hand inventory. The cost of PI inaccuracy is huge, whether it takes the form of phantom inventory or hidden inventory. These costs should justify substantial investments in improved PI systems and enhanced retail store processes that keep PI records accurate.

Lower volume retail formats with a preponderance of slower moving items will particularly benefit from improved PI accuracy, as OOS events of slower moving items can go unnoticed longer than OOS events of faster moving items. Additionally, slower moving items cannot benefit from the signals from POS generated OOS recognition that focuses on faster moving items.

D. Best Practice Recommendation to Increase Inventory Accuracy

Improvements PI accuracy do not necessarily require substantial monetary investment. Moreover, as in the situation we describe below, by better understanding PI accuracy, this retailer actually lowered their labor costs associated with checking on OOS items while increasing their PI accuracy. The steps used to increase PI accuracy included:

1. Establish current level of PI accuracy (for most firms this will be less than 50 percent).
2. Determine causes of PI discrepancies with on-hand inventory. For example, this retailer found the single biggest driver of PI discrepancies was for products in multiple locations (e.g., end-caps, in multiple planograms, at cashier, etc.)
3. Examine the store processes used to count inventory, and determine how effectively they address the leading cause(s) of PI discrepancy. For example, this retailer used manual cycle counts where more than 500 items were checked weekly, but for 50 percent of these items, there was no change to the information that was already in the system. Moreover, the scanner "gun" did not identify multi-location items, which had been identified as the major cause of PI discrepancy.
4. Implement a new process to check most likely PI discrepancies. The retailer implemented a new process for store audits that included both what to check and what not to check. The items to be checked were those that showed in the PI system that inventory was 0 or negative, items where the PI was unusually high, any

empty holes on the shelf seen by the store associate when walking the store, known problem items (such as high shrink items), items at the end of a promotional period, and the “red dot” never-out items. Items that should not be counted included new planograms, new items, and items where there are one or more physically on hand.

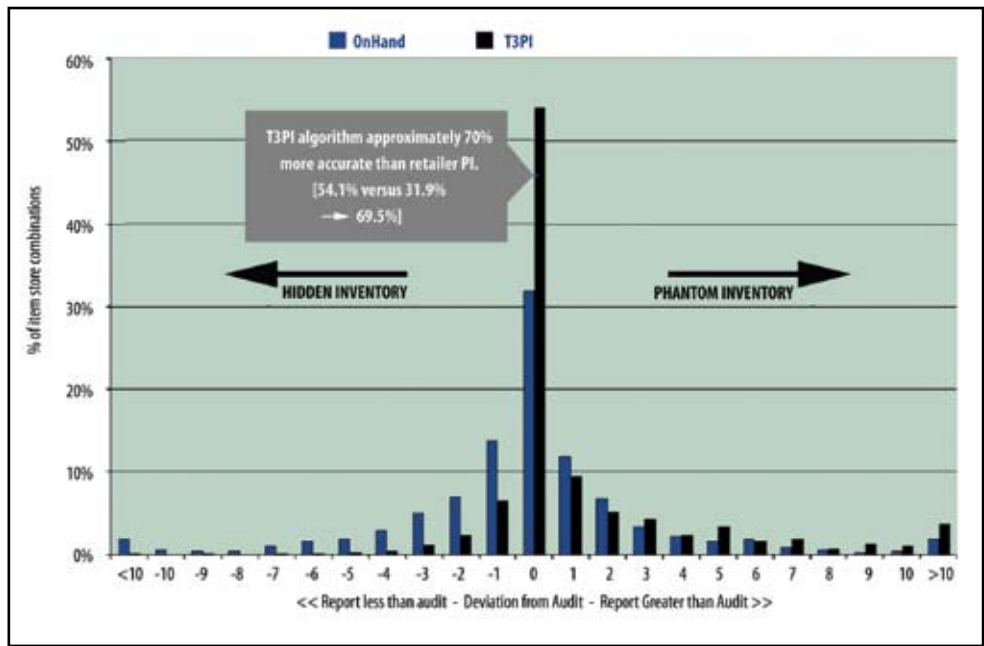
the inaccuracy is random in nature. They use a (Bayesian) probability distribution to estimate the “true” level of inventory on the shelves (DeHoratius et al. 2007). They created replenishment policies based on the statistically updated inventory records to avoid the problem of “freezing,” where a physical inventory position persists at zero while the corresponding record is positive. In addition, they show

The results of the retailer’s approach to increasing PI accuracy were impressive. In a five-month test in 20 stores, overall PI accuracy increased from 45 percent to 53 percent, and cumulative accuracy within 1 item (where PI is accurate or +- 1) improved from 64 percent to 74 percent. At the same time, by implementing the counting process that directly addressed the items with the greatest likelihood of PI discrepancy, they lowered the number of total cycle counts by 20 percent.

E. Other approaches to addressing PI accuracy

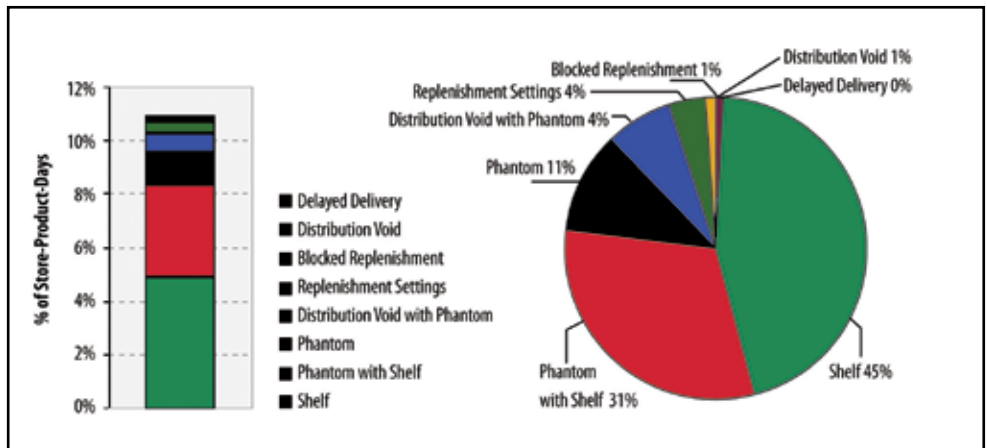
We strongly recommend correcting the inventory records through process improvement or physical auditing. However, similar to the way that mathematical algorithms are being developed to identify OOS from historic POS data, new methods and techniques are being developed to enhance PI accuracy using POS and inventory data. The researchers from University of Chicago mentioned above, for instance, recently developed an intelligent inventory management model that accounts for inventory inaccuracy, based on their findings that such a large percentage of the inventory records are wrong, but that

Figure 18: PI Accuracy of 100 items across 24 Stores



Credit: T3Ci

Figure 19: Root Causes for OOS across 100 stores, 500 products for 6 months



Credit: T3Ci

that their replenishment policies recoup much of the cost of inventory record inaccuracy, and that their audit policies significantly outperform the popular “zero-balance walk” audit policy.

Commercial providers have developed a similar approach. In Figure 18 shown below, the retailer’s PI accuracy was about 32 percent, where the algorithm’s estimation of PI was accurate in 54 percent of the cases. This approach to improving PI accuracy will be helpful particularly to larger format retailers with many fast-moving and frequently replenished items.

This approach first computes a corrected store inventory before estimating OOS levels. This permits subsequent algorithmic processing that distinguishes Store OOS from Shelf OOS. An internal model of the retailer’s replenishment algorithms permits further breakout of root causes. Figure 19 shows the results of this approach, and this reiterates our general theme that measurement needs to point to root causes that can then direct resources to solving the OOS.

3-3. DEMAND FORECASTING ACCURACY

Our previous research established that 47 percent of OOS events were caused by store forecasting. As this is the biggest chunk of root causes, we invested a lot of thought into better understanding this problem. Overall, the goal here is to understand the degree that greater the forecasting accuracy drives lower levels of OOS.

A. OOS Create a Self-Fulfilling Prophecy in Demand Forecasting

For most products, predicting sales using sales history is difficult. Estimating demand accurately is even more complicated as the only reasonably accurate data that a retailer has at its disposition is point of sales store data. However, we know that previous sales do not equal the actual demand, if lost sales have occurred. In this case demand equals sales plus lost sales.

Unfortunately, in grocery, lost sales are unobserved because most customers, who do not find the product that they intended to buy, make a decision to not buy, buy elsewhere, or substitute, without registering the non-purchase of the intended item with the store. Even when asked at the store exit whether they found what they were looking for, many customers will not be able to recall whether they found everything that they were looking for unless they had it written on a shopping list because the impulse to buy a product may have arisen in the shop but then immediately been suppressed by its unavailability. On the contrary, for instance in internet retailing, lost sales are observed as the system can monitor whether a customer clicked on a product and then did not buy it because it was not available.

USING RFID TECHNOLOGY TO ENHANCE PI ACCURACY

RFID technology can be used to support PI accuracy by addressing a number of root causes. Case level tagging can reduce or eliminate mislabeling and mispicking cases at the retailer’s DC. Corresponding automated checking when the cases (and tagged inner packs) are unloaded at the store can further improve the accuracy of flow data into the store. An important goal for RFID technology in the retail supply chain is to get a more accurate picture of backroom inventory versus sales floor (shelf) inventory. Product movement from the backroom to the shelf is monitored by RFID readers. However, at the tagged case and inner pack level interpreting this movement data is complex because partially empty cases may be returned to the backroom and this cannot be sensed by RFID alone. One approach is to instrument the compactor used for empty boxes in the backroom – a read of a case id at the compactor indicates that all its contents must have reached the sales floor.

The use of hand-held readers and multi-antenna readers that are able to scan the entire backroom can bring a more accurate and close to real time view of backroom inventory. Continuous or periodic electronic inventory counts are likely to be substantially more accurate than transactional approaches where even modest errors in RFID scanning of additions and removals will quickly accumulate.

Item-level tagging, which is starting to be used on high value items and time sensitive products such as video games and DVDs, brings clear inventory accuracy improvements. With the appropriate instrumentation there can be electronic reading, not only of the precise inventory on a “smart” shelf, but also verification that the product is in the right place for a customer to find it. Item level tagging would also improve POS checkout accuracy – however this is unlikely to be widely deployed until it is economic to tag most items in a store. In the apparel and other specialized retail environments item level tagging may already be economic because of the higher unit prices and the substantial labor savings in automated inventory counting.

Credit: T3Ci

Therefore, the inherent problem of estimating demand with unobserved sales is that all models are imperfect because as true demand is unknown it is difficult to validate how close to demand the proposed model has come. Nevertheless, researchers have attempted to estimate demand with unobserved sales. All models conclude that lost sales

can be substantial and that it is strongly influenced by average demand and demand uncertainty. We are hopeful that the next generation of models will have solved this dilemma by using longitudinal data which is currently hard to find because of the cost associated with creating such a dataset.

B. New Forecasting Models Must Attempt to Account for Lost Sales

From a more practical point of view, many software companies have developed forecasting models. However, most of them are fraught with conceptual problems. Some, for instance, do not include estimations of lost sales and simply forecast future demand on the basis of historical sales. Others develop forecasts at aggregated levels, for instance, on the distribution centre level or for product groups, which invariably leads to inaccurate forecasts for specific products at specific stores.

Progress in mathematics, statistics and computing power now allow daily, real-time forecasting for on the item and store level. This has enabled a surge in computer automated ordering systems (CAO). A leading drugstore in Europe that has implemented sophisticated, causal CAO systems claims that it has been able to reduce out of stocks and store inventory substantially. Our own research with a major European retailer supports these findings. In a field experiment in 10 stores manually measuring the OOS rates for 100 SKU over a period of 2 weeks we found the overall order related OOS rate to be 4.7 percent. However, upon closer examination we found that for those categories where products were manually ordered the OOS was 11.7 percent. In contrast the OOS rate in the categories that used an automatic ordering and replenishment system with simple heuristics was only 3.1 percent, a reduction of OOS of more than 70 percent. These findings resonate with the experience of the European drugstore that reports that the introduction of a new automatic ordering and replenishment system has lowered their OOS rate by 70-80 percent.

C. Research on the Effect of Store Manager Discretion in Ordering and Forecasting. Should Managers be Allowed to Adjust CAO Recommendations?

There has been a long debate whether store managers with their knowledge of local customer behaviour can do a better job in predicting demand than headquarter. Research in CAO seems to solve the dilemma how much discretion the store managers should be given in ordering and forecasting. Modern CAO system provides reasonably accurate proposals to the store managers who can then overrule the recommended order if they wish.

Interestingly, we encountered all types of retailers, from those who always overruled the proposals to those who never did. While all retailers had arguments for their specific policy, recent research by the Technical University of Eindhoven's Retail Operations Unit found that store managers overruled order proposals to balance the workload at the store by either shifting the order to another day or by consolidating the orders into larger case pack sizes. They conclude that the store manager's order adjustments provide valuable input into better calibrating the CAO system to store specific demand patterns and suggest that case pack sizes matter.

We also studied the ordering for advertising promoted products of a major drug chain in the U.S. In this case, a recommended order for the promoted items was provided to each manager who could then make ordering adjustments, either up or down. The recommended order program incorporated a range of expected demand variability into a statistical (Poisson) model, where along with other factors, it determined the level of safety stock for each store.

The study compared the managers who ordered more than the recommendation, less than the recommendation, and did not change the recommendation. The study found that overall managers tended to over-order relative to the actual realized demand of the promotion. Thus, managers spent time seeking to improve on the CAO recommendation while simultaneously increasing investment in unproductive inventory. The conclusion from this study is to rely on a good system rather than people. Collectively, several thousand managers make poorer decisions than the system.

D. Reaching the Ideal State: Sales Forecasting and Demand Forecasting Become the Same

One technology that should help improve demand forecasting (thus lead to ordering accuracy relative to demand) is the use of POS data. This assists ordering managers by showing the speed at which items move, and provides needed data to show changes in demand for an item relative to changes in price or other promotional activities.

However, the presence of OOS items clouds this picture. POS data only measures what customers actually purchase, but not what they intended to purchase if the item is in stock. OOS items distort the true demand in the following ways:

- When an item is OOS, it cannot be purchased, and thus the sales are truncated in the POS data, showing less than the true demand. This leads to subsequent under-forecasting of the item.
- For the 45 percent of the time that shoppers substitute another item for an OOS item, this switching behavior inflates the sales of the items that are in stock (beyond

their normal demand), while it attenuates the sales of the OOS item (below its normal demand). In either case, the POS data inaccurately reflects the true demand for both of these items.

- For the 15 percent of the time that shoppers delay their purchase until later, the intervals of purchase of the item shown in the POS data become biased. In this case, the presence of OOS items will create a situation where the actual sales rate is more “lumpy” than the true demand.

What then are the implications when lost sales are not considered when making forecasts?

- Sales forecasts are based on wrong parameters and are not set correctly (particularly for fast movers and promoted SKU), and this situation perpetuates lost sales.
- Category Management measures such as promotion and new product planning are based on wrong assumptions. A product may be delisted because of poor sales when it is simply often out of stock. Conversely, a product may be promoted because it exhibits sales which are inflated by substitution effects from stocked out SKUs.
- Inventory systems work with wrong mean and standard deviation and therefore ordering parameters (safety stock, lead time, supply frequency) are set incorrectly, particularly for fast movers and promoted SKUs).
- Shelf facings are not set correctly.
- Case pack sizes are not set correctly.
- This in turn can lead to further lost sales, loss of brand equity, inefficient supply chain and store routines and wrong allocation of store staff.

How do we address this problem?

Currently, no techniques exist to reliably and validly estimate demand under unobserved lost sales. However, new measurement techniques that estimate the lost sales during a period or OOS based on historic POS data do provide an important first step in approaching this problem. One can assume that the lost sales estimated by historic POS data is less than the true demand for the item, since the data that was used to estimate the lost sales already included an unknown number of lost sales. So the question becomes: how much should be added back into the forecast?

Our recommendation for the amount is provided in the solutions chapter, but the general approach is an iterative process where increased order sizes by a factor determined by the item’s sales velocity and volatility will reduce the amount of error in subsequent time periods. Getting it completely accurate cannot occur with current technology (after all, this is forecasting, not history), but we can remove a portion of the inaccuracy leading to more accurate forecasts that contain less noise from lost sales.

SILVER CLEANING-POLISH AND THANKSGIVING HOLIDAY SHOPPING: A REAL LIFE EXAMPLE

On the fourth Thursday of each November in the USA, nearly everyone universally celebrates Thanksgiving. Traditionally, families and friends gather at homes for the annual formal dinner. Grocery stores stock up on plenty of turkeys, sweet potatoes, stuffing mix, pumpkin pie ingredients, cranberry sauce and the host of other foods that compose the traditional dinner. Given that millions of homes serve a similar fare on a single day, surprisingly few of the staple items are OOS in the stores, even on Wednesday right before Thanksgiving Day.

Carol went shopping on Tuesday before Thanksgiving to get the final items she needed to serve her 20 guests. Since the silver serving dishes and utensils would grace the table, she had silver cleaning polish on her list. The store carried one SKU, as a convenience item, and on this day it was out-of-stock, since Thanksgiving also functions as an occasion for annual silver polishing. The silver needed to be polished; so on her way home, Carol stopped at the drug store, and found silver cleaning polish in stock.

Next year, Carol will probably need to buy silver polish again, and while she is at the grocery store she’ll probably check to see if it is in stock, and if not, she’ll stop by the drug store again and get it there. And across the USA, there are thousands of others, just like Carol, who will do the same thing. What the drug store hopes is that the grocery store doesn’t ever understand its true demand, because the grocery store has no idea how many units of silver cleaning polish it might sell. Given the lack of demand data, the grocery store will continue to under-order and run out. Meanwhile, the drug store will order enough to satisfy its regular demand plus the spillover from sales lost by the grocery store. If the grocery store could know its true demand and order accordingly next year, the drug store would be stuck with a lot of extra inventory. But by the time the grocery store figures this out, Carol will stop looking for it at the grocery store and just go to the drug store to buy it.

3-4. HAVING THE GOODS YOU NEED WHEN YOU NEED THEM

As we reported in our previous research, both store and shelf replenishment have been found to be among the biggest causes of out of stocks. OOS associated with store replenishment practices include late changes in promotion decision (after the order is placed), supplier policies that encourage retailers to wait to place an order, improper cycle/delivery times, as well as other upstream causes. In nearly 25

percent of the cases, inadequate shelf replenishment was the cause of out of stock—this is while the product is actually somewhere in the store. We found that the frequency with which shelves need to be replenished is a function of many factors, including average sales and sales uncertainty, case pack size, shelf facings and capacity, lead time and desired service level.

In this section we explore several replenishment-related factors that drive levels of OOS. These include delivery frequency and timeliness, delivery fill rate and accuracy, receiving accuracy, and backroom inventory levels. For the final factor, we recommend that best practice thinking considers a disciplined process where the retailer carries no back stock at all, and then makes allowances for certain items and times (promotions and seasonality) where some back stock may be required. Additional discussion of having adequate stock on the shelf to meet demand between delivery cycles is found in section 3-5.

A. Replenishment Breakdowns: to the Store and to the Shelf

A useful distinction can be made between “delivery to the store” in case of a sizeable back room and “delivery to the shelf” in case of a small or no back room storage, as well as between goods that are delivered from a central distribution centre (typical for most stores and categories in Europe) or that are delivered directly by the supplier (direct store delivery or DSD).

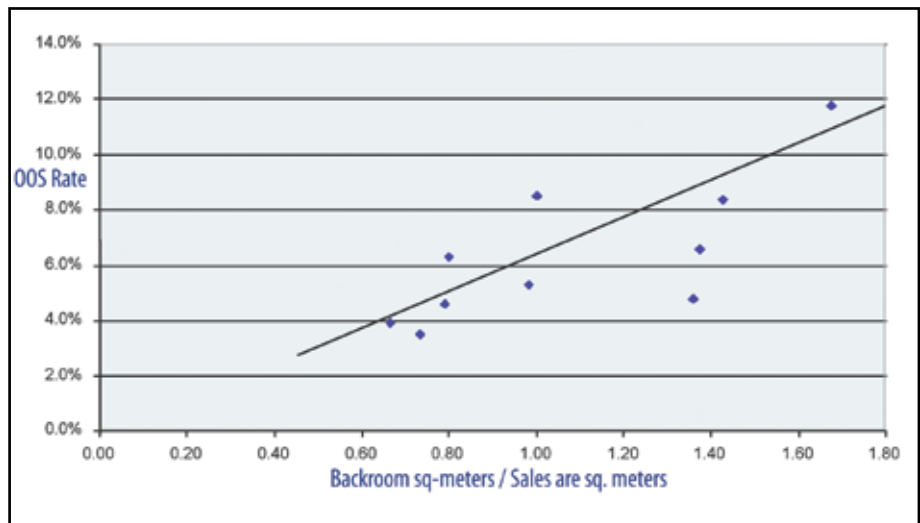
In stores without backroom storage, shelf replenishment is tightly coupled with store replenishment. When goods arrive, they are unloaded from the truck and immediately carted to the shelf.

Often this action is executed by dedicated staff who are available only for those few morning hours. During normal sales hours, if a shelf is completely depleted, it often goes unnoticed. And even if a depleted shelf is noticed, it cannot be replenished as there is no backroom storage available to replenish it.

In stores with backroom storage, typically larger stores, shelf replenishment is de-coupled from store replenishment. In new research with a major European retailer we correlated the OOS rate for 10 stores with the size of their backrooms. While the regression line in Figure 20 is derived from a small

sample and cannot be statistically projected to represent all retail stores, it suggests that perhaps paradoxically, the larger the backroom, the higher the level of out of stock. While this seems to run counter to traditional inventory theory, it can be explained by poor back room storage management. We have found very often that overflow goods were almost randomly assigned backroom storage locations and no central system tracked the movements of these goods. Typically, in larger stores, staff would spend a disproportionate amount of time searching for goods and often would not bother searching or would only replenish items that were easy to see and locate. Another clear sign of the lack of attention to the back room was that most store managers we asked could give us precise estimates of the sales area size but few could tell us the corresponding size of their backroom. The architecture drawings just gave one overall number for backroom including offices, bathrooms, changing rooms and storage rooms, and the actual backroom is not treated as an asset (as is the on-floor selling space).

Figure 20: The Relationship between Store Backroom Size and Store OOS Rate



Credit: Angerer 2006

B. Centralized Delivery vs. Direct Store Delivery

Regarding the distinction between centralized deliveries (DC) from retailer and direct store deliveries (DSD) from suppliers we found that the former was associated with lower out of stocks because store deliveries and subsequent shelf replenishment were coordinated. On the other hand, direct deliveries by the suppliers were typically un-coordinated with the shelf replenishment routines because the suppliers relied on external merchandiser or rack jobbers to replenish the shelves. Typically, the goods were put into backroom storage upon delivery where they waited for the supplier’s

merchandisers to appear. In a large U.S. retail chain, DSD posed the biggest single problem to reducing OOS not only because of the de-coupling of store and shelf replenishment, but more that the retailers found it hard to impose discipline upon the supplier's merchandisers to implement store policy.

C. Shelf Ready Packaging and Store Friendly Delivery

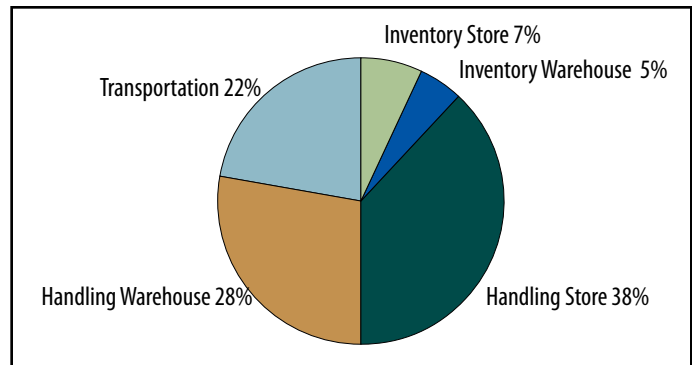
It does not come as a surprise that many retailers, particularly in Europe, have adapted their systems to couple replenishment processes and to introduce shelf-ready packaging as a new enabler of flow replenishment from the distribution center to the shelf.

Recent research by the TU/e Retail Operations Group across several retailers has found that the cost of handling product in the store accounts for 38 percent of the supply chain cost in retailing (Figure 21). Because of this high cost of store handling, retailers are increasingly interested in ways that ease shelf replenishment such as store friendly delivery and shelf ready packaging. Store friendly delivery describes methods to load pallets and products onto trucks in product groups reflecting the store layout so that they can be offloaded and transported to the shelves at once to minimize in-store transport and handling. Shelf ready packaging (SRP) refers to products that come in a ready merchandised unit which is easy to identify, easy to open, can easily be put onto the shelf and disposed of, allowing an optimisation of shelf replenishment and enhanced visibility. SRP covers all types of shelf ready packaging, including promotional displays, pallets. SRP can in many cases, impact the cost structure of a product, since it may require industrial investment or additional outer packaging cost. However, pilot projects by a group of European retailers including ASDA, Tesco, Sainsbury, and Carrefour together with many suppliers and service providers have shown that SRP significantly reduces handling cost and increases in-store productivity, on shelf availability, and product recognition on shelf by the shoppers (ECR Europe 2007)

D. Conclusion

Overall, we found a tight coupling of store and shelf replenishment to be a driver of on shelf availability. However, this requires a more integrated design of shelf space and delivery frequencies than what we have often found in practice.

Figure 21 Costs of Handling Products



Credit: TU/e Retail Operations Group

USING RFID TECHNOLOGY TO IMPROVE RECEIVING ACCURACY

RFID technology can be used to support receiving accuracy and backroom management. RFID can improve the tracking of cases and pallets as they are received from the delivery truck. Cases can be quickly sorted into known back stock vs. those going directly onto the shelf. When inventory is received accurately, inventory data accuracy (PI accuracy) will be increased.

3-5. MAKING ROOM ON THE SHELF: THE CASE FOR DEMAND-BASED PLANOGRAMS

In section 2-1, we showed how lost sales due to OOS correlate with product sales velocity. Because of this, many retailers have instituted a “red dot” program where the top identified “never-outs” are identified with a specially-marked shelf tag to alert store personnel to watch for potential OOS situations with those items. However, we view a “red-dot” program as a workaround for a bad design. It works as a medication to soothe the problem, but is not a cure. The cure is a redistribution of shelf space based on demand rather than case-packs. In this section we examine the degree to which demand-based planograms (POG) will result in lower OOS than packout-based POGs.

A. Current Situation: 91 percent of the SKUs are Allocated Shelf Space Based on Case-Pack Size

In our examination of several categories across several retail chains, we found that on average, 86 percent of the items had enough inventory on the shelf to last more than 7 days (days of supply, or DOS). This means that only 14 percent of the items need to be stocked more than one-time per week. Looking at the other end of the tail, several items had in excess of two weeks supply on the shelf. If deliveries

come weekly, the logical question to ask is, “why not give the 14 percent of the items more space, and take away shelf space from the slower-moving items?” The answer is that it is more difficult to do than it seems, and this is due to two reasons. First, most (91 percent) of the SKUs are allocated based on case packout, and this takes up most of the space on the shelf. Since labor is expensive and tracking partial cases in the back room is a nightmare, stocking a full case on the shelf makes sense. Second, there is no additional space, since a slow moving SKU cannot have less than one facing.

An empirical study at various retailers conducted by the TU/e Retail Operations Group showed that retailers have what is termed “Net Shelf Space” (NSS). NSS is calculated as the difference between the shelf space that is required to carry out the current operations with respect to customer service and costs and the shelf space that is allocated to the item or items of interest. To examine the potential excess shelf space (ESS) an item might be allocated, the researchers considered the merchandising guidelines of the retailer as well as the target shelf space advised based on a formula they derived for the maximum inventory level on hand. As expected, case pack sizes, physical dimensions of the consumer units and the shelf depth were the major drivers of ESS. When the ESS of the items is summed, retailers were found to have substantial NSS. The existence of NSS implies that there is space available to reallocate to items that do not have adequate shelf space.

We also know from multiple tests in category management that shoppers respond favorably to minor reductions in choice within a category, especially when there are reasonable substitutes. Thus, an option worth examining is finding additional space for fast moving items at the expense of removing the slowest moving items. The question is how deep can a retailer make this adjustment until the negative effects outweigh the sales gained from fewer OOS events?

B. What Would be the Effect on Sales When 14 Fastest-Moving Items Receive More Space, and 14 Slowest-Moving Items are Removed?

Using the 86 percent DOS > seven days average, if the category had 100 SKUs, then a reasonable place to begin to examine the effect of reallocating shelf space would be to find additional shelf space for the 14 items that did not have enough shelf capacity to last seven days by removing the 14 slowest moving items. Let’s make a few assumptions:

- The average product dimensions and the price margins of the 14 fastest and slowest movers will be the same.
- The ratio of sales between the fast-movers to slow movers is, on average, 10:1.
- The OOS rate for the fast-moving items is 12 percent (1.5 times the worldwide average for all items).

Using these assumptions, and using a movement of one unit per week average for the slow mover items, then in a given week, the fast movers would sell 140 units and encounter 17 OOS events, while the slow movers would sell 14 units. Given these assumptions, the retailer would gain three weekly sales in the category. This appears to be somewhat equivocal, until considerations for the total cost of OOS are considered, as well as the reduced labor and tracking of 14 fewer SKUs. Alternatively, there are some customers who wanted to buy the 14 units of the slow movers that are no longer available.

Thus, before embarking on wholesale change, each of the assumptions has to be understood. For example, if the sales velocity ratio between the fastest and slowest movers was increased, then the payoff would be greater. Alternatively, if the OOS rate on the items was decreased, then the payoff would be lower.

C. Feedback-based Approach to Reallocating Shelf-Space

Given the above discussion, a very simple solution appears. When considering the 14 fastest and slowest moving items, the results may be equivocal. However, if only a few of the fastest moving items with the greatest OOS lost sales were identified, and additional space was found for these by eliminating a few of the slowest moving items, the results would generally be overwhelmingly favorable.

Using OOS estimation using the POS estimation method, this could be easily implemented. The top three to five OOS items could be identified, and additional shelf space could be allocated to these by eliminating a few slow moving items. A month or two later, the OOS estimation could be made again, and the top OOS items would be examined. If it were any of the original three to five OOS items, then additional space would be added to them, and if not the next items would be considered. Given that there will be diminishing returns, this would continue only until the OOS reductions began to meet the sales level of the slowest moving remaining items.

The approach here is to address the items that create the most OOS. These items can be easily identified using POS estimation, and implementation would involve minor planogram redesign.

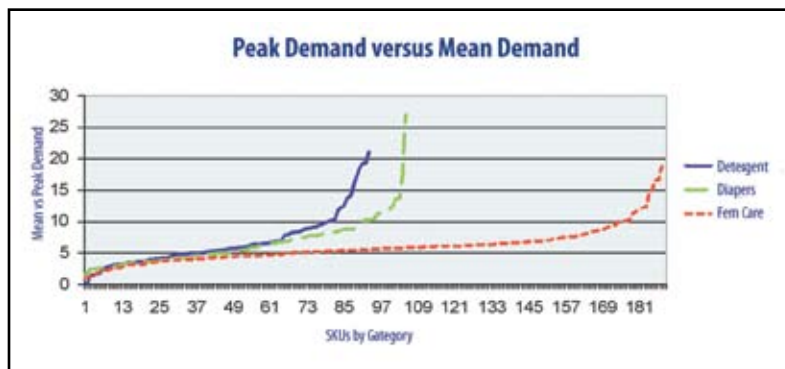
D. Considering the Potential of Demand-Based Planograms

Most available computer software ignores peak demand and demand variability. Planogram software by popular providers such as The Nielsen Company are based on mean demand.

To show the potential impact of demand-based planograms, using a Data Ventures created algorithm, we examined three categories, looking at the weekly average movement for each item, as well as the regular peak demand for each item. Building a demand-based planogram requires knowledge of the average movement of each item, as well as the variability of the demand for each item. This variability can be expressed as the multiple of peak demand versus the mean demand of the item. Those with high movement and high multiples have the greatest likelihood of going OOS, while those with slow movement and low multiples will have very low incidences of OOS.

The following chart, Figure 22, shows the ratio of peak sales to mean sales, which indicates those with the highest demand variability. In each case, there is a clear “bend” in the curve where a few items appear to be at greatest risk. This chart shows that there can be a difference of up to 20 times, or 2000 percent, between mean demand and peak demand. The demand-based planogram will provide additional shelf space for these items. The peak is 5-6 times the mean demand. For items that get above a multiple of 10, it is a planned OOS. At the bottom end, there are so many things that sell so regularly, that the space allocated to them could be reduced.

Figure 22: Ratio of Peak Demand to Mean Demand for Three Categories



Credit: Data provided by Data Ventures

E. Reactions to assortment reductions

If assortment is reduced, do shoppers see this as more of a negative issue than lost sales? Study after study suggests that a bigger assortment is not necessarily better. The early ECR studies in the USA showed consistently that when assortment was reduced by a small amount, that sales either remained constant or increased. Moreover, customer satisfaction either remained the same or increased. In research published in the *Journal of Marketing* in 1998, Susan Broniarczyk and her

colleagues in the USA provided clear empirical evidence that assortment reductions—to a point—could not be perceived by the shopper. According that research and subsequent query (see Broniarczyk and Hoyer 2006) the focus needs to be on providing an optimal assortment, rather than the largest assortment.

F. Conclusion

There is a clear opportunity to consider moving towards demand based planograms. The increase for each category, when examining recovered lost sales of the fast moving items that receive additional shelf space, does not appear to be great.

However, when examining this in the aggregate, the revenue looks more attractive. For example, if the gross margin for an item was only \$0.25, and the net sales increase would be only 10 items per week, the annual gross margin per category would be \$130. However, the cost of OOS is much greater than the lost sales, and when the reduced labor for employees and customers is considered, the return is substantial. Moreover, because this method relies on POS estimation, the approach is scalable, so that the consideration can be not for a single category for a single store, but for several categories across hundreds of stores.

3-6. KNOWING WHERE EVERYTHING SHOULD BE: THE CASE FOR PLANOGRAM (POG) COMPLIANCE

In this section we focus on merchandising management, and we report on research that examines the relationship between planogram (POG) compliance and levels of OOS. Overall, we found significant effects of planogram compliance, however, in most cases we examined, POG compliance was greater than 90 percent, thus the statistically significant difference was not a large practical difference.

A. Findings from the Study

In our new research we found on average we found a relationship of 1/10 of 1 percent change in OOS levels for every 1 percent change in POG compliance. Surprisingly, we found POG compliance to be very high (greater than 90 percent) in the retailers we studied. For retailers and categories with high levels of POG compliance, there will not be much effect to address this. However, for categories that have a low level of POG compliance can have a substantial effect. For example, if a category has 60 percent compliance, and it can be raised to 90 percent, then there will be the opportunity to decrease OOS by three percentage points.

B. General Issue of POG Compliance

While the previous studies have addressed getting the product to the store, this study addresses merchandising processes in the store. When a planogram is created for a retail category, space and position of goods has been allocated based on known physical dimensions of the items and the number of items in a case pack. As such, the planogram optimizes the shelf space utilization given consideration of stocking efficiency.

POG compliance first involves having the items in the category that are supposed to be there termed “in distribution”. However, some items that are not specified on the POG (not “in distribution”) find their way to the shelf, while other items that are listed on the POG are not found on the shelf. Secondly, POG compliance involves having the items in the category in the correct place on the shelf. Incorrect placement occurs when the incorrect number of facings is provided for an item, when the item is placed on a different shelf rather than the one specified, or when the order of the items on the shelf is different than the order specified. Simple categories may carry 75-100 items, while complex categories carry 300-400 items. Thus the opportunity for compliance deviations is huge.

The link between POG compliance and OOS is both direct and indirect. An item that is in distribution but does not have a physical place on the shelf (i.e., a distribution void) cannot be tracked for OOS manually. Similarly, an item that is physically present on the shelf but is not on the POG could go OOS and not be recognized. Indirectly, POG compliance impacts OOS due to the ability to easily physically recognize low stock and OOS situations on the shelf. Compliance also maximizes restocking efficiency and accuracy.

C. Overview of the Study We Conducted

To examine POG compliance, we identified four categories (diapers, laundry, femcare, and hair care) to study. We first had to establish a “best-practice” methodology for measuring compliance, as there was no commonly agreed method to do so prior to our study (see the following section on Best Practice Measurement of POG Compliance for details). We used this approach and measured POG compliance in each of the four categories in 10 stores (of a

single grocery retailer) over a 14 week period.

After the completion of the 14-week period, we obtained measurements of OOS levels for that 14-week period for each category in each store. The OOS measurements were estimated by Standard Analytics using the POS data provided by the retailer for the 14-week period and the previous 52-weeks. We examined the correlation of the POG compliance and the OOS levels for each category in each store for the 14 week period. Two examples of the correlations are provided in the charts that follow (Figures 23-24). The strongest correlation between planogram compliance and on-shelf

Figure 23: POG Compliance and On-Shelf Availability in the Laundry Detergent Category

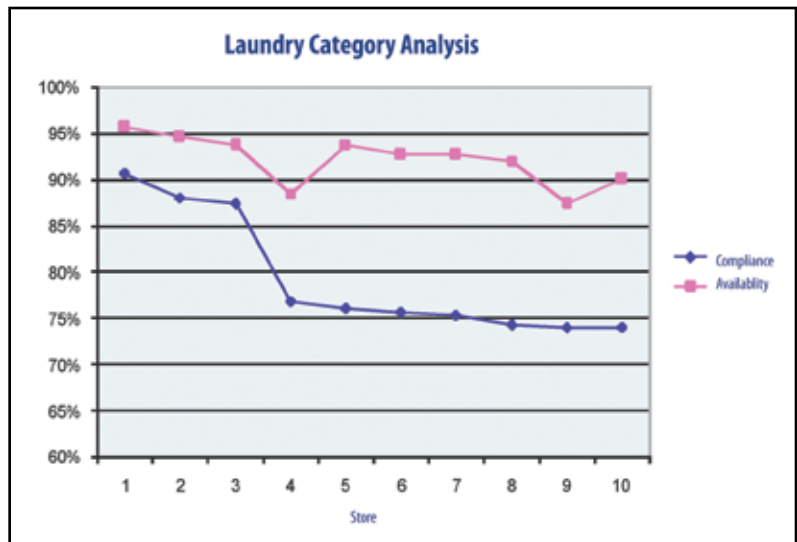
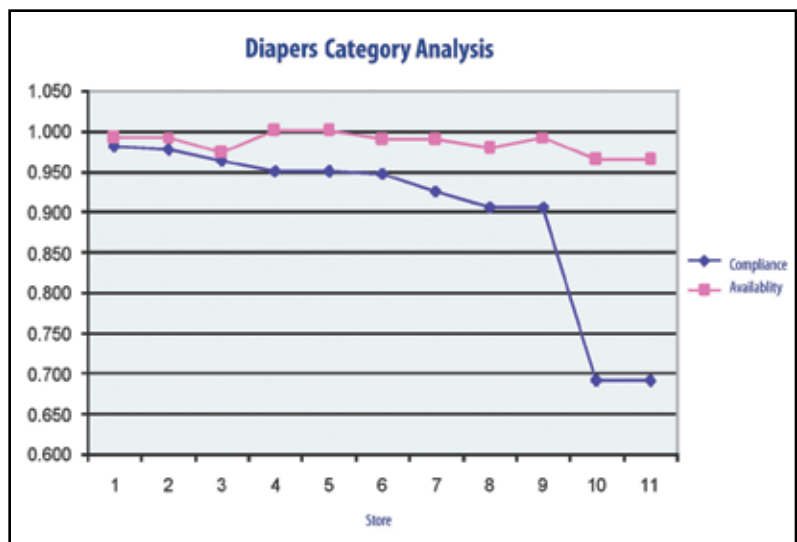


Figure 24: POG Compliance and On-Shelf Availability in the Diaper Category



availability we found was for the laundry category (correlation was 70 percent), which translates into an impact of about $\frac{1}{4}$ of 1 percent shelf availability increase for every 1 percent increase in compliance. For the diapers category, the impact was less, where the impact we observed was about $\frac{1}{10}$ of 1 percent shelf availability increase for every 1 percent increase in compliance.

D. Data from other studies

Research by T Netherlands TU/e Retail Operations Group in dairy categories found planogram compliance to be an important issue that requires a retail management attention. Their evidence clearly linked the majority of non-compliance with facing differences. They identified four main drivers of non-compliance: 1) local store management, 2) a significant adoption time for changes, 3) different local circumstances than assumed in the planograms (e.g., dairy) and 4) the lack of incentives from the headquarters. The major consequence of a lack of planogram compliance proved to be a substantial loss of efficiency both in the marketing strategy as in the operational executions, as such indicating that planogram integrity is a serious issue

3-7. KNOWING WHERE EVERYTHING SHOULD BE: KEEPING THE SHELVES STRAIGHT

While planograms are usually developed by headquarters, the actual maintenance of planograms in day-to-day operations is with the stores. Item management reflects the degree of maintenance of planograms, or in other words, the degree to which the products are in their assigned shelf space. In this section, we specifically examine the impact that retail maintenance of shelf-tag accuracy, the number of OOS “holes” that get covered, the number of SKUs with limited visibility or are otherwise hidden have on the overall level of OOS. In a manual order situation, failures in these merchandising practices will increase levels of OOS.

A. Common Failures of Item Management

As part of this research, we walked the shelves of supermarkets around the world, and we found that products were often not in their assigned space. Often we found them somewhere other than where the shelf-tag indicated they would be, hidden behind other products, and found “holes” covered by other items that would otherwise provide a clear signal that an item was out of stock. We synthesized our observations and derived the following four common failures of item management which must be addressed when trying to impose discipline in retail operations.

- Wrong tag: Mismatch between the product assigned to a shelf space as defined by a corresponding tag and the product actually occupying the space defined by the tag, for instance, Cheer sitting on the shelf space defined for Tide.

- Shelf tag missing: An item is in distribution, but when it is OOS, the shelf tag gets removed, thus making the OOS invisible to shoppers and store management.
- Product hidden: When overflow product is hidden behind other SKUs, for instance, Cheer and Tide both stocked on the shelf but some overflow Cheer product hidden behind Tide. This is often a symptom of wrong shelf capacity and/or case pack sizes.
- Holes covered: If an empty facing is covered by another product then the situation of out of stock is not visible. This is sometimes negligence but more often intended behavior to hide out-of-stocks, either to display nicely stocked shelves to customers or hide out of stocks from store managers. In both cases it makes matters worse as stocking errors are not identifiable.

B. Tracking the Extent of Item Management Failures: A Study of Shelf Tag Removal

Many retailers that use automation such as shelf label readers, do indeed “look for holes”. However in some retailers it is accepted practice to “hide holes” by removing shelf labels if no product can be found. To measure the extent that this practice occurs, a study was conducted in 24 stores at a major U.S. retailer, examining a sample of approximately 100 CPG items. Auditors visited the stores four-to-five days per week over a three-to-six-week period. The auditors utilized an application running on a hand held, radio frequency (RF) enabled, barcode reader. For each item in the study the auditor had to read the shelf label and enter the quantity on the shelf. If there was no shelf label for that item, this was indicated by a special key. A total of approximately 40,000 observations were captured. Observations were eliminated in the cases where a store did not carry the product (it was not in distribution at that store), and thus a shelf label was not reported. Of the remaining observations, 7 percent indicated the shelf label was not present. This finding suggests that additional study of the effect of item management failures on OOS was warranted.

C. A Test of the Effect of Item Management Compliance

A European retailer participated in a study designed to unravel the cost of item mismanagement. The difference between our proposed study and many others the retailer had previously considered was that most studies simply count holes in the shelf facings, but do not check thoroughly whether products have the right tag, are hidden or are covering OOS of other products.

For this study, the retailer provided 20 stores that we divided into test and control store, being careful to match each test store with a similar control store. To begin the study, merchandisers went into each test store to examine

the targeted categories (laundry, diapers, femcare, hair care), and to check the degree to which items were in the space they were assigned to according to the list of common item management failures. The products were then “trued-up”, i.e., an ideal situation was established by assigning products to the right tag and taking hidden products as well as products that hid out of stocks of other products off the shelves. It is important to note that out of stocks were not replenished with backroom product. To the contrary, when the merchandiser left the store, the shelves painfully displayed the out of stocks to both customers and store managers. However, when the next delivery arrived, out of stocks were of course eliminated. Merchandisers returned to each test store once a week to “true-up” any deviations.

The control stores were not “trued up.” Their state of item management was checked at the beginning, at the middle and at the end of the three month test period, in order to allow a comparison between test and control stores.

The results were striking, and are shown in the Figure 25 below. We measured OOS using the measure of lost units and lost sales developed by Data Ventures. We found that lost sales in the test stores where items were trued up were on average only 6 percent compared to the control stores where they were 10 percent. We found a particular strong impact on promoted items. Overall, our research shows that

implementation of a disciplined item management process reduces OOS on average by four basis points.

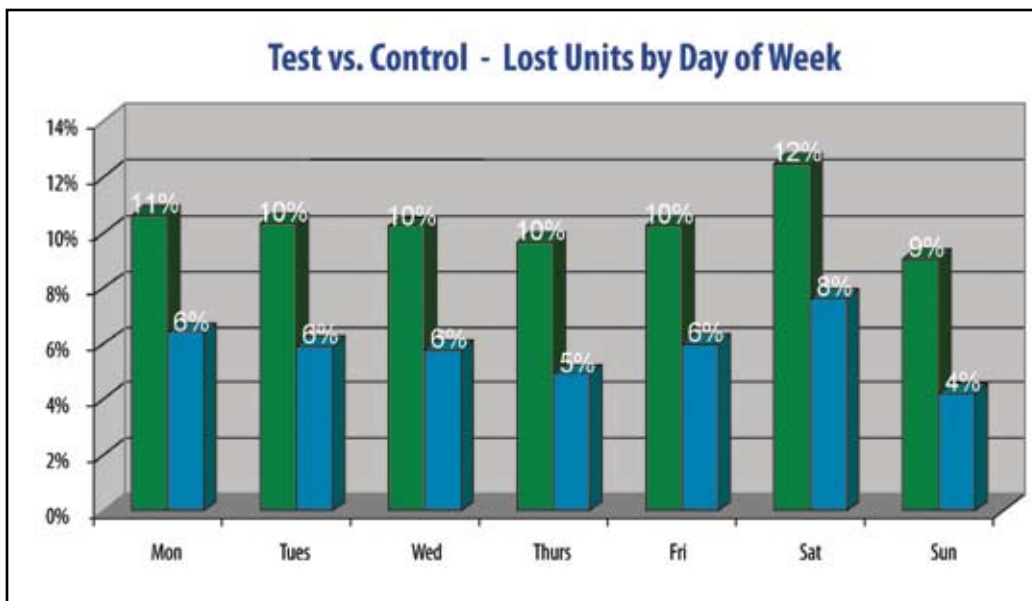
D. Conclusion:

Evidence clearly shows that item management failures in retailers are common, and our study shows that when these failures are addressed, that the impact on OOS levels is substantial. In subsequent discussions with retailers, we probed the degree that these failures were a matter of policy or practice. Here is what retail managers told us:

- Almost all retailers already have policies aimed at eliminating these behaviors
- Policies are not followed because of
 - o Discipline
 - o Less than 100 percent sell through of promotions
 - o Inadequate shelf space for packout
 - o Too many items in assortment

Simple improvements is shelf tag accuracy, keeping product from being hidden behind other products and not covering OOS holes will improve the accuracy of manual ordering and lead to lower levels of OOS.

Figure 25



Credit: Data Ventures

Getting and Keeping Lower Levels of OOS

4

OVERVIEW

Throughout Chapters 1-3, we have demonstrated several options available to retailers to reduce OOS. These include keeping a focus on the items that account for the most lost sales, using new technology to measure and identify the OOS and their patterns, getting better data to make forecasts, keeping product information accurate (both product data and perpetual inventory), keeping shelves in line with the planograms, keeping the items on the shelf in good order, and others. Throughout, we have emphasized the need for measurement of OOS to point to root causes that will then provide direction for solutions

In this chapter we present logical and systematic approaches that retailers can use to address OOS. This chapter is organized into the following five sections.

4-1. THE ABILITY TO MEASURE PROVIDES THE ABILITY TO FOCUS

Measurement of OOS leads to efficient and effective solutions
Measurement must identify the products with high OOS payoff and the stores with high OOS payoff

4-2. TAKING ACTION

Is it a store OOS or a shelf OOS? Is the root cause product-related or store-related?
The extent of implementation should be based on the resources that are available

4-3. A COMPREHENSIVE APPROACH TO REDUCING OOS EVENTS, DURATION, AND LOSSES

From forecasting to shelf replenishment and everything in-between
Data accuracy is the foundation
Can a retailer focus on everything?

4-4. A FOCUS ON THE HIGH DEMAND ITEMS

Constant high demand items
Temporary high demand items

4-5. BRINGING IT ALL TOGETHER, AND LOOKING FORWARD.

Report conclusions
The future of OOS reduction

4-1. THE ABILITY TO MEASURE PROVIDES THE ABILITY TO FOCUS

Measurement of OOS Leads to Efficient and Effective Solutions

We have found that a major cause of failure to systematically reduce and maintain lower OOS levels is not focusing on the most critical root cause areas determined by analysis and continued measurement. It is crucial to have the measurement capability to be able to point towards the dominant root causes, focus on the OOS that are the source of the greatest loss, and continually feed back progress made on OOS reduction.

As we have shown in Chapter 2-1, such measurement can be manual, estimated by POS data, or tracked by perpetual inventory systems, and we have provided examples of each approach. When manual measurement of OOS is made through examination of a sample of items in a store, each item that is found to be OOS can be linked to its likely root cause through a systematic yet simple process of checking each OOS against a hierarchical listing of known OOS causes (i.e., begin with PI accuracy, if accurate then check to see if the item was on promotion, and so on). The crucial objective for any measurement method is the need to link the OOS to its root cause, which can then allow the retailer to clearly see the dominant root causes and thus direct towards the proper solution. This manual approach is appropriate for lower volume stores and for stores with slower moving items.

Alternatively, for large volume stores, and stores dominated with faster moving items, newer technology can be implemented to measure OOS on a continuing and efficient basis. We have also demonstrated in Chapter 2-1 that estimation through POS data can reveal OOS with great accuracy. We recommend that retailers who have the resources

and product movement characteristics to adopt this approach for three reasons:

- First, OOS estimations made via this approach can be aggregated to show which products and which stores tend to have higher levels of OOS. This provides the ability to target and focus.
- Second, this approach provides estimates of multiple OOS attributes, which allows for the calculation of multiple OOS rates. In particular, this provides the ability to estimate OOS loss rates, which increases the efficiency in targeting which OOS to address.
- Third, the event frequency and duration can be linked to root causes, as we showed in Chapter 2-3. These identifying patterns provide a diagnostic approach to linking the root causes to solution areas. Figure 26 provides an example of the way that typical OOS patterns can be linked to one or more of 17 retail solution areas.

Figure 26: Applying OOS Patterns to Likely Solution Areas

Connecting Measurement to Root Causes to Solutions							
Link to Solution Areas	Assessments of Root Causes						
PI Accuracy			X			X	
Demand Based POG		X	X	X			X
Improved Backroom - Constant Demand		X	X				
Safety Stock - Constant Demand		X	X			X	X
Stocking Notification - Constant Demand		X	X				X
CAO Ordering				X			
Manual Ordering							
POG Compliance			X	X			X
Improved Sorting							
Data Synch		X					
Demand Forecast	X	X			X		
Safety Stock - Temporary Demand	X						
Stocking Notification - Temporary Demand		X					
Improved Backroom - Temporary Demand							X
Work Backroom - Operations			X	X			
Inadequate Order Quantity	X					X	

Based on this rationale, we recommend that retailers create and systematically use some sort of POS-based OOS measuring system, whether from a commercial vendor or internally developed.

Measurement must identify the products with high OOS payoff and the stores with high OOS payoff

As discussed in section 2-1, not all OOS events have equal cost to the retailer, and similarly, not all efforts to reduce OOS provide the same return on the resources invested. The second major recommendation is that retailers seek to identify two dimensions of OOS loss: the products that have the highest level of OOS and OOS-related loss, and the stores that have the highest level of OOS and OOS-related loss. When these dimensions are clearly identified, then an action plan can be put into place that can focus on these products and/or stores. This allows the retailer the choice to reduce the overall OOS rate as efficiently as possible, or it allows the retailer to strategically select certain SKUs, categories or stores.

4-2. TAKING ACTION

Is it a store OOS or a shelf OOS? Is the root cause product-related or store-related?

- Our recommended approach takes the following three steps:
1. Measure and Assess
 - High OOS risk products (fast movers, or other strategic SKUs)
 - High OOS stores
 - Shelf versus Store OOS
 2. Solve high risk products with Store OOS solutions
 3. Solve high OOS stores with Shelf OOS Solutions

Step 1: Measure and Assess

In section 4-1 we focused on how to measure OOS in order to solve OOS. Once we know where the OOS issues rest, retailers need to form an action plan based on the resources available. The action

Credit: Standard Analytics

plan we recommend in this section is based on having such a measurement approach in place, because:

- If OOS problems are localized to stores then it is a store fix; and
- If OOS problems are universal across stores then it is probably a product fix.

Addressing OOS in this manner will provide the greatest improvement for retailers relative to the resources available.

Step 2: Solve high risk OOS products with store OOS solutions

Store OOS are generally product issues, i.e., the same products are OOS across most stores. These are caused by inaccurate product data, poor forecasting, insufficient delivery cycles, or improper shelf-space allocation. Thus the solution needs to begin with the items that generate the greatest loss due to OOS. As we showed in section 2-2, the 80-20 principle applies store sales. In the specific example derived from this research, only 360 items accounted for nearly 20 percent of the total OOS losses. As the specific items and their impact are known, the place to start is to lower the OOS losses on this relatively finite number of items.

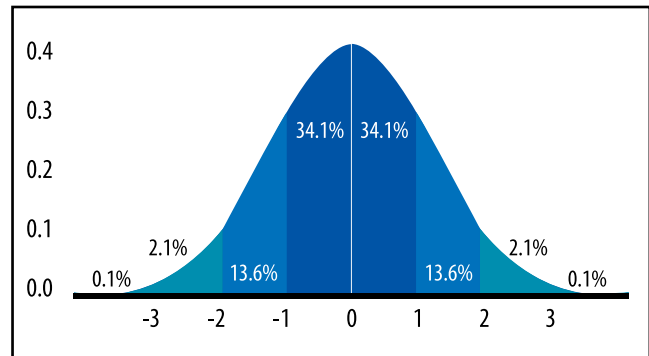
Step 3: Solve high OOS stores with shelf OOS solutions

Shelf OOS are generally caused by issues related to specific stores, i.e., given similar store characteristics in terms of size, product mix and volume; some stores will have higher levels of OOS than other stores. These differences are caused by incorrect manual ordering, lack of planogram compliance, insufficient shelf replenishment processes and poor on-shelf execution.

While we do not have specific analysis showing the distribution of variance in OOS rates among stores in a chain, a helpful place to begin would be to assume a normal distribution (as illustrated in Figure 27). If a normal distribution was the case, then out of 100 stores, 15-17 would be “best practice” stores, demonstrating consistently lower levels of OOS losses, 65-70 would be typical (within one standard deviation of the mean OOS loss for all stores), and 15-17 would show OOS losses consistently below one standard deviation of the mean OOS loss for all stores. Even if a “normal” distribution was not the case for a certain group of stores, there would still likely be a small group of best practice stores that would set a standard for the rest of the group, and a small group of stores that would have larger OOS related sales losses.

The measurement system will identify both the best practice stores as well as the high OOS loss stores. The measurement will also identify the root causes that are having the greatest impact on the OOS loss. The general approach is to transfer the practices that address the dominant root causes from the best-practice stores to the high OOS loss stores.

Figure 27: Plot of normal distribution



Credit: Wikipedia.org

The Extent of Implementation Can be Based on the Resources that are Available

Notably, the approach we recommend can be implemented at the level of resources that the retailer has available. For example, if the measurement system identifies the 500 items that drive the greatest OOS loss, a retailer may not be able to address all 500 at one time if at all. Our recommendation is to work at the level of capacity to address a portion of the 500 items. If there are resources to address 100 items, then deal with them. Addressing a portion will work to lower OOS losses. Moreover, OOS can be addressed serially, such as addressing 50 at a time, solving this group, and then moving to the next 50. For example, if the measurement points to a root cause on insufficient shelf allocation that leads to OOS in a group of fast moving items, then implementing demand-based planograms that incorporate those items can substantially reduce OOS losses across all stores.

A similar approach can be made when addressing stores that have high levels of OOS relative to their peers. Selecting the 15 or 30 stores with the highest OOS losses and addressing the replenishment and merchandising practices at those stores does not necessarily require new technology, but improved processes and training. This can also be done serially, one store at a time, or in small groups of stores that have similar OOS loss characteristics.

The point of this recommendation is to show that any retailer can follow this approach and reduce losses from OOS, regardless of the level of available resources. One retailer may make OOS loss reduction a major initiative, while another may only be able to address a very limited number of products and/or stores. Both can benefit.

4-3. A COMPREHENSIVE APPROACH TO REDUCING OOS EVENTS, DURATION, AND LOSSES

One objective of this report has been to systematically present a comprehensive approach to OOS, following a logical sequence of root causes and solutions. Throughout Chapter 3, we provided a sequential examination of OOS causes and solutions, which followed the order presented in Figure 1. Addressing any of the root causes will lead to lower levels of OOS, however, sustaining a low level of OOS losses requires that each of the major areas and sub-areas shown on Figure 1 be addressed, because they build on each other and they interact. While retailers should use the action steps presented in section 4-2, there is a related comprehensive approach to solving OOS that starts with data accuracy and takes a logical progression through in-store replenishment. It is this comprehensive view that needs to be understood to systematically attenuate OOS, and maintain these lower levels on a permanent basis.

Figure 28 presents a grid that shows the dependencies between the major root cause areas, and it also provides an order of flow of possible errors in the total replenishment. To begin, the grid separates store OOS (which primarily result from errors in ordering and delivery) from shelf OOS (which occur mostly because of operations issues). This distinction is also helpful because a different set of people and processes are involved in store ordering than in store operations, and it matches the recommended approach in section 4-2.

For store OOS, data accuracy is the foundational building block for other sustainable solutions. Product data accuracy, perpetual inventory accuracy, and POS data accuracy can drive improvements in OOS losses, and they form the foundation for other solutions. Forecast error and delivery error also contribute to store OOS, so that by the time the product gets to the store it has substantial opportunity to not be the correct amount of product to meet demand.

For shelf based OOS, the product delivered (whether the correct amount or not) is ineffectively moved to shelf because shelf capacity may not handle the packout or demand needs. There can also be inefficiencies in the process of replenishing the product to the shelf either as trucks are unloaded or moved from backstock. For displayed product

there is the additional challenge of keeping both shelf and displays stocked properly.

The order suggests that while errors at the top may be compounded down the line, they may also be overcome, or at the least mitigated by superior execution near the bottom. On the other hand, errors at the bottom create problems that will more likely directly create OOS with little chance of mitigation.

4-4. PRACTICAL STEPS TO ADDRESS OOS OF HIGH DEMAND ITEMS

We demonstrated that high demand items create the largest lost sales due to OOS, and in this section we specifically address approaches to retailers who wish to focus on these high demand items. This section takes several of the approaches and outlines their usage in a more specific manner as applied to high demand items. High demand items have two categories, constant high demand and temporary high demand. Each is addressed somewhat differently. Figure 29 provides a summary of the approach described below.

A. Identify constant high-demand OOS items

- As demonstrated in section 2-2, a relatively small number of SKUs are sold on a daily basis.
- Primary emphasis is to eliminate OOS on constant high demand items since movement is known and forecast should be accurate.
 - Address high-demand OOS through safety stocks on these items, enhancing backroom to shelf processes and use of demand-based Planograms (POGs).
 - RFID can play a role to enhance backroom processes.
- Secondary emphasis is to reduce OOS (duration)
 - Improve methods of sorting (off the truck). Triage sorting into immediate OOS, direct to shelf, direct to backroom. RFID can enhance sorting triage
 - Shorten replenishment cycle
 - Real time notification of OOS so cycle is not missed (should be few instances due to constant demand nature)

B. Identify temporary high-demand OOS items (typically caused by promotions; also caused by external factors such as weather, seasonality, etc.)

- Define as “expected lift of ___ percent by the promotion” (typically defined as 4-6 x average daily movement)
- Primary emphasis is to reduce the duration of OOS of temporary high-demand items. These cannot be

Figure 28: Overall View of Retail Practices that Impacts OOS

TYPE	ROOT CAUSE AREA	ISSUE DESCRIPTION	Usable Solution
Store Based Out of Stocks "Ordering"	Data Accuracy	Product data is inaccurate; perpetual inventory is inaccurate; POS data is inaccurate.	<ul style="list-style-type: none"> • Fix product data through data synch • Improve PI accuracy • Review POS scanning practices
	Forecast and Order Accuracy	Sales forecast is understated where OOS are unknown/not adjusted for in sales history. It is overstated where SKUs in history benefited from switching due to OOS from other SKUs. Demand forecast starts with the errors unknown from the sales forecast and attempts to estimate true demand based on unscientific judgment.	Add back measure of lost sales <ul style="list-style-type: none"> • Due to OOS in the estimate • Due to poor execution • Due to Data Synch errors
	Order Quantity	Demand forecast adjusted by inventory quantity which is frequently inaccurate.	<ul style="list-style-type: none"> • Enhance PI accuracy • Follow CAO recommendation for safety stocks level • Don't hide product • Use RFID to track cases and pallets
	Replenishment	Delivery cycle is too infrequent to match demand for fast moving items; quantity is different from order; delivery arrives late	<ul style="list-style-type: none"> • Adjust delivery cycle to meet most "stressed" items • Monitor delivery frequency and timing
	Capacity (Time Supply)	Inadequate shelf capacity to meet frequent peak demand needs. Few systems calculate for their regular peak demands.	<ul style="list-style-type: none"> • Demand-based planograms • Safety stocks
Shelf Based Out of Stocks "Operations"	Capacity (Packout) and Planogram Compliance	Multiple of case pack required in shelf capacity for efficient operations that avoids partial cases not fitting in the dedicated shelf space. Good packout should avoid product being hidden behind adjacent product or in the backroom. Packout can be poorly planogrammed or maintained in the perpetual inventory system.	<ul style="list-style-type: none"> • Improved packout practices • Adjust case pack sizes • Enhance planogram compliance
	Shelf Replenishment	Inefficient and ineffective movement of product from the backroom to the shelf, or from the truck as it is unloaded to the shelf or into backstock.	<ul style="list-style-type: none"> • Backstock to shelf process • Sorting • Notification of OOS • Shelf tags

completely avoided, but the retailers can control the damage by shortening the duration.

- Can be reduced with improved backroom sorting and backroom to shelf processes;
 - Can be reduced by improved notification of low or OOS levels or unanticipated demand, and by reduced ordering/delivery cycle time; and
 - Can be reduced by re-forecasting demand for the week based on the first day of sales.
- Secondary emphasis is to eliminate OOS on temporary high-demand items.
- Can be eliminated by carrying backroom safety stock;
 - Can be eliminated by including feedback of OOS duration and estimated lost sales from previous promotions when estimating promotional demand; and
 - Can be eliminated by coordinated ad/price reduction decisions with ordering cycles.

OOS in these items will have the greatest effect on reducing lost sales.

- Measure OOS using the new technology that identifies OOS from POS data. The data is already being collected, thus the measurement provides an additional application for getting a return on invested capital and labor that is already allocated to collecting this data. Estimates from these algorithms have reached reasonable levels of accuracy, matching the accuracy levels of the error-prone and labor intensive manual audits. Moreover, this measurement provides an estimate of the actual sales that were lost while the item was OOS. Vendors of these systems provide reports that show where the greatest levels of OOS occur, and they point to areas that need to be addressed. This allows resources to be efficiently devoted to reducing OOS.
- Identify OOS patterns. Many OOS function in a behavioral pattern that suggests the likely root cause of the OOS and points towards the obvious solution.
- Fix the on-hand inventory counts (so that perpetual inventory matches actual inventory).

Figure 29: Solution Grid for High Demand Based OOS

Eliminate	<ul style="list-style-type: none"> • Maintain adequate safety stock • Develop and implement backroom to shelf processes • Utilize RFID to identify backroom stock • Develop demand-based planograms* (*see following slide) 	<ul style="list-style-type: none"> • Carry backroom safety stock • Include feedback of previous OOS levels when forecasting demand • Coordinate ad / price reduction decisions with ordering cycles
	Reduce	<ul style="list-style-type: none"> • Implement "triage" sorting of product off truck • Shorten replenishment cycle • Implement real-time notification of OOS so cycle is not missed
	Constant High Demand	Temporary High Demand

Because the ability of using the POS data estimation of OOS is so central to effectively addressing and lowering OOS, the data that goes along with the system needs to be accurate. POS and inventory systems are inexorably linked in retail. Our research showed two particularly strong effects on OOS levels, perpetual inventory accuracy, and data synchronization.

The POS OOS estimates also provide us with the information

necessary to address two additional areas that we identified as critical for reducing OOS.

- POS estimated OOS data leads us to make demand-based planograms.
- POS estimated OOS data helps us to arrive at a measure of true demand which is sales (observed from POS) plus lost sales (unobserved, but new technologies help us estimate).

As this shows, OOS estimation from POS data is a central core technological competency required to efficiently and effectively address OOS, particularly in high volume stores with many items that sell multiple units daily.

4-5. BRINGING IT ALL TOGETHER AND LOOKING AHEAD

In summary, we have presented many solutions to solving OOS and made numerous recommendations.

One major story that we need to reiterate after researching a variety of efforts aimed at reducing OOS is that the new technologies that have been developed to estimate OOS from POS data need to be adopted and pursued by retailers. Retailers should use this technology to:

- Identify the 20 percent of the items that constitute the majority of sales and concurrent OOS. This is fairly simple to do given that POS data already contains this information. Concentrate on these items when addressing OOS for two reasons. First, most OOS sales loss comes from faster moving items. Second, reducing

However, we have also provided several recommendations for smaller volume stores, and those with slower moving items. It is a matter of linking the measurement to the root causes. Simple processes can be followed to link manual measurement of OOS to root causes. In addition, our general approach to taking action works for smaller or larger volume stores, as simply a matter of scale.

The Future of OOS Reduction: We Are Closer, but Still a Step Away from a Final Solution of Functionally Zero OOS Levels

Much like the economics concept of “full employment” not actually being defined as “zero unemployment,” there is a logical structural level of OOS that are too costly to eliminate. Our best estimate of this level is probably individual to the retailer and would be determined by looking at the best stores at the end of the normal distribution curve. Zero OOS is not a realistic or intelligent goal. Imagine you had full visibility of items on the shelf (item-level RFID, smart shelf tags and POS system), then finding out what is out of stock on the shelf would be simple. However, as our solution grid shows, that even if this is perfect, OOS could still occur to varying or unexpected demand, and therefore it depends on adequate ordering to effectively address OOS.

Technological solutions have arrived to help us reduce OOS. On the POS side overall OOS estimation is accurate, but there are some sloppy practices. On the inventory system, we know what is supposed to be in the store, but we often don't know where it is in the store.

It is still clear to us that we are one generation of technology away from having a complete solution—a technology where we can identify products, match up the PI and run the types of reports and identification of patterns, all as one integrated informational sequence. It's a pretty big step, but all the pieces that we have to talk about are just that, pieces, and we are fitting them together in a report, and it's both easy and difficult. Easy because we understand each of the pieces pretty well, but also difficult because we know the solution is still out of our grasp. We can significantly alleviate the pain, but we really don't have “the final cure.”

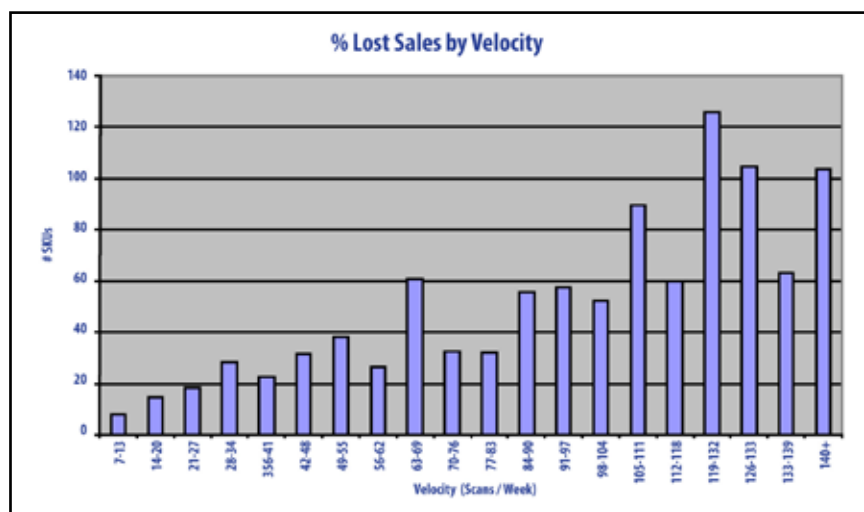
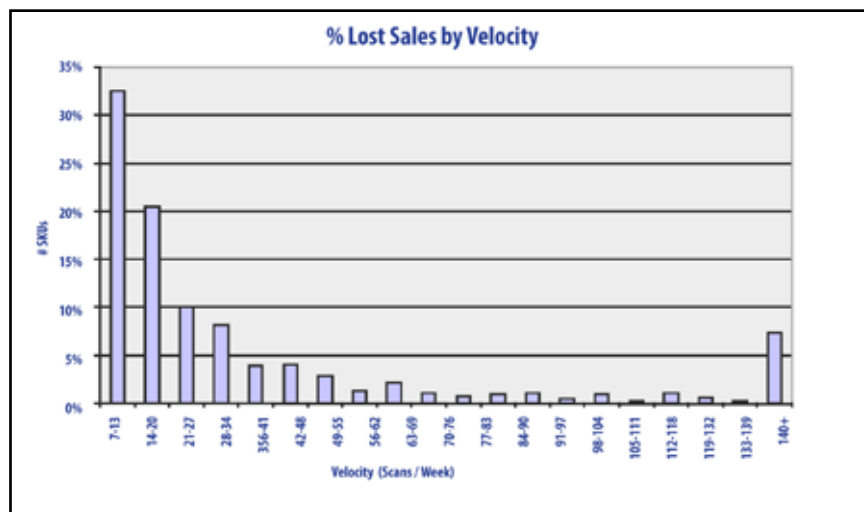
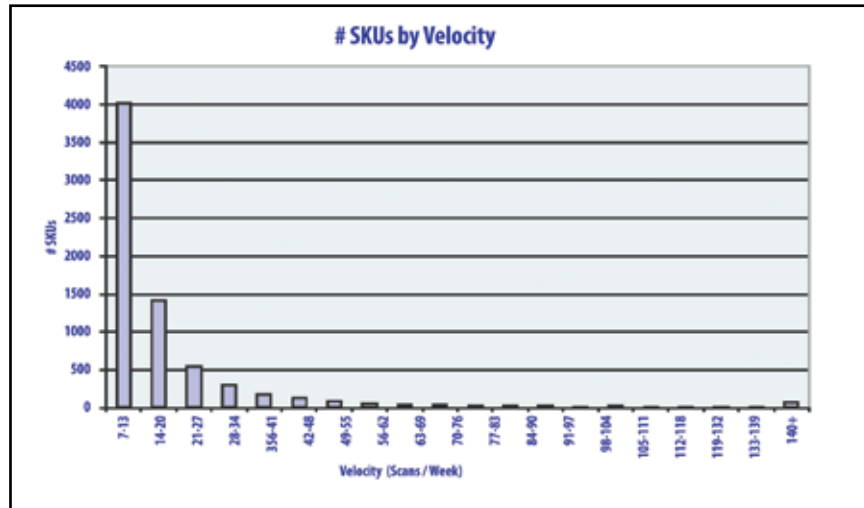
So, there is more work to be done, continuing to look for ways to reduce OOS and satisfy shoppers. But we believe by instituting the recommendations we've offered in this report a significant permanent reduction in OOS is achievable and measurable. Resulting sales improvements, cost reductions and positive impact on shopper loyalty to stores are very real. Following our method you can determine the amount of reduction you want to pursue.

OOS are no longer a zero sum game. For years retailers have traded shoppers disgruntled because of OOS back and forth with no real net difference in the number of shoppers for any given retailer. But now some retailers are stopping the loss of disgruntled shoppers through aggressive OOS reduction programs. Those that choose not to gain control of OOS will continue to lose shoppers but not get new shoppers from other retailers. A thorough analysis of OOS is the only way to determine what plans and resources should be devoted to improvement.

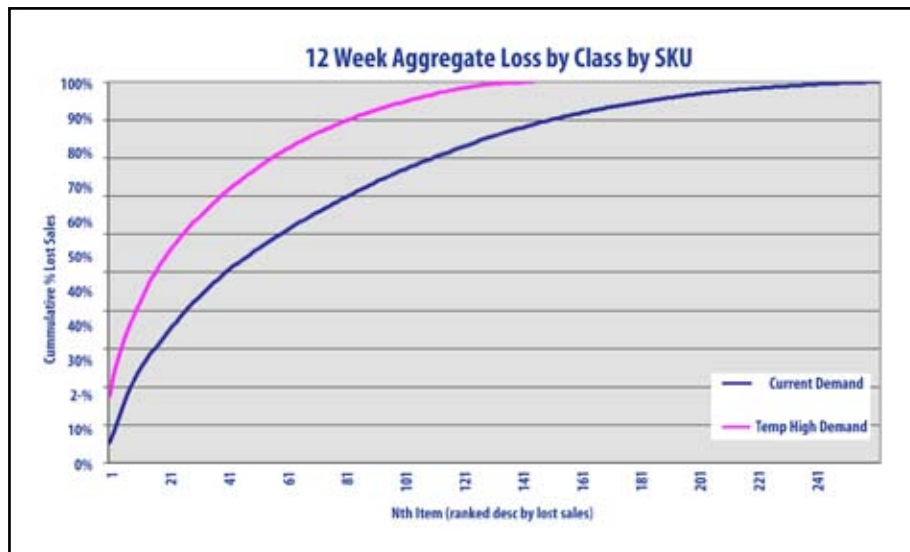
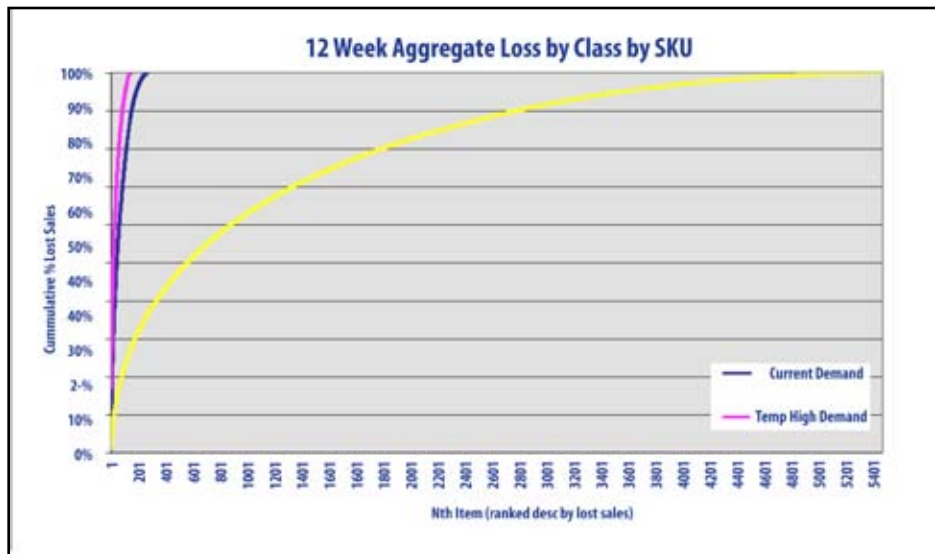
Appendix

3

APPENDIX 1: ITEM VELOCITY AND LOST SALES



	Velocity Upper Bound	# SKUs	Lost Sales	% Total Loss	\$ Loss/SKU	Relative Magnitude Loss
7-13	14	4014	83493.9	0.325378	20.8	8.106083209
14-20	21	1417	52640.32	0.205141	37.15	14.4771362
21-27	28	542	25657.12	0.099987	47.34	18.44769557
28-34	35	289	20939.2	0.081601	72.45	28.23553979
35-41	42	173	10003.98	0.038986	57.83	22.53513295
42-48	49	126	10233.91	0.039882	81.22	31.65226984
49-55	56	73	7166.8	0.027929	98.18	38.25921918
56-62	63	49	3335.54	0.012999	68.07	26.52793878
63-69	70	34	5315.8	0.020716	156.35	60.92897059
70-76	77	34	2826.47	0.011015	83.13	32.39661765
77-83	84	22	1807.56	0.007044	82.16	32.01868182
84-90	91	18	2562.2	0.009985	142.34	55.47211111
91-97	98	18	2663.43	0.010379	147.97	57.66372222
98-104	105	9	1206.21	0.004701	134.02	52.22911111
105-111	112	11	2528.45	0.009853	229.86	89.57672727
112-118	119	3	459.04	0.001789	153.01	59.62966667
119-125	126	8	2582.39	0.010064	322.8	125.795625
126-132	133	6	1614.01	0.00629	269	104.8306667
133-139	140	4	646.53	0.00252	161.63	62.98875
140+	100000	71	18922.82	0.073743	266.52	103.8631268



APPENDIX 2A: LIST OF REFERENCES

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**APPENDIX 2B:
LISTING OF ACRONYMS AND TERMS USED IN THIS REPORT**

Acronym	Term	Comment
CPG	Consumer Packaged Goods	
DC	Distribution Center	
DOS	Days of Sale	
DSD	Direct Store Delivery	
EPC	Electronic Product Code	
FMCG	Fast Moving Consumer Goods	
GTIN	Global Trade Identification Number	
OOS	Out of Stock	
PI	Perpetual Inventory	
POG	Planogram	
POS	Point of Sale	
RFID	Radio Frequency Identification	
SKU	Stock Keeping Unit	
SRP	Shelf-Ready Packaging	
UPC	Universal Product Code	
Term:	Store OOS	
Term:	Shelf OOS	
Term:	Backstock	
Term:	Safety Stock	

**APPENDIX 3
ESTIMATING OF THE IMPACT OF OOS ON LOST SALES.**

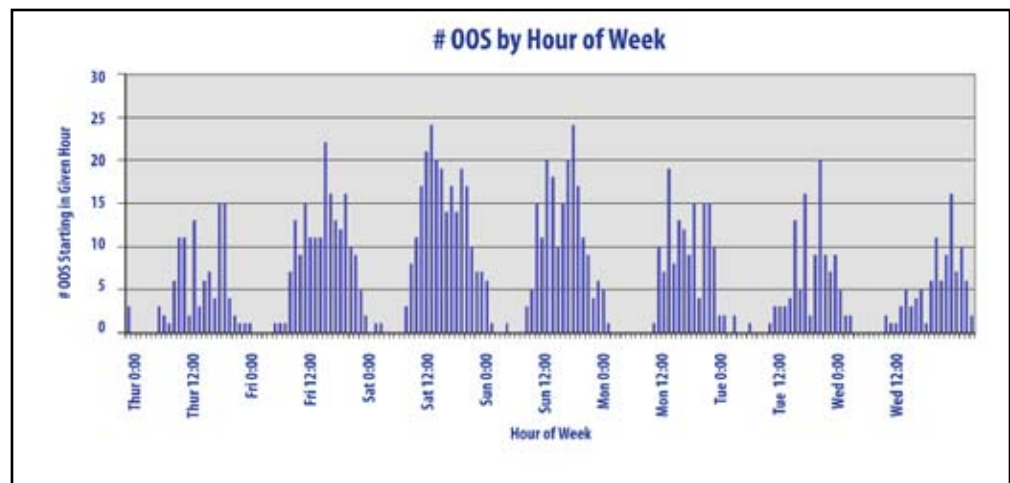
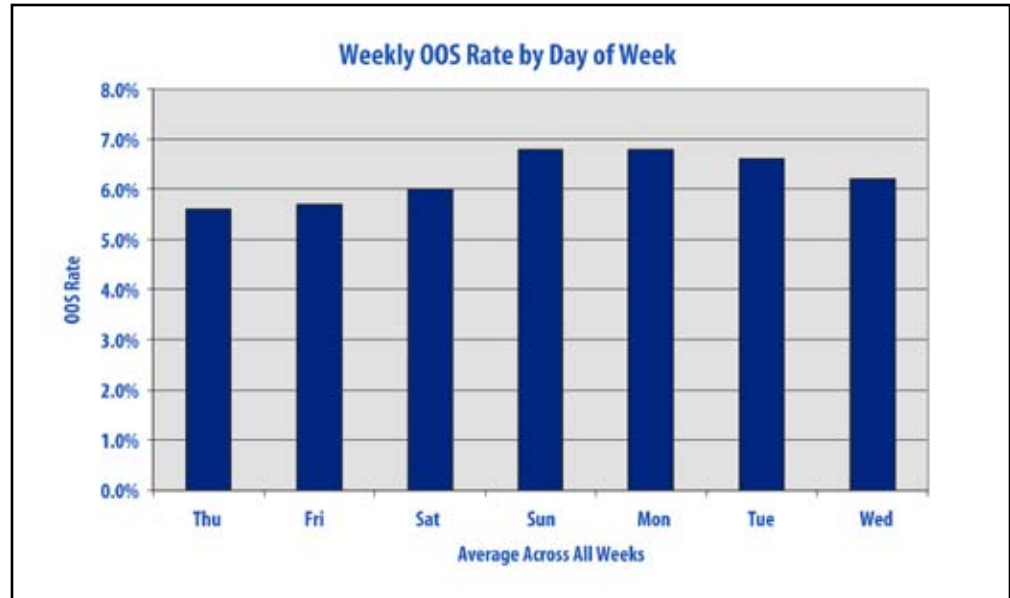
The basic estimation of the lost sales due to OOS requires knowing three pieces of information. The first is the OOS rate for the category or organization of interest. In our 2002 study, we found that to average 8.3 percent. The second is to understand the sales losses due to various consumer reactions. For example, in our 2002 study, we found that manufacturers on average lose 30 percent of the sales when consumers confront an OOS item (due to brand switching and not purchasing at all). The final is the total sales of the organization or category. The following Exhibit shows how this can be calculated.

OOS RATE	_____ %	EXAMPLE:	
X		AVG OOS RATE	8%
CATEGORY AVG		X	
LOST SALES	_____ %	MFR AVG LOSS	30%
X		X	
TOTAL CATEGORY/ ORGANIZATION SALES	\$ _____	CATEGORY SALES	\$1B
=		=	
SALES LOST TO OOS	\$ _____	LOST SALES	\$24,000,000

Note that this is a rudimentary estimate of the impact of OOS, but it is a good starting point. The issues addressed in section II of Chapter 1 of this report demonstrate that the true cost of OOS is much greater than the simple estimate of lost sales of a given item or category.

APPENDIX 4 DAY OF WEEK AND TIME OF DAY PATTERNS

The first chart shows the typical weekly pattern of OOS identified using estimates from POS data. This pattern matches the pattern shown in our 2002 study which relied on in-store audits. The second chart shows the time of day when OOS begin. By identifying the peaks (Friday afternoon, Saturday noon and Sunday late afternoon) retail managers can create process and deploy stocking labor to reduce OOS.



APPENDIX 5A STUDIES INCLUDED IN THIS REPORT

The studies that have led to the findings in this report were conducted in 2005 and 2006. Several of these were conducted by the research team, some were commissioned by the research team, and others were conducted by other researchers and integrated into this study. The major studies included:

- USA study that established best practices for planogram compliance measurement and examination of impact on OOS
- European study examining correlates of OOS
- USA study that examined perpetual inventory accuracy and OOS levels
- USA study that examined the impact of promotional forecasting and OOS
- European study that examined merchandising and shelving impact on OOS
- USA study that examined the effect of personnel longevity and deployment on OOS
- USA study that examined the effect of sales velocity on OOS
- USA study that examined the effect of RFID on OOS

APPENDIX 6

Compliance Measurement

Compliance really breaks down into three components – distribution, space and arrangement. To do the final calculation we calculate each of those components into a total with each component being one third of the total.

DISTRIBUTION

For calculating distribution an item in distribution that is not supposed to be is an error. An item that is supposed to be there that is not is an error. Divide by the total number of expected items in distribution. That number is then multiplied by two and subtracted from 100 percent. This multiplication is done because it is nearly impossible to get an error below 50 percent since to do so would mean the store would be carrying very few items at all regardless of authorization by HQ. They would simply have empty space in the category which does not realistically occur. So this effect must be considered.

SPACE

Space is calculated on the items with a known expected space. If the item has a different number of facings than expected, it is an error. The calculation is the number of errors as a per cent of the total number of items with an expected space.

ARRANGEMENT

There are 3 parts to arrangement.

1. **Is the item on the expected shelf** is measured by taking the total number of items expected in the planogram with errors in their shelf location as a per cent of total # of expected items found in the planogram.
 - **Example:** if there is a vertical arrangement of the Pantene Brand and the SKU from shelf 1 is switched with a SKU on shelf 2, that would be two errors and divided by the number of SKUs in the planogram that have been found (i.e. Distribution errors are neutralized by not counting the items missing in distribution and not counting the items in distribution, but not on the planogram)
2. **Is the brand in the expected order** is measured by determining by shelf how many brands are not in their expected order and taking that as a per cent of the total number of expected brand/shelves in the planogram.
 - **Example:** if a planogram is vertically arranged by brand from top to bottom on 5 shelves, and the second brand in the order is switched with the third brand in the order that is two errors per shelf for a total of 10 errors. If there are 10 brands in total all having items on all 5 shelves, that is a possible 50 brand/shelves. So the score would be 10 errors divided by 50 possible.
3. **Is the brand item within the expected order** is measured by determining whether each brand/shelf has exactly the right order. If it does not that is an error and is calculated as a percent of the total number of expected brand/shelves in the planogram.
 - **Example:** if the planogram calls for skus to be ordered A-B-C-D-E and they are ordered A-B-D-C-E, that is one error. If there are 50 total brand/shelves as in example in #2, then the calculation would be one error of 50 possible. In fact any order other than A-B-C-D-E would produce an error in this calculation. If item B is not in distribution and the order is A-C-D-E, this is not an order error – it would be a distribution error.

Planogram Compliance Checking Process

Make 3 “passes” through each category recording different information on each pass on the report provided.

Pass 1: Distribution Space and Shelf # collection

Look at the shelf and check the planogram report for

- Is the item in distribution anywhere on the planogram?
 1. If yes, checkmark the “Distrib?” column
 2. If yes, write down the number of facings in the “Facings?” column
 3. If yes, write down the shelf number (#1 should be the bottom) in the “Shelf?” column
 4. If no, write it down including UPC, item number on the back page

Notes:

- * If the SKU has a shelf-tag but there is an empty hole above it, the SKU is still considered there, but make a note of the out of stock in the left hand margin.
- * If an item is not on the planogram but has product on the shelf and the shelf tag is gone or has “Discontinued” on it, the item is still considered in distribution and should be written down as an extra item on the last page. Please make a note of the “discontinued” indication

Pass 2: Brand Arrangement collection

Check the shelf against the planogram report (read shelf from left to right)

- For each shelf in the report:
 1. Pay no attention to the order of ITEMS within each brand – this pass is just looking at BRAND order
 2. Determine if the BRAND follows the BRAND that is before it on the report (excluding missing items)
 - a. If so, put a “yes” in the green subtotal line under the “Brand Order” column
 - b. If not put a “no” in the green subtotal line under the “Brand Order” column
 3. Extra items in distribution would create a “no” if they are not in the Brand order listed on the planogram report

*Note that for “mirrored categories” begin check from the right side of the category, and go to the left. Do this on every shelf. If some shelves are mirrored and some not, read left to right.

Pass 3: Item Arrangement collection

Check the shelf against the planogram report (read shelf from left to right)

- For each BRAND by SHELF in the report:
 1. Pay no attention to the order of the BRANDS, - this pass is only looking at ITEM order
 2. Ignore any extra items in distribution that are not on the report as if they do not exist
 3. Ignore any items missing in distribution – treat them as if they are in the correct order (example if item “B” is missing from a lineup of “A-B-C-D” but the lineup is “A-C-D”, it is correct)
 4. Determine if the **ALL** of the ITEMS within each brand follow the ITEM within the same brand that is before it on the report
 - a. If **all** items do follow the proper order within the brand, put a “yes” in the green subtotal line under the “Item Order?” column
 - b. If **any** do not follow, put a “no” in the green subtotal line under the “Item Order?” column
 - c. If you can’t determine the answer, write “can’t tell” in the green subtotal line under the “Item Order?” column.

How Compliance Gets Computed

Note: all calculations are deviation from 100 percent. Thus all of the following percentage calculations are “1 – error percent”.

Calculation 1: Distribution Compliance. Expected SKUs not in distribution PLUS Excess SKUs in distribution DIVIDED BY Expected # of SKUs on POG. The resulting number is the Distribution Compliance Percentage. Logic: For any POG there is a set of items expected to be present. Variance from this set (those not there and those in excess of the ones supposed to be there), detracts from the implementation of the plan.

Sub-Calculation 1: To create a basis for remaining calculations, so as not to penalize other measures for distribution failing, take the total Expected SKUs on POG MINUS the Expected SKUs that were not found. That number will be less than or equal to the Expected SKUs on the POG, and is referred to as Expected # of SKUs in Distribution.

Calculation 2: Facing Compliance. Number of Facing Errors DIVIDED BY Expected # of SKUs in Distribution. Logic is that for the numerator and the denominator we have eliminated the distribution compliance variance.

Arrangement Compliance Calculations (3-6):

Calculation 3: Right Shelf Compliance. Number of Wrong Shelf errors DIVIDED BY Expected # of SKUs in Distribution.

Calculation 4: Brand Block Compliance. Number of Brand Block Errors DIVIDED BY the Number of Brand Blocks.

Calculation 5: Brand Block Item Order Compliance. Number of Brand Blocks with Item Errors DIVIDED BY Number of Brand Blocks.

Calculation 6: Total Arrangement Compliance. SIMPLE AVERAGE of Calculations 3, 4, and 5.

Logic for Arrangement Compliance: Planograms are established for shopper and stocker convenience as well as to maintain/enhance brand equity and store sales. The shelf order of the brands presents a logic to the shopper in terms of position (what brand is adjacent to the brand), logical price points, and ease of finding desired items. The POG for the category tells a story. The degree to which the arrangement adheres to that story, the better the story is communicated. The storyline can be disrupted through placement of the brand blocks on the wrong shelf, mis-ordering of the brand blocks on the shelf, and mis-ordering of the items within the brand block.

Calculation 7: TOTAL Compliance: SIMPLE AVERAGE of Calculations 1, 2, and 6.

Best Practice Approach to Planogram Compliance Measurement

The effective measurement of POG compliance involves three basic components:

1. Distribution: to what degree do the items on the shelves match the items that are supposed to be on the shelf?
2. Space: to what degree does the space allocated to the item on the shelf match the planogram? This is operationalized as the number of facings for each SKU.
3. Arrangement: to what degree does the arrangement of the items on the shelf match the arrangement specified on the POG? There are three components to this:
 - Item on the correct shelf
 - Brands arranged in the correct order on the shelf
 - Items within the brand arranged according to the POG

To make the measurements, auditors reviewed each category in each store once a week, using a form we provided that is shown in Figure XX below. Detailed instructions that we provided to store auditors can be found in the appendix as well as the process used for calculating POG compliance from the data collected by the auditors.

COMPLIANCE CHECKING REPORT										
Store #:		Auditor Name:			Audit Date/Start Time:					
Shelf		Width: 16 ft								
UPC	ID	Name	Date?	POG Fa.	Facings?	Shelf?	Brand	Bld. Order?	Item Order?	Comments
3700092290	3700092290	Tide LC Lgh Cpr Reg Nbr 50_16		3				XXXXXX	XXXXXX	
3700092297	3700092297	Tide LC Lgh Cpr Lins Nbr 100_32		3				XXXXXX	XXXXXX	
3700039683	3700039683	Cheer Lq Free 80 oz		2				XXXXXX	XXXXXX	
3700097000	3700097000	Gain LC Lgh Cpr Reg Nbr 100_32		3				XXXXXX	XXXXXX	
1111187270	1111187270	Wsk HE 80 oz		1				XXXXXX	XXXXXX	
1111187411	1111187411	Wsk LC Lgh Cpr Reg Nbr 80 oz		2				XXXXXX	XXXXXX	
3320009520	3320009520	A-H LC Lgh Cpr Reg Nbr 100_25		3				XXXXXX	XXXXXX	
1111148104	1111148104	Surf LC Lgh Cpr SpB Nbr 100_32		3				XXXXXX	XXXXXX	
2420004956	2420004956	PUREX ULT LQ/MTN BRZ 100 OZ		2				XXXXXX	XXXXXX	
2420004957	2420004957	Purex LC Lgh Cpr Nbr Nbr 100_25		3				XXXXXX	XXXXXX	
XXXXXX	XXXXXX	XXXXXXXXXXXXXXXXXXXX		XXXXX	XXXXX	XXXXX	XXXXX	XXXXXX	XXXXXX	
Shelf 4										
UPC	ID	Name	Date?	POG Fa.	Facings?	Shelf?	Brand	Bld. Order?	Item Order?	Comments
3700092291	3700092291	Tide LC Lgh Cpr Reg Nbr 100_32		4				XXXXXX	XXXXXX	
3700092293	3700092293	TIDE ULT LQ 4RLD 150oz		2				XXXXXX	XXXXXX	
3700039684	3700039684	Cheer Lq Complete 80 oz		3				XXXXXX	XXXXXX	
3700032123	3700032123	Gain LC Lgh Cpr Reg Nbr 100_25		3				XXXXXX	XXXXXX	
1111187266	1111187266	Wsk LC Lgh Cpr Reg Nbr 80		2				XXXXXX	XXXXXX	
3320009500	3320009500	A-H LC Lgh Cpr Reg Nbr 100_32		3				XXXXXX	XXXXXX	
1111148006	1111148006	Surf LC Lgh Cpr Reg Nbr 100_32		3				XXXXXX	XXXXXX	
2420004820	2420004820	Purex LC Lgh Cpr Reg Nbr 100_32		3				XXXXXX	XXXXXX	
2420004959	2420004959	Purex LC Lgh Cpr Reg Nbr 100_25		2				XXXXXX	XXXXXX	
XXXXXX	XXXXXX	XXXXXXXXXXXXXXXXXXXX		XXXXX	XXXXX	XXXXX	XXXXX	XXXXXX	XXXXXX	
Shelf 3										
UPC	ID	Name	Date?	POG Fa.	Facings?	Shelf?	Brand	Bld. Order?	Item Order?	Comments

About the Authors

Thomas W. Gruen, Ph.D.

Thomas Gruen is a Professor of Marketing at the University of Colorado at Colorado Springs, where he has served on the faculty since 2001. He was on the faculty of the Goizueta Business School at Emory University from 1996-2001. He holds Ph.D., MS, and MBA degrees in Marketing from Indiana University's Kelly School of Business. Before entering the academic world, he worked as a retail trade association executive for ten years, managing advertising and publications for membership-based organizations.

Tom has been studying out-of-stocks since 2000. From 2000-2002, Tom obtained a major research grant from the Procter & Gamble Corporation, and led the research project team that produced "Retail Out-of-Stocks: A Worldwide Examination of Extent, Causes, and Consumer Responses." Along with his research partner from the London Business School, Dr. Daniel Corsten, he is conducting a follow-up study on solutions to retail out-of-stock problems that is the subject of this report.

His other research focuses on the management of customer relationships. Most of his recent research has focused on retailer-manufacturer relationships in the fast-moving consumer goods industry. His current research interests include retail out-of-stocks, category management, supplier-retailer scorecards, and customer-to-customer value creation. His research has been widely published including the Harvard Business Review, Journal of Marketing, Journal of the Academy of Marketing Science, Journal of Retailing, Journal of Business Research, Journal of Applied Psychology, and ECR Journal.

At UCCS, Tom teaches retail management, e-commerce, and marketing strategy to both MBAs and undergraduates. While at Emory, Tom taught Customer Relationship Management and Marketing Research to MBA classes as well as in executive education programs. In addition to the above responsibilities, he is a regular Visiting Professor at ESCP in Paris, France, is a member of the editorial review board for the Journal of the Academy of Marketing Science.

On a personal note, Tom lives in Colorado Springs, Colorado, with his wife and three children. A complete vita and additional information can be found at www.uccs.edu/tgruen.

Contact:

Thomas W. Gruen, Ph.D.
Professor of Marketing, College of Business
University of Colorado at Colorado Springs
Colorado Springs, Colorado 80919, USA
(719) 262-3335
tgruen@uccs.edu

About the Authors

Prof. Daniel Corsten

Daniel Corsten is Professor of Operations and Technology Management at IE Business School in Madrid and formerly Visiting Associate Professor of Operations Management at London Business School. Before he taught for more 10 years at the University of St. Gallen, Switzerland, as Assistant and Associate Professor and Vice-Director of University's Institute of Technology Management. He also visited the Wharton School at University of Pennsylvania, Philadelphia, INSEAD Singapore and Fontainebleau and Bocconi University, Milan.

At the heart of Daniel's research are supply chain management and service operations in diverse industries such as retailing, computer, automotive, software and logistics services. Currently, he is working on a multi-year research project on retail out of stocks with some leading retailers. His research appeared in Journal of Marketing and Journal of Physical Distribution and Logistics Management as well in managerial journals such as Harvard Business Review. He authored several books on supply chain management (in German).

A leading academic in the Efficient Consumer Response movement, Daniel was Founding Editor of the ECR Journal and President of the ECR Research Foundation (2000-2006). He co-authored award winning case studies on collaborative performance management and sustainable supply chains and has won two teaching awards. He is a regular speaker at international conferences and a consultant to Fortune 500 companies.

Daniel Corsten holds a MSc from the University of Cologne and a DBA/Ph.D. of the University of St. Gallen. He has worked as International Marketing Manager at Bayer AG, Leverkusen and as Project Manager at Agfa AG, New Jersey.

Contact:

Prof. Dr. Daniel Corsten
Professor of Operations & Technology Management,
IE Business School,
María de Molina, 11,
28006 Madrid
Daniel.corsten@ie.edu

