November 2019

Quantifying and Validating the Retail Value Delivered through the SAS-Rebotics Platform[1]

A Case Study

Author:
Thomas W. Gruen, Ph.D.
Professor of Marketing
University of New Hampshire

[1]This case study is the joint work of the author, SAS Retail Services, and ReTech Labs. In addition to the author, Scott Lemos, Lecturer and Data Scientist at UNH assisted Dr. Gruen with the analysis.

About the author

Dr. Thomas W. Gruen, serves as Professor of Marketing and Department Chair at the University of New Hampshire. He holds Ph.D., MS, and MBA degrees in Marketing from Indiana University's Kelly School of Business.

His research focuses on the management and governance of customer relationships, with a focus on fast-moving consumer goods (FMCG) retail and its supply chain. His retailing research has examined multiple issues including retail out-of-stocks and customer-to-customer value creation. His research has been widely published in highly respected journals including the Harvard Business Review, Journal of Marketing, Journal of Retailing, Journal of the Academy of Marketing Science, Journal of Service Research, Journal of Business Research, Journal of Applied Psychology, and Journal of Operations Management.

Tom has been working in the area of retailing for more than 20 years and engaged with the Efficient Consumer Response (ECR) movement in 1997 addressing issues of category management and out-of-stocks in the FMCG world.

Beginning in 2000, Tom began addressing issues of availability and out-of-stocks in retail. The first major study, supported by a generous grant from Procter & Gamble, resulted in a ground-breaking research study published in 2002, titled *Retail Out of Stocks: A Worldwide Examination of Causes, Rates, and Consumer Responses*. This study produced several derivative publications including "Stockouts Cause Walkouts," published in the Harvard Business Review. The study also attracted worldwide industry and academic attention, and this led to presentations at conferences including Food Marketing Institute (FMI), Grocery Manufacturers Association (GMA), and National Association of Chain Drug Stores (NACDS).

Tom continued his research and consulting on out-of-stocks and on-shelf availability with a second grant from Procter & Gamble. This study focused on methods to address out-of-stocks, and incorporated work with retailers along with major industry groups including GMA, FMI, and NACDS. The report was published in early 2008 by GMA and was titled *A Comprehensive Guide to Retail Out-of-Stock Reduction in the Fast-Moving Consumer Goods Industry*.

Tom's recent research on availability has focused on integrating new technology and artificial intelligence of retail store shelves and merchandise, designed to lower out-of-stocks and improve availability. This research was sponsored by SAS Retail Services, and it involved observations and examination of the effects of this new technology. This project was completed in 2019 and following pages are the results of the case study titled, *Quantifying and Validating the Value Delivered through the SAS-Rebotics Platform*. Tom continues to work with SAS Retail Services to disseminate the results of the research and further probe how this new technology can benefit retailers.

Additional information about the author, Thomas Gruen, Ph.D., can be found at paulcollege.unh.edu/person/thomas-gruen.Information on SAS Retail Services can be found at www.sasretail.com.

Quantifying and Validating the Retail Value Delivered through the SAS-Rebotics Platform

Introduction

It's 2019 and technology has infused almost all parts of consumer packaged goods (CPG) retail. Manufacturers get real time or daily reports of their brands' sales by store; shoppers investigate and often purchase online, inventories are managed perpetually; shoppers are aided by kiosks and virtual assistants; and retailers use customer loyalty data to understand shoppers' tendencies and promote directly to individual shoppers. It seems that having the right product in the right place at the right time should be a reachable goal for supply chains of fast-moving consumer goods (FMCG) through grocery and general merchandise retailers.

Out-of-Stocks – The Retail Scourge that Won't Go Away

Even with these technologies, out-of-stocks continue to plague retailers, and typically run at 8 percent.[2] Products can be out of place on the shelves, inventory counts are notoriously inaccurate, and shoppers continue to get frustrated when they are unable to find items they had planned to buy. On the retailers' shelves and in their coolers, where most of the shopper interface takes place, retailers have had to rely on high-cost labor to monitor and identify problems and solutions, with technological support often limited to inventory checks using a handheld reader to check each stock-keeping unit's (SKU) shelf tag one-at-a-time. With a retail grocery and merchandise store handling 20,000-100,000 SKUs, challenges and opportunities for merchandise management abound.

The branded goods manufacturers (also commonly referred to simply as "brands") know what gets sold into the stores, and they also know what gets sold out (from data syndicators such as IRI), but they have little visibility of what occurs on the shelves. Monitoring store conditions for promotional items and regular items could be of immense value to brands in determining promotional budgets and collaborating with retailers to enhance sales.

Thus, retailers have a huge incentive to address the ability to know what is on the shelf, and the major areas to be addressed include the following:

- The opportunity for improving out-of-stocks on the shelves (note that the term "shelves" refers to all merchandising areas of the store including center store shelves, perimeters, and coolers) has been estimated at 4% of sales.[3] Capturing a portion of this presents a huge sales opportunity for retailers from shoppers already in the store.
- Store associates spend considerable time identifying the items on the shelf that need to be addressed, leaving less time to actually address the issues identified. Shelf issues that constantly occur include planogram

[2] This percentage was established in 2002 (see Gruen et al. 2002 (study available at www.availabilitylab.com) and in spite of industry efforts, this percentage has been confirmed in recent studies including the FMI/GMA Trading Partner Alliance report in 2017 and in a widely distributed report by the consulting firm IHL in 2018.

[3] The sales opportunity was quantified by Gruen et al, 2002 (study available at www.availabilitylab.com), and confirmed by subsequent studies, including IHL in 2018 (https://www.ihlservices.com/product/oosoutofluck/). What is interesting is that this opportunity has remained the same for so many years.

compliance, item invaders and wanderers, hidden items, missing or incorrect shelf tags, and covering "holes" with available products to hide out-of-stocks.

- Inventory accuracy is notoriously low, and hovers around 50%.[4] Phantom inventory prevents automatic ordering and causes perpetual out-of-stocks, while the ability to identify actual inventory and match the on-hands with the perpetual inventory database is tedious and time consuming.

These costs can be substantial, and an example of them is provided in Figure 1. In summary, significant opportunities abound in the following areas:

- Increased sales to existing customers through higher availability
- Labor efficiency that focuses on fixing and less time spent identifying
- Lower labor costs surrounding correcting inventory issues
- Higher customer satisfaction
- Improved inventory investment through improved ordering and inventory accuracy

Figure 1: Sample Calculation of Total Cost of Out-of-Stocks

The Cost of Out of Stocks

- Retailers experience **8%** OOS
- **75%** caused by store
- **30%** lost sales to another store
- Retailers lose **4%** of their annual sales due to OOS items
- OOS events
  - Distribution
  - Store - store is out of inventory
  - **Shelf** - inventory in store, but not on shelf
- OOS Attributes
  - Number of occurrences over time
  - Number of simultaneous occurrences
  - Duration
  - Shelf availability
  - Lost sales - unit & monetary
  - Number of customers impacted

Cost of Out of Stocks for 100 store chain	Retailer Example
Avg. $ volume/week (000)	$298
Shoppers encountering 1 or more OOS	40.0%
% times shoppers involve store labor	10.0%
# stores in chain	100
Annual labor cost in chain	$4,080,878
Annual lost sales in chain (000)	$61,984
Annual lost sales profit in chain (5%)	$3,099,200
TOTAL COST OF OUT OF STOCK	$7,180,078

Addressing the Opportunity

There are promising automation technologies being developed to address these opportunities on the retailers' shelves. These involve the use of artificial intelligence (AI) and machine learning and are based on scanning and capturing the inventory on the shelf, digitizing and analyzing the images, and having the technology provide the auditing and reports of the shelf conditions. With these AI generated reports, all stakeholders have new information to help them address the problems and capture some of the opportunity in improved shelf conditions.

[4] This surprising and troubling finding has been found in several research studies. See Gruen, et al, 2007 at www.availabilitylab.com for additional research on how inventory inaccuracy contributes to out of stocks.

There are several entrants in the field that are beginning to provide these services, including ReTech Labs, Bossanova, Trax, SES-Imagotag, and others. The data collection tends to fall into three types: Robots, Mobile (hand-held), and Fixed Cameras. There are some variations of the above, such as linking fixed cameras with smart shelf tags, and mobile data collection using drones instead of human labor.

The major considerations to the data collection type for retailers includes the frequency of data collection, the technology and equipment costs (CAPEX, leases, maintenance, processing), the flexibility of data collection (which categories get examined), and the ability to take action on identified issues. The three types of data collection instruments and the four considerations are summarized in the table below (Figure 2).

A fixed camera can collect data as frequently as desired but is limited to what it can view from its position. These are of strong interest to brands who can monitor their shelf position within a category as well as direct-store-delivery (DSD) suppliers who can view their products between stocking visits. Robots have the ability to collect data from large areas of the store at regular intervals. The overall CAPEX (or lease cost) is high, and there is a need for maintenance, and they need a place to live in the store, further complicating retailers' lives. Mobile devices have low cost and high flexibility, but they can only provide data when a person is physically present, which reduces the frequency of data collection. The processing must be provided in real time so the person can take action. The real advantage of mobile device is that the person is in the store and available to address any recognized issue as soon as it is identified.

Figure 2: Comparison of On-Shelf Data Collection Methods

Data Collection Type:	Technology and Equipment cost	Frequency of data collection	Flexibility of data collection	Ability to take immediate action
Fixed Camera	Low	High	Low	Low
Robot	High	Moderate	Moderate	Low
Hand-held mobile	Low	Low	High	High

Industry Structure

Given the advantages and disadvantages of the three different data collection types of the new shelf technologies, understanding the overall industry structure in FMCG retail is critical to optimizing solutions. The two primary players are the manufacturers (brands) and retailers. However, the complete supply and support chain is more complex with three other regular entities involved in shelf merchandising. These are described below.

1. Sales and Marketing Agencies

A sales and marketing agency (SMA) will represent multiple national and regional CPG companies (brands) to retailers, and they function as the sales arm for the brand. Revenue is generated based on commissions for the sale of goods to retailers. The agencies provide a range of customized sales, marketing and technology solutions on behalf of the CPG companies that include headquarters sales, analytics and intelligence services, retail services, marketing services, and order processing, among others.

2. Direct-Store-Delivery (DSD) Companies

Direct to Store Delivery (DSD) is a form of distribution where the distributor/supplier delivers directly to the retail store, skipping the retailer's distribution center. DSD is a business process that manufacturers use to both sell and distribute goods directly to point of sales (POS) or point of consumption (POC) including additional product and market related services such as merchandising, information gathering, or equipment service and bypassing any retailer or wholesaler logistics. DSD is mainly used by the manufacturers of perishable consumable goods such as tobacco, greetings cards, beverages, baked goods and snacks, and pharmaceuticals.

3. Merchandising Service Providers (MSP)

Merchandising Service Providers (MSPs) are retailer-centric and have alignment with retailer partners instead of alignment with specific CPG brands (SMAs contract with the CPG brands). The MSPs provide customized, in-store retail merchandising service solutions that deliver results through innovation, highly trained personnel and integrated technology. MSPs are paid by the retailer using funds collected from the CPG companies. The services they perform are shown in the table below (Figure 3).

Figure 3: Services Provided by MSPs

Category Resets	Item stocking	Store layouts
New Item Cut-Ins	Continuity work	Full store remodels, new store build-out and refreshes
Display building	Project work	Category mapping
Assembly	Data collection	POG services
Installation	Analytics	Insights strategy

Enter the SAS-Rebotics Solution

One of the leading merchandising service providers, SAS Retail Services, partnered with the technology company, ReTech Labs, to create the SAS-Rebotics platform to deliver its new strategy to assist FMCG retailers termed "SAS Retail 2.0." SAS-Rebotics provides AI technology that allows its associates in the stores to capture digital images of a store's shelf using a mobile device similar to a mobile phone. The digital images are transmitted to the technology platform servers and are processed immediately. Within minutes, a real-time report of each section of the store is returned to the merchandising associate, providing a prioritized work plan to address the issues identified by the technology. The time that the merchandising associate used to spend identifying issues can now be transferred to actually addressing issues. It also provides all stakeholders with an accurate, ongoing assessment of the on-shelf conditions to address short-term and ongoing inventory and merchandising problems and opportunities.

The SAS-Rebotics technology solution is closing the loop for eliminating out-of-stocks on the shelf. This solution makes it three times more efficient to identify out-of-stocks on shelf compared to the human eye trying to locate holes or plugs. With the SAS-Rebotics generated recap and issue list the SAS merchandising team can correct and increase on-shelf availability right on the spot, driving store sales for retailers.

The Challenge to SAS-Rebotics

The research team has established the specific goals and KPIs for the SAS-Rebotics solution:

1. Increase sales through improved planogram compliance; increase sales due to reduced out-of-stocks; increase sales through improved inventory accuracy.
2. Increase speed, accuracy, and efficiency of shelf maintenance processes utilizing the technology platform's mobile device and its associated leading-edge systems to inform human activity; reduce overall operating costs for shelf management.

The challenge is to test and validate that the above two goals are achievable through the SAS-Rebotics platform.

The Pilot Study Plan and the Field Experiment

SAS Retail Services found several of its retail customers open to piloting the new technology, and they elected to pilot with three regional grocery chains located in the northeastern United States, piloting the technology in multiple stores in each chain.

A field experiment was established with one of the three chains, and over a 10-week period, from March 18-May 31, 2019, the technology was pilot tested in five stores. The pilot covered 45 categories in the stores, covering more than 20% of the retailer's total number of categories.

From these 45 categories, five target categories were selected to allow in-depth examination and analysis as well as to provide a more targeted focus for the merchandising associates among the 45 total categories being scanned in the pilot. The categories represented a broad sample of the store's categories, and included:

- Frozen Pizza
- Ready-To-Eat Cereal
- Granola Bars
- Dog Treats
- Deodorant

The hypotheses and overall model tested in the pilot study focused on the following two stages:

1. Use of SAS-Rebotics technology will lead to the following enhancements of store merchandising:
   a. increased POG compliance
   b. higher on-shelf availability
   c. improved inventory accuracy (inferred from the number of "zero" on-hands)
2. These enhancements will lead to increased unit and dollar sales

Measurement of the store merchandising enhancements would be made directly and compared from the beginning to the end of the pilot period. Measurement of the increased unit and dollar sales would be made in two ways: the first is a direct measure from the beginning to the end of the pilot period. Second, in order to rule out competing explanations such as seasonality or weekly variations in sales, effects of promotions, or other confounds, SAS and the retailer also measured sales of the categories of the five pilot stores against the sales of a selection of five control stores.

Measurement of the Pilot and Control Stores in the Field Experiment: Difference Test

Each pilot store was matched with a similar control store in the region. The actual measurement of unit and dollar sales was the weekly difference in sales across sets of approximately 900 SKUs across the five categories for the pilot and control stores. The number of SKUs per category varied across each of the pilot and control stores, but it remained constant over the 10-week test period. The following table (Figure 4) shows the number of SKUs per store that were tracked over the 10-week period. In total we tracked 4,443 SKUs in the pilot stores and 4,511 SKUs in the control stores each week. Given the additional SKUs, the aggregate sales volume of the SKUs tracked in the control stores was slightly greater than that aggregate sales volume of the SKUs tracked in the pilot stores. The focus of the study was to examine changes in the differences in these aggregate sales of the 10 weeks of the study.

Figure 4: Total SKUs Per Category and Store

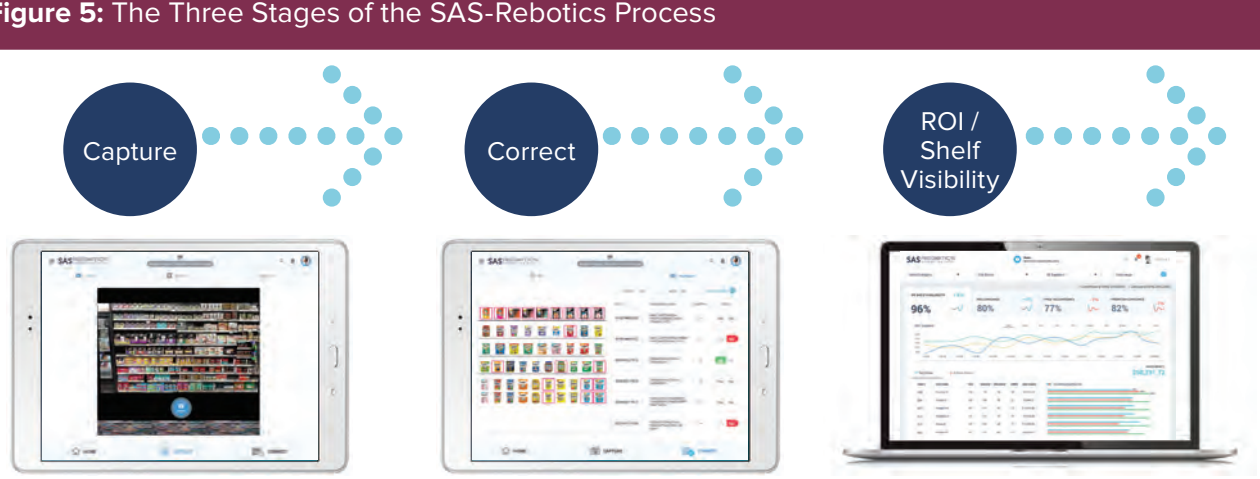
Store Status:	**Group**	**SKUs:** Cereal	Deodorant	Dog Treats	Frozen Pizza	Granola Bars	**Total SKUs:**
Pilot	1	203	281	120	98	142	844
Control	1	229	281	158	115	158	941
Pilot	2	246	280	81	107	109	823
Control	2	215	228	120	115	159	837
Pilot	3	227	281	158	115	133	914
Control	3	219	287	120	116	132	874
Pilot	4	228	281	158	115	146	928
Control	4	227	279	152	115	159	932
Pilot	5	222	281	158	115	158	934
Control	5	228	280	158	115	146	927
Average:		224	276	138	113	144	895

The goal of matching each pilot store with a control store required each set of the pilot and control stores to be affected by the same promotions schedules and weekly sales variation, so differences in sales could be isolated and attributed to the efforts of the SAS-Rebotics technology. Managers of the control stores were "blind" to the pilot study. If the control stores knew they were part of the study, they could alter some regular processes and impact the findings. Therefore, to insure the control stores were completely blind to the pilot study, merchandising teams could not take direct measurements of availability, compliance, or inventories in the control stores during the test period – it was business as usual, with the "normal" merchandising associates providing typical retail services over the 10-week period.

In the pilot stores, additional merchandising associates were deployed to implement the SAS-Rebotics technology. Normal retail services provided by SAS were continuing simultaneously in the pilot stores, matching what was occurring in the control stores. The additional merchandising associates working with the new technology had to be

trained to scan the shelves, and they had to be trained on reading the results once they were received. Merchandising associates also had to use the retailer's inventory readers to determine inventory accuracy (how many units the scan showed compared with the number in the retailer's perpetual inventory database). Merchandising associates scanned and addressed all 45 categories daily (M-F) during the 10-week pilot period. The exhibit below (Figure 5) depicts the three stages of the merchandising associates' work using the SAS-Rebotics system:

Figure 5: The Three Stages of the SAS-Rebotics Process

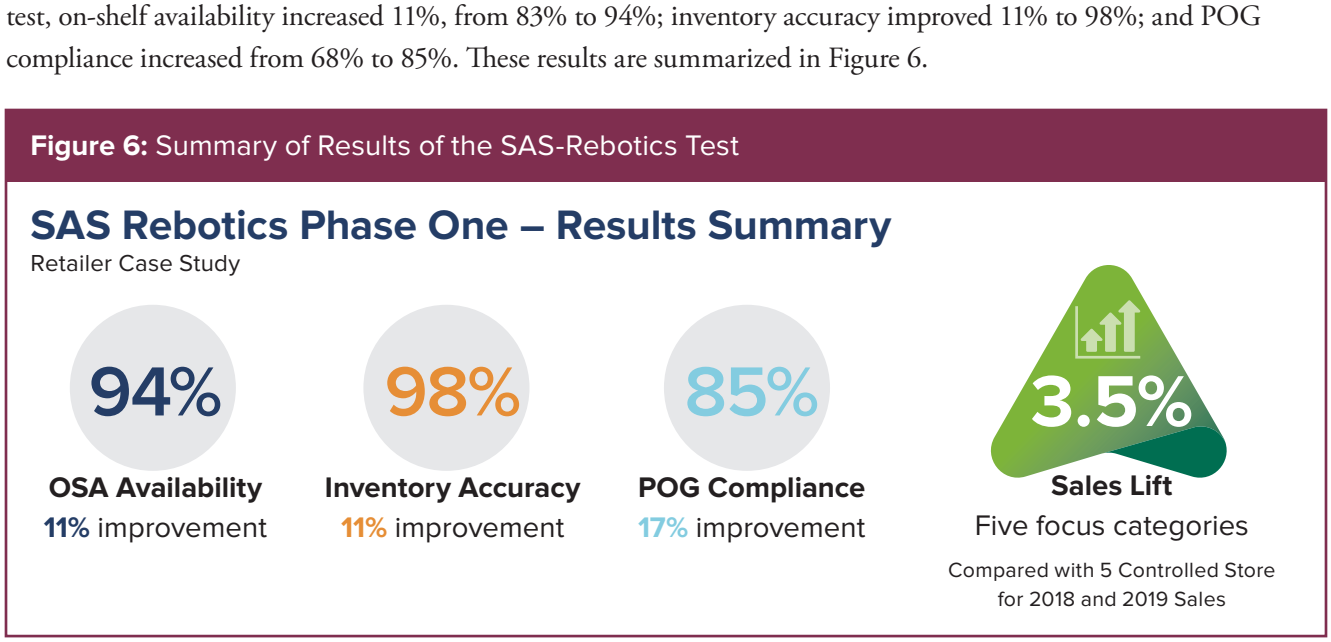


Results

The results of the study provided clear evidence that the pilot is able to capture a significant part of the opportunity available through applying the SAS-Rebotics technology and processes to the retailer's shelf management.

Direct measures:
The merchandising associates captured pictures using SAS-Rebotics technology which identified shelf issues on spot for resolution. During the pilot, by capturing and correcting shelf issues on the spot during each day of the 10-week test, on-shelf availability increased 11%, from 83% to 94%; inventory accuracy improved 11% to 98%; and POG compliance increased from 68% to 85%. These results are summarized in Figure 6.

Figure 6: Summary of Results of the SAS-Rebotics Test

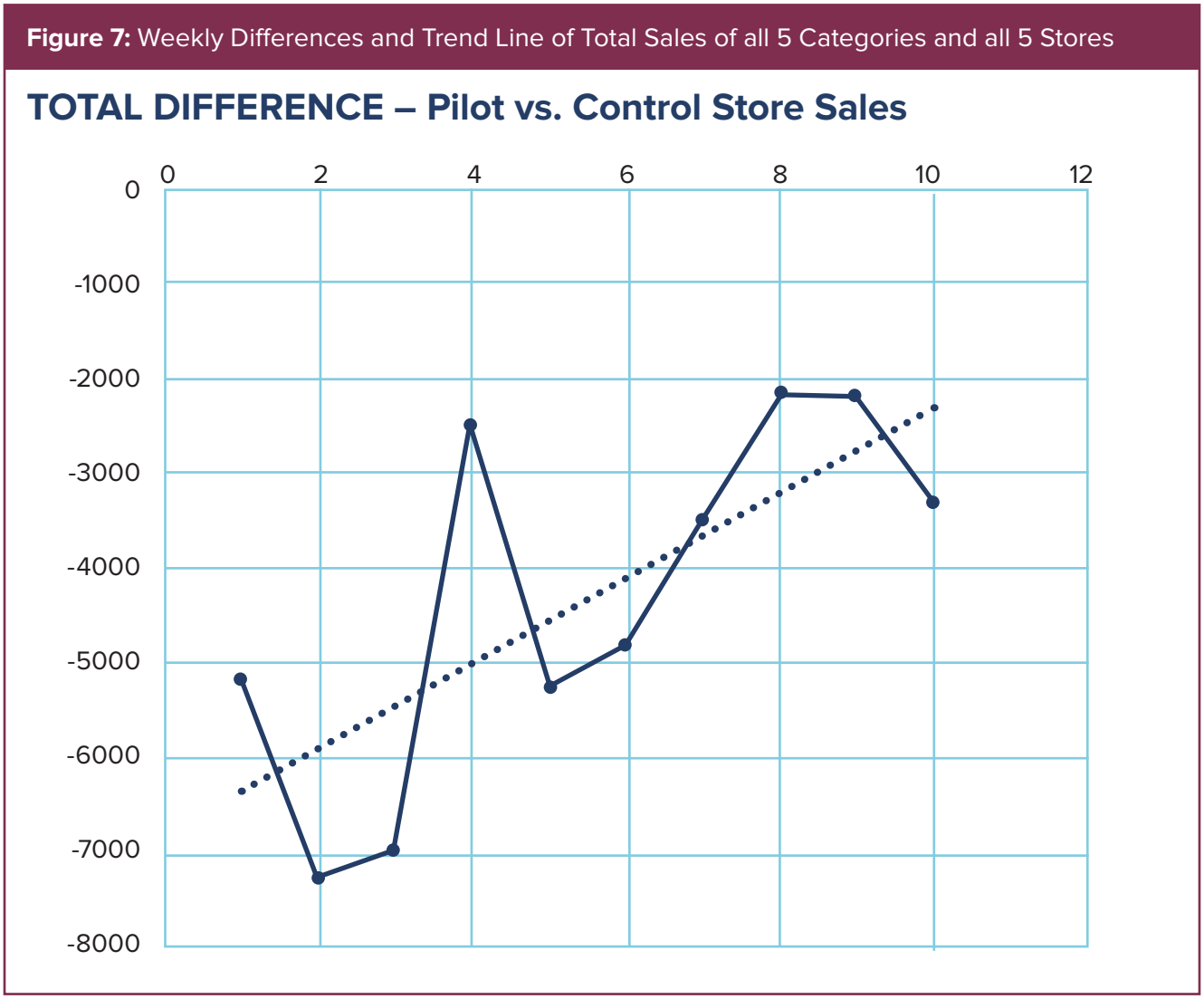


Differences in Sales Volumes of Pilot vs. Control Stores

The impact of the pilot on sales in the targeted categories was examined from several angles. The most direct was a "difference" test, where total sales of the five target categories was compared between the pilot and the control stores and examined on a weekly basis. At the beginning of the study, the total aggregate sales of the SKUs tracked at the control stores was greater than the total aggregate sales of the SKUs tracked at the pilot stores, therefore the focus was measuring that gap, with the general overall hypothesis that the impact of the SAS-Rebotics intervention would narrow the gap over the course of the 10-week test period.

As illustrated in Figure 7, in the first week the gap was $5,190, and by the end of the pilot period that gap had shrunk to $3,327, indicating an improvement in the pilot stores of $1,864 over the control stores. To understand the meaning of this difference, divide the $1,864 sales increase by five stores and again by five categories, to obtain the average sales lift of approximately $75 per category per store. This translates to a sales lift of 3.5% of the average category sales ($75 / $2,132 weekly sales). This difference can be annualized to $3,900 per category per store ($75 per week * 52 weeks per year).

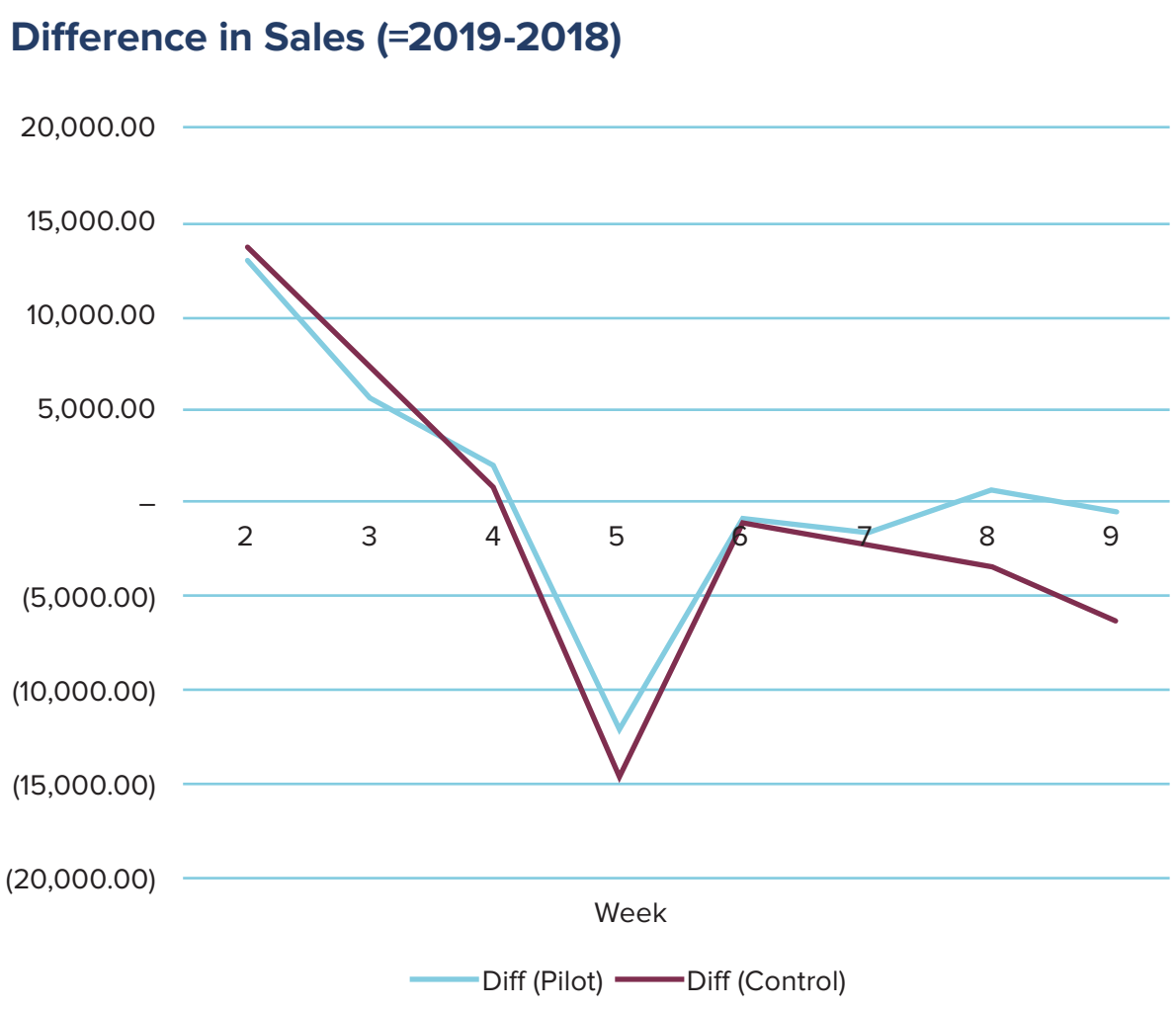
Figure 7: Weekly Differences and Trend Line of Total Sales of all 5 Categories and all 5 Stores



To validate the 3.5% sales increase, the data was examined in multiple ways including subtracting the first and final weeks from the analysis (which improved the results dramatically), examining the individual pilot and control store pairs, and using unit sales instead of dollar sales volume. Each of these additional analyses suggested that 3.5% sales increase is a conservative estimate of the impact of the SAS-Rebotics pilot on category sales.

As a final validation, and to eliminate the possibility that there may be other growth factors associated with one or more of the pilot stores vs. the control stores, we compared the same 10-week period in 2018 of the control and pilot stores to the 10-week test period in 2019, then computed the differences between the control vs. the pilots between the two years. Over the first three weeks, there were no differences, but from week 4 and continuing through week 10, the "differences within differences" of the pilot stores was higher than that of the control stores, and this distance continued to widen after week 6 (see Figure 8). This analysis shows that the pilot stores outperformed the control stores, and annualized, this total $3,471 per category per store, is strikingly close to the $3,900 per category per store we found when examining 2019 alone. Furthermore, examining every individual store pair, the pilot store outperformed the control store, demonstrating the positive effect across all pilot stores.

Figure 8: Comparison of Sales Differences Pilot vs Control Stores Over Previous Year



Examining a Lag Effect Following the 10-Week Test Period

For four weeks following the 10-week pilot period, the sales of the pilot and control stores were monitored, comparing the differences in sales of the five target categories. There were two alternate possibilities either 1) the 10-week test of the SAS-Rebotics would produce a lag effect, where the sales gains would continue (due to improved overall store inventory and merchandising processes), or 2) that without the ongoing SAS-Rebotics monitoring, the sales differences between the pilot and control stores would return back to previous levels. Week 11 showed a lag effect, but in week 12, two of the control stores had a large sales spike that did not occur in the pilot stores, confounding the results. Therefore, no conclusion regarding the lag effect can be confidently made with this study alone.[5]

Conclusion and Implications

A variety of research has pointed to a 4% sales opportunity for retailers to address out-of-stocks. The key finding of this study, that of a 3.5% sales lift suggests that monitoring and visibility of the shelf conditions through technologies like the SAS-Rebotics platform provides the key to unlocking this door. There are several reasons to subscribe to this theory. The first is that studies in out-of-stocks in online environments have provided new insights to shoppers' reactions to out-of-stocks that could not be measured directly in the store. These point to the importance of transparency of information regarding out-of-stock items, and they highlight the rewards of tidy shelf management. The transparency of the shelf conditions that are available through the SAS-Rebotics tool drives retailers to adopt these improved practices. The second is that inventory accuracy is notoriously low in retail environments, and the new technology provides a means to improve the accuracy of inventory counts. Other retail practices, such as leaving holes open on the shelf when an item is out of stock have been shown in previous research to lead to improved results, and the SAS-Rebotics platform addresses these practices.

The findings from this study can be exported to similar stores and situations by plugging in the number of categories and stores in the formula shown in Figure 9. The only piece of information that needs to be estimated is the average weekly sales lift provided by the solution. Once this is estimated, then the number of categories that will be addressed in the store and the total number of stores is the other information that needs to be put into the formula. In this study, we found a $75 weekly sales lift, based on categories averaging $2,132 in weekly sales, which is 3.5 percent. Retailers with larger or smaller average weekly category sales can adjust accordingly, using the 3.5 percent finding from this study as a starting point, adding additional sales through enhancing availability using the SAS-Rebotics solution.

Figure 9: Extrapolating the Findings Across a Chain For a Full Year

$_____ weekly sales increase per category through increased availability
x 52 weeks/year
x _____ categories
x _____ stores
= $_____ Total

Example: $75/category x 52 weeks x 200 categories x 100 stores = $78,000,000 annual sales

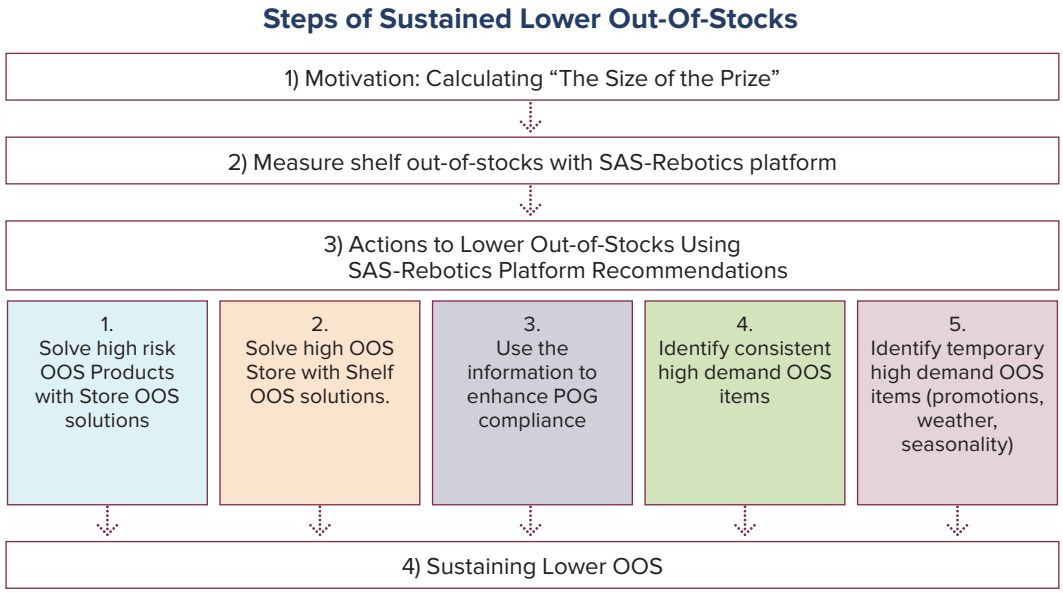
Alternative calculation: the above example translates to approximately $35 million sales increase for each $1 billion of sales. A retailer with $4 billion sales volume could see $140 million in additional sales.

[5] The difference in Week 11, the first week after the pilot ended was $-3,749, so we did see some positive lag effect. But the following weeks showed a fast drop-off. Week 12 had the largest deficit, but part of that was attributable to two of the control stores having large sales spikes that were not seen to the same level in the test stores. Following the conclusion of the SAS-Rebotics pilot program, the total difference went back to the pre-pilot level, and the average difference for four weeks following was $-6,159. Therefore, it is likely that a 10-week test is not a long enough period to alter other store processes which would be necessary to see a lag effect.

Action Steps for Retailers

Implementing the SAS-Rebotics platform is one key step that retailers can take. However, to realize the full benefits and long-term potential, this needs to be part of an overall approach to addressing out-of-stocks. This includes the following the action steps shown in Figure 10.

Figure 10: Taking Action to Address Shelf Out-of-Stocks



Limitations of the Study and Future Research Opportunities

The research here would be categorized as a field study, and it does not have the controls in place to ensure the same level of validity of findings that are provided in a laboratory study. Moreover, the control stores and pilot stores do not match on every characteristic, and it would be preferable to not only match up control with pilot stores, but also monitor ongoing operations in each to rule out any confounds. However, the assumptions of similarity during the pilot period of promotions, resets, unusual events such as weather or changes in economic conditions rule out most major known reasons for confounds. Thus, the likelihood that confounds rather than the intervention account for the results reported here is very low.

The pilot study depended on daily interventions, with merchandising associates scanning the target categories five days a week. The results do not provide an indicator of the minimum number of required weekly readings to have an impact, and it does not provide information on the ceiling effect of the frequency of readings. From the earlier discussion of the advantages and disadvantages of the mobile data collection, frequency and regularity of readings are more difficult than with other data collection methods (specifically, robots or fixed cameras). However, there is also a likely ceiling effect where the value of increased frequency diminishes. Knowing the "sweet spot" for the frequency of scanning and intervention will be important to optimizing the value of the SAS-Rebotics solution.

Future research on additional benefits of the SAS-Rebotics technology - Propositions that were not explicitly examined in this study, will bring additional value to the retailers

In addition to the benefits hypothesized and measured, there are additional benefits expected from the pilot study that we did not measure, and therefore we present these as propositions:

- Higher on-shelf availability leads to improved customer satisfaction, retention, and category purchasing. Further testing of this could be done using loyalty card data to observe this effect. A second method would be to take a survey of a sample of shoppers at the test and control stores before the pilot starts and again after the pilot ends.
- Use of SAS-Rebotics technology allows personnel to spend less time identifying issues and more time fixing – greater efficiency of personnel time. This could be measured directly by the number of "fixes" per hour per associate. The assumption would be the SAS-Rebotics would increase the number of fixes / hour / associate. This could also be addressed qualitatively by asking associates involved in the pilots to make estimates of their time spent identifying vs addressing issues with and without the SAS-Rebotics technology.
- Improved store stocking, backroom, and ordering processes lead to better investments in inventory (higher ROI). This could be measured by tracking the retailer's records by examining age of inventory and inventory ROI before and after the pilot period.
- Prioritization of process improvements for ordering, back room organization and management, inventory handling, and shelf stocking. Use of the SAS-Rebotics technology provides retailers with data-driven information about shelf conditions. This can be valuable when examining other store process improvements as it provides information in advance of sales history which is a lag indicator.

Final Words[6]

This case study reports the implementation and findings from a 10-week study that was carried out in five pilot stores from March-May 2019. The pilot test covered 45 categories where the shelves were scanned daily (Monday-Friday) by SAS Retail Services merchandising associates using the SAS-Rebotics platform. Using the reports returned by the platform in real time, the merchandising associates would implement the recommendations. As a result, the merchandising associates were able to alter much of the time previously used to identify shelf out-of-stocks and planogram non-compliance issues, to implementing the solutions generated by SAS-Rebotics.

As a result, the value delivered through the SAS-Rebotics solution to the retailer was significant. To reiterate the findings presented previously and in more detail in this case study, the following benefits were obtained from the 10-week pilot study in five stores:

- Across 45 categories, on shelf availability (OSA) improved 11 percent
- Across 45 categories, inventory accuracy increased 11 percent
- Across 45 categories, planogram compliance showed an 17 percent improvement
- All of these led to a 3.5 percent sales lift in the categories in the pilot stores compared with sales in the control stores over the same 10-week period.

The SAS-Rebotics solution can lead to substantial returns, and all of this comes from the shoppers already in the store.

[6] Additional information about the author, Thomas Gruen, Ph.D., can be found at paulcollege.unh.edu/person/thomas-gruen. Information on SAS Retail Services and Retech Labs can be found at www.sasretail.com and retechlabs.com, respectively.