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Item-Level RFID for Apparel: The Bloomingdale's RFID Initiative

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ITEM LEVEL RFID FOR APPAREL: THE BLOOMINGDALE'S RFID INITIATIVE

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EXECUTIVE SUMMARY

Item-level RFID has the potential to improve many in-store processes for retailers. In particular, the business case for RFID for apparel retailers looks promising. Previous studies have shown the benefits of RFID at the pallet and case level, such as reducing out of stocks and improving inventory count accuracy. It seems logical, therefore, that item-level RFID would provide even more benefits. In this study, we examine the use of item-level RFID at a major apparel retailer, Bloomingdale's. Specifically, the use cases of inventory accuracy and out of stocks are investigated, with incidental attention to cycle counting and loss prevention. Results clearly indicate the tendency for inventory accuracy to diminish over time, as well as the potential for improvement in inventory accuracy due to RFID. Improved inventory accuracy leads to fewer out of stocks, less safety stock, and better ordering and forecasting, among others. The ability to quickly and accurately conduct cycle counting facilitated by RFID, rather than doing large scale inventories once or twice per year, offers the advantage of keeping inventory accuracy high. Finally, for loss prevention, RFID provides the advantage of knowing exactly what was stolen, when it was stolen, and from where it was stolen. In addition to the insights this provides to improve loss prevention methods, knowing exactly what was stolen allows the retailer to adjust inventory counts accordingly and order more product, as needed.

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Introduction

"RFID in the apparel retail value chain is an item-level proposition, and the place to begin is in the store" (Kurt Salmon Associates). Our previous research on RFID in the supply chain and in the retail space supports the assertion that benefits can be found for both the retailer and supplier at the store level. While tagging pallets and cases as a stand-in for item-level tagging has demonstrated benefit, actually tagging at the item level within the retail environment can now be demonstrated to provide greater opportunities both for retailers and for their suppliers.

Item-level tagging is at the heart of nested visibility (see Figure 1), described as the ability to track and identify products at various levels from production through sale. In the consumer packaged goods industry, the current state of product visibility is generally pallet and case level; therefore, product visibility is lost once case- or pallet-level product leaves the backroom for the sales floor and is removed from the case. By starting the investigation at the item-level, one is able to investigate the usefulness of the tagging for visibility at other levels (such as using the item tagging as surrogates for case and pallet tagging).

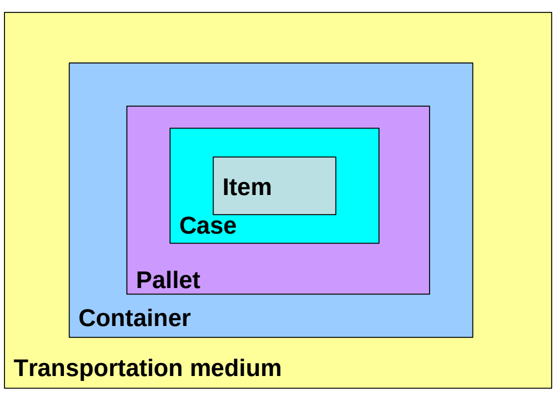

Figure 1. Nested visibility

Research into item-level tagging demonstrated that RFID benefits do not end at the store. If we begin the investigation of RFID benefits at the store, then both the tagging—and the benefits—can be pushed up the supply chain. Ultimately, the maximum value for RFID is realized when it is used throughout the supply chain in the places where it provides the most benefit for one or more specific business processes.

The research conducted at Bloomingdale's is part of a larger research effort to demonstrate and quantify the business value of using RFID item-level tagging as part of the ongoing day-to-day business operations within a retail environment. Bloomingdale's reputation in the retail industry and their willingness to incorporate RFID item-level tagging into their existing business processes provided a unique and valuable research opportunity.

Company Overview & RFID Use Cases

Macy's, Inc. is one of America's premier national retailers, operating 40 Bloomingdale's stores and more than 810 Macy's stores in 45 states, the District of Columbia, Guam and Puerto Rico. Bloomingdale's was among the best performing Macy's, Inc. divisions in 2007 and continues to be recognized for its originality, innovation and fashion leadership (Macy's Investor Relations, 2008).

The primary uses for RFID examined at Bloomingdale's were inventory accuracy and out of stock. In this particular study, item level RFID tagging and physical inventory counting was investigated *in situ*, primarily to determine the effect of item level tagging on inventory accuracy, which is known to cause other problems, such as out of stocks. Cycle counting and loss prevention were also addressed, though neither was a primary focus of the study. Overall, the results can be used to provide guidance to companies as they investigate whether, and to what extent, to implement RFID.

Inventory Accuracy: The Root of all Problems?

The amount of product retailers think they have on hand (also referred to as perpetual inventory or PI) is usually wrong. Many previous studies have shown the inaccuracy of a typical retail store's perpetual inventory count, for example 51% inaccuracy (Kang and Gershwin, 2007); 65% inaccuracy (Raman, DeHoratius, and Ton, 2001); and 55% inaccuracy (Gruen and Corsten, 2007). Subsequently, many decisions, such as ordering, forecasting, and replenishment are based on a number that most studies find is wrong more often than it is right!

When evaluating inventory accuracy, there are two basic categories of inaccuracy: understock and overstock. Research has found that about half of the time, inaccuracy in PI is due to understock (i.e., PI shows more inventory than is actually in the store, also known as phantom inventory), and about half the time inaccuracy in PI is due to overstock (i.e., PI shows less than what is in the store, also known as hidden inventory) (Gruen and Corsten, 2007). Both types of PI can have a detrimental effect on the retailer. For understock, the most serious and directly related problem is out of stock; the system thinks it has inventory on hand (i.e., phantom inventory), thus, fails to order new inventory. For overstock, the most pressing problem is excess inventory (i.e., hidden inventory) because the system thinks it does not have as much as it really does, thus ordering unnecessary inventory. This unnecessary inventory potentially results in excess holding costs, excessive markdowns which impact margin, reduced turns, and breakdowns in store execution (which can lead to execution-related errors such as out of stocks) due to the inefficiencies created by the extra inventory.

There are several known causes of inventory inaccuracy (Gruen and Corsten, 2007; Kang and Gershwin, 2007; Waller, Nachtmann, and Hunter, 2006). Among the most common causes are theft, cashier errors, and incorrect manual adjustments. Theft leads to understock situations.

For example, the system thinks there are 10 items on hand, but three were stolen leaving a true on hand of only seven. Left alone, this error will grow over time as more items are stolen. Cashier errors can result in both overstock and understock. For example, if a customer is purchasing three items of product A and three items of product B, but the cashier mistakenly enters six items of product A, then the PI for product A will be understated by three units and the PI for product B will be overstated by three units. Finally, physical inventory counts can be incorrectly manually adjusted by employees. For example, when an employee believes the product to be out of stock, physical inventory count may be mistakenly set to zero when, in reality, product is in the backroom. Although there are other things that cause inventory inaccuracy, such as mis-shipments, improper returns, and damaged/spoiled products, the aforementioned account for most of the problems.

Companies can address inventory accuracy problems or errors in a variety of ways, as presented in Table 1. First, companies can conduct physical counts frequently and adjust PI accordingly. Unfortunately, this strategy is very expensive and is less than perfect. Manual inventory counts are rarely, if ever, perfect. Second, companies can let the system adjust PI automatically based on an estimated error rate. For example, if the company estimates that 2% of the items are stolen per month, then the system could make a 2% adjustment each month. The problem with this strategy is that the adjustment factor is difficult, if not impossible, to determine. Finally, the company can try to eliminate the source of errors by better inventory management, reducing theft, etc. Kang and Gershwin (2007) suggest auto-ID (RFID) as one method to help companies eliminate the source of errors.

Sources of Error in PI	Results in Understock?	Results in Overstock ?	Solutions Available
Incorrect manual adjustment	Yes	Yes	Manual adjustments restricted and based on cycle count
Theft	Yes	No	Identify what leaves the store and where
Damaged	Yes	No	RFID identification allows segregation and subsequent removal from inventory
Improper returns	Yes	Yes	Handled automatically if RFID-enabled point of sale
Mis-shipment from DC	Yes	Yes	RFID receipt or cycle counting will modify PI accordingly based on actual
Cashier error	Yes	Yes	Handled automatically if RFID-enabled point of sale

Table 1. Sources or Error in Inventory Accuracy

Research Methodology

To investigate item-level RFID use cases, two stores were chosen: one RFID-enabled store and one control store. Both stores were in the same geographic region (major metropolitan area in the northeastern U.S.). Two departments – men's denim jeans and women's denim jeans – were included in this study. During the 13-week pilot, physical counts (RFID and/or bar code) were taken three times per week (Monday, Wednesday, and Friday) for five weeks in order to establish a baseline for both departments in both stores. For the remaining eight weeks, physical counts (RFID and/or bar code) were conducted two times per week (Monday and Friday.) A professional inventory service was contracted to perform the bi-weekly inventory counts before the store opened; the inventory service followed the same procedures throughout the study to count inventory on the sales floor and in backroom storage areas.

The test store was equipped with static readers at all employee and customer entrance/exit doors. Cycle counting (i.e., physical inventory counting) was conducted with handheld RFID readers (in the test store) and with barcode scanners (in both the test and control stores).

There were between 9800 and 10,500 items included in this study. Items were RFID-tagged upon arrival at the store; thus, they could be read when moved from the receiving area to either a stock room or the sales floor. Tags were removed at point of sale and discarded. Returned merchandise was re-tagged by a store associate using a printer/encoder near the department.

The baseline portion of the study was used to determine actual physical inventory counts at both the test and control stores. These inventory accuracy numbers (actual inventory) were compared to Bloomingdale's Item File (Perpetual Inventory) for both the test and the control stores throughout the 13-week study. Once RFID was in place, the RFID inventory numbers were used at the test store for comparison to both PI and bar code inventory figures. Changes to PI were not made during the study; rather, simulated changes were made to PI (in a parallel system) to determine whether greater inventory accuracy could be achieved by updating PI with RFID inventory numbers.

During the course of the study, metrics were gathered on inventory accuracy (what the system shows versus what was counted by hand or by RFID), out of stocks, and cycle counting time. Loss prevention was assessed anecdotally.

Results

Inventory Accuracy

For each Bloomingdale-specific combination of stock keeping units (SKUs/UPCs) in each store, inventory accuracy was calculated by subtracting the physical inventory count, as determined by either RFID-read or barcode scan, from the system count (i.e., PI). Thus, we were able to obtain a measure over the 13-week period of actual inventory and the decreased accuracy over time, as displayed in Figure 2. In this case, since the pilot did not plan for changes to the item file (PI), we are able to see the actual decline in inventory accuracy over time.

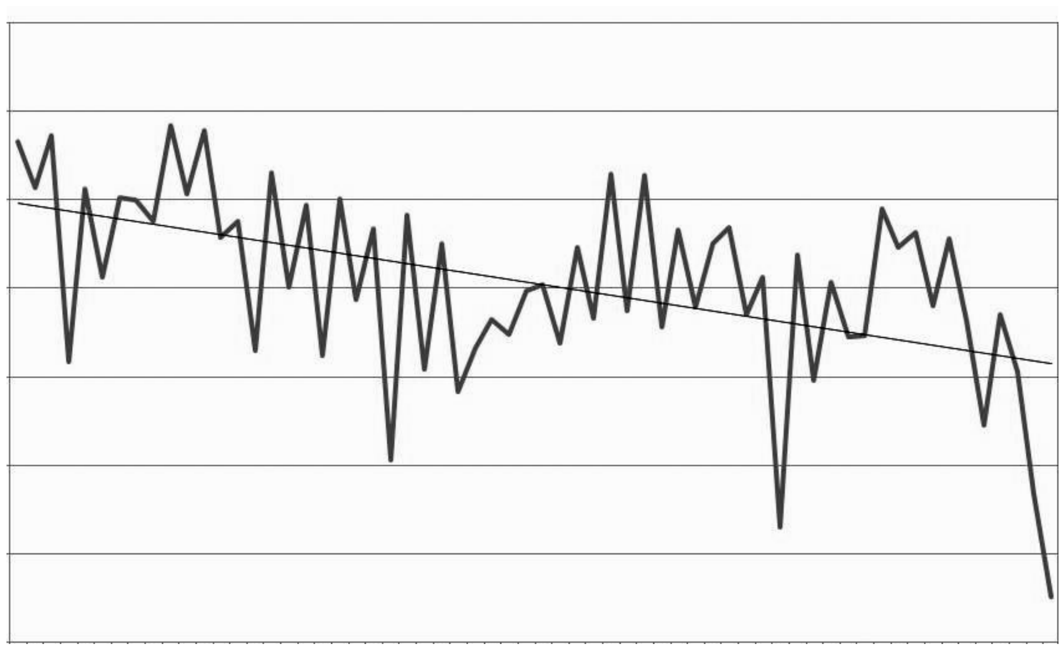

Figure 2: Accuracy Deterioration

These results over time were placed into one of three categories: perfect (physical inventory count = PI); overstock (PI<physical inventory count); or understock (PI>physical inventory count). The results, therefore, show the percentage of SKUs/UPCs that fall into each category (rather than the magnitude of the error for each SKU/UPC). Results for the test store are provided in Table 2 and Figure 3; results for the control store are in Table 3 and Figure 4.

Test Store	*Pre-RFID*	*Post-RFID*
Perfect	Baseline	-3.13%
Overstock	Baseline	-0.75%
Understock	Baseline	+3.87%

Table 2. Test Store Inventory Accuracy

Table 2 has two columns: Pre-RFID period and Post-RFID period. The Pre-RFID period establishes the baseline (as described earlier). As no adjustments were made to PI, we would not expect to see improvements over time. In fact, the perfect category continued to decline over the pilot with an overall decline of 3.13%, with a correlating rise in understock of 3.87%. This provided insight into the causes of inaccuracies, allowing for further investigation into the specific causes of the increase in understock.

During the course of the study, the overall pattern was the same at both the test and control stores; the perfect category decreased due to an increase in understock. In addition, the overstock also increased by 1.47% at the control store, suggesting additional sources of inventory inaccuracy at one or both departments within the control store.

Control Store	*Pre-RFID*	*Post-RFID*
Perfect	Baseline	-4.24%
Overstock	Baseline	+1.47%
Understock	Baseline	+2.78%

Table 3. Control Store Inventory Accuracy

Information from Tables 2 and 3 are presented graphically in Figures 3 and 4. From these figures, we can see the consistent pattern of inaccuracies at both stores. Whereas the tables provided the mean (average) percentages during the periods before and after RFID, the graphs provide the values over time during the data collection period. From Figure 3, we see that the overall inventory pattern (e.g., relative values of understock, overstock, and perfect) remains relatively stable during the pilot, while also demonstrating the slight downward trend of the perfect category.

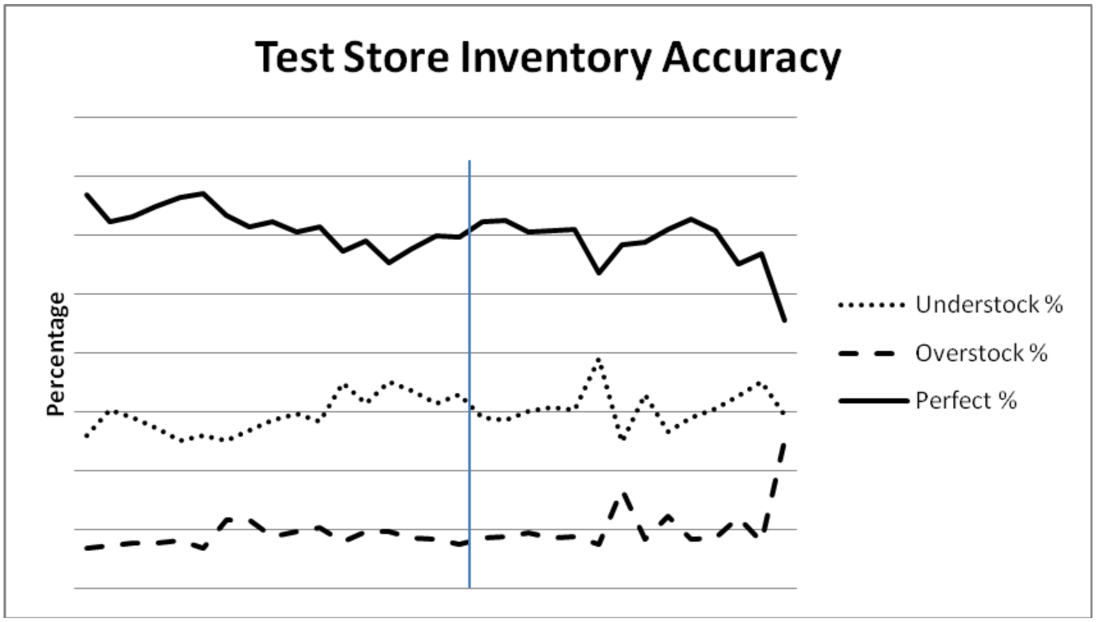

Figure 3. Test Store Inventory Accuracy

Figure 4 tells a similar story, though with much less consistency across both the pre- and post-RFID periods. The vacillations in Figure 4 provide a graphical illustration of the interrelatedness of the three inventory measures: notice the wide swing in percentages of overstock and perfect; as one increased, the other decreased. Thus, as described above, changes in any of the three measures of inventory accuracy will, of necessity, be reflected in one or both of the other measures.

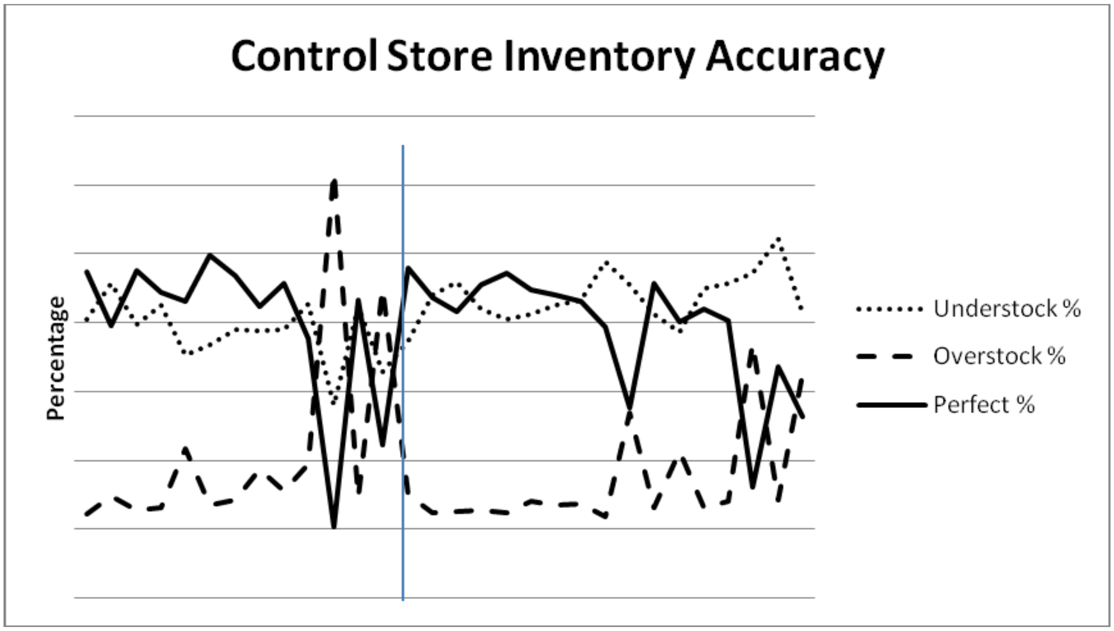

Figure 4. Control Store Inventory Accuracy

As noted above, inventory accuracy continued to decline during the course of the study. To investigate the potential RFID effect, a simulation of Bloomingdale's PI was used to replicate the changes that would have been made by using RFID data to update the Item File used as Bloomingdale's master record of PI. Essentially, the data obtained from RFID cycle counting was used to update the simulated Item File. As seen in Table 4, the adjusted overall inventory accuracy improved by over 27%, with a corresponding decrease in understock of 21%. The overstock figure accounts for the remainder of the adjustment, decreasing by a little over 6%. This follows logically from the previous discussion of the source of errors in Bloomingdale's Item File. Since the majority of the inventory inaccuracy in the test store is understock , RFID adjustments to PI would correct the inflated understock percentage. The resulting increased accuracy would be less likely to deteriorate over time, as taking inventory more frequently than is the current practice would allow for more frequent and more accurate assessment of inventory levels.

Adjusted Accuracy for Test Store	*Pre-RFID*	*Post-RFID*
Perfect	Baseline	+27.19%
Overstock	Baseline	-6.18%
Understock	Baseline	-21.01%

Table 4. Test Store Inventory Accuracy after Simulated Inventory Adjustment

Quantifying these percentages and patterns of inventory inaccuracy provide useful insight and information in assessing the financial impact to a specific retail model. In the case of Bloomingdale's, for example, let us assume that overstock leads to carrying excess inventory equal to about 10% of total inventory. Thus, if one has (for illustrative purposes only) an overstock of 5,000 units at a retail value of $150, then the retailer has $75,000 per day in unnecessary holding costs for inventory (5,000 units x 10% x $150) that the retailer doesn't know is in the store. In essence, the overstock creates "hidden" excess inventory (e.g., inventory not accounted for in the inventory system of record) in the stock room, on the sales floor, or both. The inventory is not in the system, therefore, is not taken into account when the system generates re-orders. The result is overstock that is not seen, may not be sold at full retail, and will likely continue to increase, as the inaccurate system generates automatic re-orders. This hidden cost becomes even larger when markdowns are taken for merchandise that doesn't sell, because it was not in the inventory system. Each of these potential scenarios has quantifiable financial repercussions.

Out of Stocks

Bloomingdale's did not use RFID to directly affect store-level out of stocks; that is, changes were not made to supply chain replenishment practices and RFID was not used to generate replenishment orders. However, as an illustration of the effect of inventory accuracy on out of stocks, it is worthwhile to investigate out of stock patterns during the time of the study. Figures 5 shows actual out of stock versus out of stock as measured by PI for both departments (combined) at the test store across the 13-week period. [Note: Out of stock, in this case, is store-level out of stock rather than only shelf out of stock; i.e., the product was not in the store anywhere (backroom or shelf).]

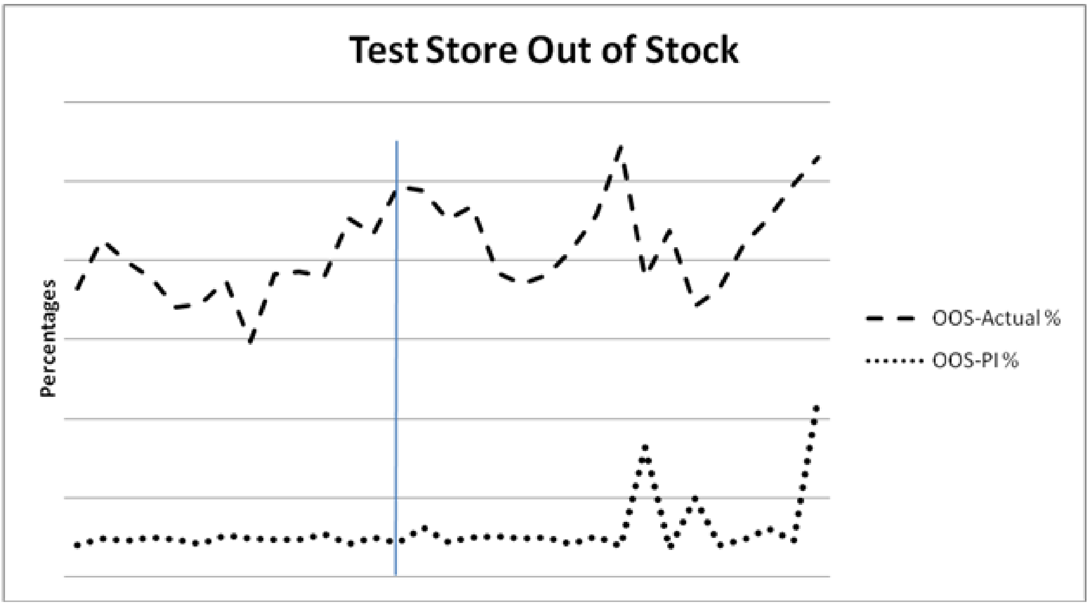

Figure 5. Test Store Out of Stock

In Figure 5, the OOS-PI (i.e., what the system thinks is out of stock) is the dotted line; OOS-Actual (i.e., what is physically out of stock, based on the cycle counting) is the dashed line. Again, we have hidden the exact values to protect confidential information. The two lines clearly illustrate the difference between what the system thinks is out of stock and what is actually out of stock. The system consistently underestimates the percentage OOS. The impact of this difference is profound. Let's assume the difference is, on average, 10% (not actual number; used for illustration purposes only). This means that for 10% of the items, the system thinks the items are in stock; in reality, however, there are none in the store. If the customer asks a sales associate about an item of interest—and the system says it should be in the store—the sales associate would most likely look for the item without success. Certainly, this is a losing proposition for both the customer and the retailer. For comparison purposes, the difference between PI and actual OOS for the control store is shown in Figure 6. The OOS percentages at both stores remain consistent during the pilot.

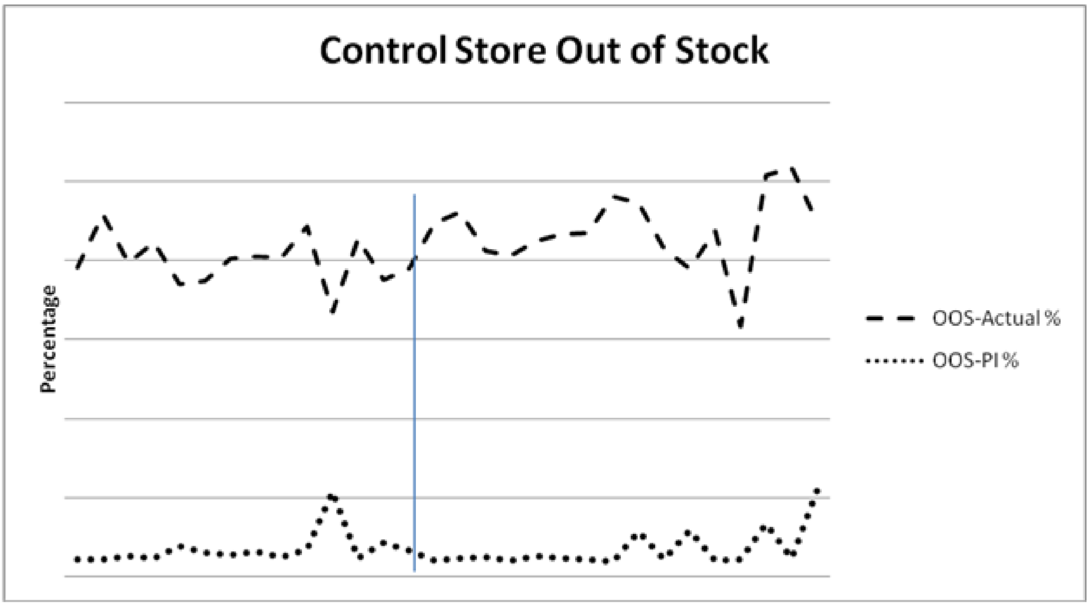

Figure 6. Control Store Out of Stock

It is important to recognize that the OOS illustrated in Figures 5 and 6 present the minimum level of OOS (i.e., OOS at the store level), without capturing what is likely to be a higher OOS figure on the retail floor (i.e., OOS at the shelf). The inventory of all items, whether back room or sales floor, was used to determine the level of OOS, regardless of whether the inventory was resting on the sales floor or waiting in a back room. Higher sales floor OOS levels are likely, as sales floor associates are expected to be customer-facing and, therefore, spend only a small percentage of the work day moving stock from one or more back room locations to the sales floor. Thus, decreasing sales floor OOS levels would require a combination of RFID inventory information and changes in existing processes.

The financial impact of OOS (which is a function of understock) is obvious – the product is not available for sale, resulting in lost sales. However, the problem is exacerbated by 'frozen' inventory. Frozen inventory occurs when system-generated inventory reorder points are affected by (understock) inaccuracies in PI; specifically, the inaccuracies in the inventory system of record prevent orders needed to correct OOS situations. This occurs when PI is greater than the reorder point and the product is out of stock. Because an item is actually out of stock, it can't be purchased by the consumer; therefore, no point-of-sale to decrease PI will be made. Without the point-of-sale decrease, PI will remain greater than the reorder point and no orders will be placed; essentially, the inventory status becomes 'frozen' and will not change until someone changes PI. If one assumes (again, for illustrative purposes only) that a specific item is frozen for an average of 15 days over the previous quarter, the average number of sales per day generated by that item is three sales per day, and the retail value is $150, then the actual potential cost of frozen inventory for our illustration becomes $6,750 in lost sales for this one item over the course of the quarter. Thus, the model of Number of Days Frozen times Average Sales per Day times Retail Value allows a retailer to quantify the daily cost of frozen inventory which results from understock.

Cycle Counting

As demonstrated earlier, cycle counting, whether by hand or with RFID, can improve inventory accuracy. This is intuitive, as counting merchandise validates what is—or is not—on hand. As illustrated in Figure 1, system-generated PI will deteriorate over time. As discussed earlier, events such as theft, cashier error, and incorrect adjustments will cause PI to become inaccurate; therefore, one solution to the inventory accuracy problem is to cycle count more frequently. Currently, Bloomingdale's does a full physical inventory count one time per year.

Given the scope and complexity of their retail operations, increasing the frequency of this full-scale inventory count effort may not be practical or fiscally responsible, especially using bar codes and hand counts; it simply takes too long and costs too much to do a hand count of items several times per year. With RFID, however, it is possible to conduct cycle counting more frequently, whether counting an entire store or targeted departments. This increased frequency of inventory and accuracy counting (with reduced human effort) is possible using handheld RFID readers. The addition of other RFID inventory capturing options, such as smart shelves and zonal monitoring, allows for the possibility of real-time, continuous, inventory counting with no human effort.

During the course of the study, we tracked the amount of time it took to RFID cycle count and barcode cycle count the same items on the same day in the same store, providing a direct comparison between the two methods. The number of items counted varied between 9800 and 10,500. Table 5 provides the mean number of items and associated cycle counting times for a 10-day period of the pilot. With RFID, the inventory scanning of over 10,000 items took two hours, far less than the 53 hours required with barcode scanning. On average, 209 items could be counted per hour via barcode whereas 4767 items could be counted per hour via RFID. Overall, the net result is a 96% reduction in cycle counting time by using RFID cycle counting rather than barcode counting.

Mean number of items	Mean RFID cycle counting time	Mean barcode cycle counting time	Improvement
10489	2 hours	53 hours	96% less time with RFID

Table 5. Mean Cycle Counting Times

Given the substantial reduction in time to cycle count, retailers such as Bloomingdale's could create cycle counting strategies for taking and updating inventory counts more frequently than once or twice per year. With the above example, Bloomingdale's could take inventory counts 26 times with an RFID handheld reader in the amount of time it takes to do one inventory count with a barcode scanner; thus, they could take inventory counts every other week for an entire year (for a total of 26 cycle counts) in the same amount of time it takes them to do an enterprise-wide annual inventory count. Certainly, inventory accuracy is higher when taking and updating inventory counts bi-weekly than it is when taking inventory counts annually.

Loss Prevention

For the examination of RFID's impact on loss prevention, RFID data generated from key read points were used to provide loss prevention insight. As described earlier, the tags were removed at point of sale. Thus, any tags seen at the employee or customer entrances would be potential theft occurrence or store associate error (i.e., they failed to remove the tag). To eliminate the latter from consideration, each RFID read from the employee and customer entrance was matched against a point of sale for the same product. If a match was found, then the read was attributed to store associate error. If no sale of that product was found, then it was considered a theft occurrence. Over the course of a few weeks, several items were deemed stolen, based on the above approach. In two cases, the perpetrators were caught. For this merchandise, the retailer is provided two key pieces of information. First, the retailer knows exactly what, when, and where (i.e., employee or customer entrance) was stolen. This can be used as insight into instituting proper loss prevention methods. Second, the retailer, by knowing exactly what was taken, can adjust PI accordingly and, if appropriate, order more merchandise to replace the stolen items. Too often, PI will continue to show product available for sale when it is not. No product for sale and nothing on order means no sales for the retailer.

Discussion

The growing body of research related to RFID and the subsequent improvements in inventory accuracy, out of stock, cycle counting, and loss prevention provides a solid foundation upon which specific actions can be identified and implemented to increase financial performance. Supply chain considerations (e.g., where in the supply chain to implement item-level tagging) have been resolved by some retailers and are still being addressed by others. The impact of process changes are becoming more apparent, as retailers are able to quantify the financial implications of more frequent cycle counts, more accurate identification of inventory location (stock room versus retail floor, for example), and process execution opportunities. Specific questions which can be addressed by the use of RFID inventory data include: Who moves the product from the stock room to the retail floor? How often? Using what set of information? How many items are in a frozen OOS condition? What is the cost of our frozen OOS? How much hidden excess inventory do we carry? At what cost?

The use of RFID in the retail space has potential benefits for customer service. Accurate and timely information about product order, delivery, location, and stock level allow retailers to have the products their customers want to purchase. Having what the customer wants when the customer wants it is key to success in retailing.

As with all good research, the outcome generates additional questions. The clarity of the questions being generated by RFID research into the retail space will determine the benefits to be gained all along the supply chain, up to and including the sales floor. Retailers who apply their unique knowledge of their operating model to RFID inventory data will be able to develop and use models to assess, monitor, and improve financial performance. Gathering the RFID inventory data is quickly becoming the easier part of the equation.

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