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Retail Analytics and Behavioral Operations: A Recipe for Superior Performance

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Retail Analytics and Behavioral Operations:

A Recipe for Superior Performance

by Mark Barratt and Nicole DeHoratius

In the complex, high-pressure retail environment of the 21st century, industry leaders looking for every competitive advantage possible are increasingly relying on analytics. Traditional retail challenges such as demand forecasting, assortment planning, category management, inventory replenishment, and labor planning are prime candidates for analytics, generally, and the application of operations research tools, specifically. This is especially true as ever-increasing amounts of transactional data become available to retail managers. In the absence of effective analytics, retailers run the risk of poor inventory on-shelf availability (OSA), out-of-stock (OOS) scenarios, and low conversion rates,[1] which can negatively affect retail sales, customer satisfaction, and, ultimately, chain-wide profits. In this *Executive Update*, we'll explore how to blend analytics with behavioral research for operational success.

IDENTIFYING AND MITIGATING THE SOURCES OF POOR DATA QUALITY

One obstacle to achieving performance improvement through rigorous analytics is poor data quality. Retail decision makers rely heavily, for example, on inventory and sales data to replenish shelves, plan future assortments, set store staffing targets, and conduct promotions. Research has shown that the quality of retail data, in particular, the accuracy of recorded inventory (i.e., the quantities identified by the computer system as being on store or distribution center [DC] shelves), to be poor.[2] Figure 1 illustrates the many steps in the retail supply chain through which inventory and information about inventory pass. An error[3] in the execution of any one of these steps, if not identified and corrected, can cause a discrepancy between inventory and information about inventory. See sidebar for an example of such an error.

Given the importance of analytics and the cost of poor data quality, namely, suboptimal analytics for retail decision making, several researchers have attempted to identify the source(s) of execution errors as well as what retailers might do to prevent them. Previous literature[4] has identified such factors as complexity of store environment (e.g., variety of products offered, density of inventory presented, audit frequency), item characteristics (e.g., sales volume, unit cost), channel selection (e.g., Web, brick-and-mortar), and labor characteristics (e.g., full-time vs. part-time, employee tenure). We

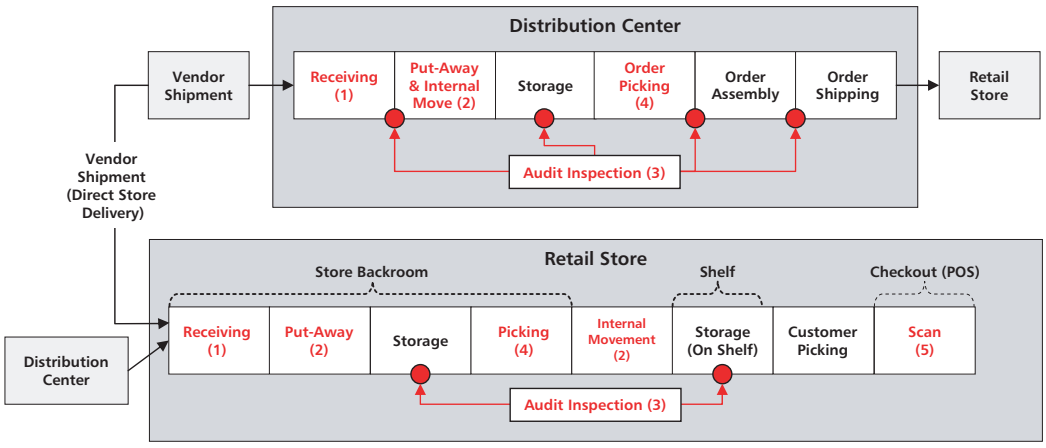

Figure 1 — Sample inventory management process of a distribution center and retail store.

argue, however, that finding solutions to the problem of poor data quality, and thus suboptimal retail analytics, requires an approach, not heretofore considered, that entails the observation of individual behavior in the field and the identification and testing of plausible solutions through field- or laboratory-based experiments.

ADOPTING A BEHAVIORAL PERSPECTIVE TOWARD IMPROVING EXECUTION

We propose that adopting a behavioral perspective will enable retailers to improve execution through a better understanding of how individual capabilities and characteristics, along with situational characteristics (e.g., organizational culture; workplace design; processes, tasks, and procedures), influence the likelihood of execution errors occasioned by employee handling, moving, and storing of inventory.[5] Other academic fields, including economics, finance, accounting, law, marketing, and strategy, have adopted a behavioral perspective with considerable success.[6] Although a behavioral perspective has been utilized in understanding consumer behavior through field-based observation, such techniques have not been applied to improve retailers' understanding of the challenges faced by employees responsible for operational tasks. Previous studies have alluded to these challenges, but have not established with certainty the underlying reasons that store-, item-, and employee-level factors matter. Reviewing archival data for clues is a valuable first step, but understanding the retail context requires a deep knowledge of the behavior of individual employees within that context.

Although important, individual capabilities and characteristics along with their impact on operational performance are not our focus here. We instead refer interested readers to three theoretical lenses through which to view operational performance:[7]

1. **Cognitive psychology** — considers how mental processes are organized and how perception, attention, memory, problem solving, reasoning, and decision making are linked to skill acquisition and individual performance differences
2. **Social psychology** — considers how individual behavior is shaped by the presence of other individuals and how group dynamics influence motivation, performance, and productivity
3. **System dynamics** — considers the behavior of groups and individuals embedded in complex systems and their response to existing feedback loops

In general, this *Update* promotes the designing of a system within which employees, which we assume retailers have hired based on previously established criteria, will be able to work in ways that reduce the likelihood of execution errors. Eliminating execution errors is presumed to improve the quality of data an organization utilizes for analytics, and thereby ultimately improves decision making. In the next section, we highlight questions that retailers can explore through behavioral observation, drawing heavily from research by D.M. Stewart and R.B. Chase on the design of foolproof service systems.[8]

A FAULTY PALLET PLAN

Arriving on the forklift at the pallet-racking location in the distribution center to put away a pallet of product, Jim noticed another pallet in the allocated slot. Quickly looking around at the rows of racking slots and spotting an empty slot nearby, he put the pallet in the empty slot, scanned the original location, and returned to the receiving area to collect the next pallet. This seemingly innocuous action has wide-ranging implications. Surrounded as it was by other similar pallets of product, the pallet was as good as lost — unless someone scanned all the pallets in the vicinity of the intended racking slot.

Due to this erroneous action, another employee trying to pick from the designated location likely wouldn't find the requested product in stock. When a researcher asked the audit supervisor in this case why what they had just witnessed had happened, the supervisor replied, "He just wants to make his bonus, but we would have lost the pallet had we not been here watching this."

ESSENTIAL ELEMENTS OF A BEHAVIORAL PERSPECTIVE

Retailers use analytics to make key decisions about the format, content, and operations of stores and DCs. Let's

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examine the essential elements of a behavioral approach that can help retailers improve data quality and thereby their analytical decision-making processes.

Design and Layout

Retailers can evaluate the design and layout of stores and DCs to assess how challenging it is for employees to locate inventory and replenish shelves. For instance, some retailers have elected to eliminate backroom storage and minimize extra storage locations to make it easier for employees to find and track inventory that exceeds the space in assigned locales. Retailers can further determine whether maintaining multiple locations in DCs and stores for the same item (e.g., promotional areas, endcaps) influences employees' abilities to accurately locate, audit, and replenish items within the chain. Additionally, it is unclear whether clustering similar items in stores and DCs contributes to or prevents mis-picks and confusion among employees.

Shelf-Space Allocation

Shelf-space allocation is another important retail decision. The more inventory units in a given square footage, the greater the likelihood of inventory inaccuracy.[9] Inventory density is often responsible for confusion among retail employees, as items are miscounted or mistakenly interchanged with other similar items. Measuring the likelihood of such errors and incorporating this probability into the shelf-space allocation algorithm may prove useful.

Shelf-space allocation considers not only the number, but also the depth, of "facings" allocated to a product. Retailers have sometimes found store shelving or DC storage racks to be too deep or too high, making it challenging to see or count inventory. Moreover, signage that clearly indicates the location of specific product categories is important not only for customers, but also for employees seeking to replenish shelves quickly.

Coordination

Coordination between vendors and retailers could potentially eliminate some execution errors. For example, in instances of a mismatch between replenishment quantity and peg size, employees are forced to make ad hoc decisions often about where to store extra inventory. Retailers and vendors can also coordinate delivery methods. Observational studies can reveal whether smaller deliveries of like items result in fewer errors than larger deliveries of broad assortments of items. Tradeoffs between the transportation inefficiencies occasioned by less-than-truckload (LTL) deliveries and the improved accuracy resulting from less complex purchase orders (POs) and PO-receiving processes would clearly need to be evaluated.[10] Some manufacturers induce distributors to order assortments of different products in the interest of full truckload (FTL). But does this increase the potential for errors and confusion? Would LTL perhaps be more ideal if all items in one load were the same?

Product Packaging

Product packaging could improve accuracy, using colored packaging (by category), for example, to improve product identification and thereby reduce replenishment and counting errors.[11] Use of colored packaging could also improve pallet stacking, particularly with respect to organizing pallets on trucks not only by retail store but also by aisles within the store. Such methodical organization of the inventory prior to delivery helps to speed replenishment and reduce mistakes by eliminating the need to search for store-specific pallets on a truck and, once in a store, to move pallets between aisles searching for the right storage location. Instead, pallets can be delivered to the appropriate aisles within stores, between-aisle movements can be eliminated, and the number of inventory handoffs can be minimized. Hewlett-Packard provides a well-known example of the influence of product packaging. The challenge of trying to match the numbers on printer cartridges to those on store shelves has long frustrated consumers. By shortening the identifying numbers to only a few digits and, in some cases, a letter, HP has made it easier not only for customers to find the right cartridges, but also for store employees to replenish inventory in the correct spot, which makes it more likely that inventory records will reflect actual inventory available on the shelf.

Tasks and Processes

Redesigning tasks and processes is another route to eliminating execution errors. With respect to choice between random and fixed assignment of materials in stores and DCs, using fixed assignment puts employees at risks for developing degrees of "routinization," whereby the habits they develop supersede their ability to problem solve. One pharmacy we studied changes the location of products in its storage carousels for the express purpose of forcing workers to think and not operate based on habit. Assigning employees a variety of tasks, in lieu of repetitive ones, can also avoid development of "scripts"

that encourage employees to operate on "autopilot." Finally, retailers need to address the classic scanning errors that occur at retail store checkouts (e.g., employee use of multiplier buttons to register quantities of similar products that are, in fact, different flavors or varieties). It is also important for retailers to establish and evaluate employee compliance with standard operating procedures. Through observation, retailers can determine the extent to which employees follow such procedures and, when they don't, why not. It is generally less likely that employees aren't motivated to carry out the task rather than procedural changes being warranted; front-line employees closest to the process often develop shortcuts and beneficial workarounds not previously considered possible.

Culture and Incentives

The culture and incentives that drive behavior in a retail organization can also play a significant role in reducing execution errors and improving the quality of operational data.[12] Consider the example presented in the sidebar, in which the employee appears to lack any understanding of the consequences of his or her errors, and whose behavior, in the absence of any feedback, is likely to continue. Absent accountability for errors made in the course of execution, there is no incentive for employees to improve the accuracy of the tasks they perform.

Accountability also entails, however, a culture that assures psychological safety; that is, a culture in which mistakes are not penalized but treated as learning opportunities.[13] The manager in one DC we studied researched every delivery error a store reported.[14] Viewing these reports as feedback on the performance of DC employees, the manager used the knowledge derived as a learning opportunity. Managers of other DCs who, abiding by the "rules," did not research any complaints below a given dollar threshold were more likely to attribute errors to store processes than to consider the possibility that their processes might be flawed. It was no surprise to us that stores shipped by the former DC exhibited far less inventory inaccuracy than stores shipped by the other DCs. We suspect as well that the former DC experienced far less employee turnover than the other DCs, many of its employees having been with the firm since its inception.

The metrics an organization uses also defines culture. Retail often exhibits tension between productivity and accuracy, leaving employees who feel they are unable to deliver on both dimensions torn. By observing employees, retailers can determine the amount of rework done as the consequence of execution errors. When we take such rework into account, it becomes clear that productivity and accuracy go hand-in-hand.

Retailers should, therefore, be thinking about the design of their supply chain structure, products, and tasks in the same way manufacturers consider the design of their products. Manufacturers have adopted a concept termed "design for assembly" to ensure that products are easy to manufacture and the employees who execute the manufacturing tasks are less likely to make mistakes.[15] The philosophy of design for assembly is to create, through standardization, a product with the fewest number of individual parts, rendering it easy to assemble correctly through error proofing; to minimize the number of steps required to complete the assembly task; and to design the individual parts so as to guide their alignment and assembly.[16] This philosophy is certainly one that retailers can emulate. In fact, we urge retailers to devise an index similar to the design for assembly index, a measure of design efficiency, to track their own execution capabilities.

Field-Based and Laboratory Experiments

Finally, retailers can benefit from learning how to design and execute field-based (e.g., pilots) and laboratory experiments.[17] Those firms that find it difficult to design pilots and laboratory studies tend to avoid them. In our experience, many pilot studies are designed without appropriate controls, resulting in managers having difficulty properly interpreting the experimental outcome. Not all firms have the resources to run controlled experiments, but those that do find them to be tremendously valuable in evaluating the impact of design and process change on operational performance.[18] We believe investing in, or partnering with organizations and academics that have, these capabilities is critical to operational success. Through experimentation, retailers can blend analytics and behavioral research in order to assess how individual employees will behave under particular sets of circumstances and learn how to design systems that make it easier for employees to behave in ways that improve operational performance.

SOME CONCLUDING THOUGHTS

We argue that analytics should be coupled with studies of behavior within complex systems.[19] In retailing,

effective analytics is more than a firm's data management prowess and the statistical sophistication of its leadership team. It also presumes an understanding of how execution errors within retail supply chains can result in discrepancies between what automated decision support tools believe to be the current operating state of retail stores and DCs and the actual state as experienced by consumers. Execution within retail supply chains is a major driver of on-shelf availability.[20]

By improving the understanding of the context within which employees operate, adopting a behavioral perspective facilitates the design of operating environments where mistakes are unlikely or readily identified. Such environments help ensure that the quality of the data representing supply chain activities (i.e., the information about what took place) matches the tasks executed by employees. Retailers can only be assured that the decisions recommended by their analytical tools are appropriate when their data is of sufficient quality. We believe data quality will become increasingly important with the growth of multichannel integration in retailing.

In closing, we encourage retailers to conduct field-based pilots and consider undertaking laboratory experiments to identify how various operating contexts affect individual behavior — and the potential for errors — within the retail supply chain. Such experiments can enable managers to quantify the impact of adopting specific changes within the retail chain. This type of scientific evidence, as well as being a basis for identifying the financial gains likely to accrue from the adoption of particular changes, might also be used to inform adjustments to the operating plan based on lessons learned from the evaluation of pilots or laboratory experiments.

ENDNOTES

[1]Conversion rate is a measure of a retailer's ability to convert customer arrivals and traffic into sales. A high conversion rate implies that a large proportion of customers visiting a store makes a purchase. Appropriate store staffing levels are often viewed as critical to retailer conversion metrics.

[2]DeHoratius, Nicole, and Ananth Raman. "Inventory Record Inaccuracy: An Empirical Analysis." *Management Science*, Vol. 54, No. 4, 2008; Barratt, Mark A., Elliot Rabinovich, and Anníbal Camara Sodero. "Inventory Accuracy: Essential, But Often Overlooked." *Supply Chain Management Review*, March/April 2010; Kang, Yun, and Stanley B. Gershwin. "Information Inaccuracy in Inventory Systems: Stock Loss and Stockouts." *IIE Transactions*, Vol. 37, No. 9, 2009.

[3]Errors are defined as "individuals' decisions and behaviors that (1) result in an undesirable gap between an expected and real state, and (2) may lead to actual or potential negative consequences for organizational functioning that could have been avoided." Zhao, Bin, and Fernando Olivera. "Error Reporting in Organizations." *The Academy of Management Review*, Vol. 31, No. 4, October 2006.

[4]Barratt et al. See 2; DeHoratius, Nicole, and Zeynep Ton. "The Role of Execution in Managing Product Availability." In *Retail Supply Chain Management*, edited by Narendra Agrawal and Stephen A. Smith. Springer, 2009.

[5]Swain, A.D., and H.E. Guttmann. *A Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications*. US Nuclear Regulatory Commission, 1985; Kim, J.W., and Wondea Jung. "A Taxonomy of Performance Influencing Factors for Human Reliability Analysis of Emergency Tasks." *Journal of Loss Prevention in the Process Industries*, Vol. 16, No. 6, November 2003.

[6]Gino, Francesca, and Gary Pisano. "Toward a Theory of Behavioral Operations." *Manufacturing & Service Operations Management*, Vol. 10, No. 4, 2008.

[7]For more information on each of these lenses, see: Anderson, John R. *Cognitive Psychology and Its Implications*. Worth Publishers, 2005; Sterman, John D. *Business Dynamics: Systems Thinking and Modeling for a Complex World*. McGraw-Hill, 2000; Weick, Karl E. "The Social Psychology of Organizing." In *Managerial Psychology: Managing Behavior in Organizations*, edited by Harold J. Leavitt and Homa Bahrami. Addison-Wesley, 1979.

[8]Stewart, Douglas M., and Richard B. Chase. "The Impact of Human Error on Delivering Service Quality." *Production and Operations Management*, Vol. 8, No. 3, 1999.

[9]DeHoratius and Raman. See 2.

[10]Jiang, Yan, Nicole DeHoratius, and Diego Klabjan. "Inventory Management with Purchase Order Errors and Rework." Social Science Research Network, 12 December 2011.

[11]DeHoratius, Nicole, and Joseph Van Orden. "Zeta — A Model of Process Excellence." CAPS Research, 2007.

[12]DeHoratius, Nicole, and Ananth Raman. "Store Manager Incentive Design and Retail Performance: An Exploratory Investigation." *Manufacturing & Service Operations Management*, Vol. 9, No. 4, 2007.

[13]Edmondson, Amy C. "Learning from Mistakes Is Easier Said than Done: Group and Organization Influences on the Detection and Correction of Human Error." *The Journal of Applied Behavioral Science*, Vol. 32, No. 1, 1996.

[14]DeHoratius and Raman. See 2.

[15]We would like to thank Marshall Fisher and Serguei Netessine for their input on this concept.

[16]Boothroyd, Geoffrey, and Peter Dewhurst. "Product Design for Manufacture and Assembly." *Manufacturing Engineering*, Vol. 100, No. 4, 1988.

[17]Informative with respect to this discussion, see: Anderson, Eric T., and Duncan Simester. "A Step-by-Step Guide to Smart Business Experiments." *Harvard Business Review*, Vol. 89, No. 3, March 2011.

[18]Cramer, Mike. "The Emerging Role of Operations Research at McDonald's." *OR/MS Today*, August 2009.

[19]The use of video analytics to document employee as well as consumer behavior is an emerging tool retailers can use to attain this balance between behavioral research and analytics.

[20]DeHoratius and Ton. See 4.

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