Inventory Management at Office Depot Europe

ESCF OPERATIONS PRACTICES: INSIGHTS FROM SCIENCE

TU/e
EINDHOVEN UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF INDUSTRIAL ENGINEERING & INNOVATION SCIENCES
CONCISE SUMMARY OF THIS BEST PRACTICE

The process of selling consumer products or services to customers through a supply chain becomes more complex over time, while retail companies have to guarantee ever faster service and higher product availability. Office Depot Europe deals with the classical inventory challenge: keeping the inventory value as low as possible while reaching the targeted service levels and creating an efficient inbound flow. Therefore, trade-offs have to be made between keeping vast amounts of stock to maximize availability and minimizing costs. Within the collaboration between ESCF and Office Depot Europe, an Inventory Transaction Model was developed, which gives insight into the stock breakdown, ensures an improvement on the classical inventory dilemma, and optimally manages the supply chain. With this model, a foundation was laid to build further upon in the years after. In addition, research has been done on the benefits of multi-echelon inventory control, and demand in non-stationary situations. The Inventory Transaction Model was implemented and further improved by the supply-chain optimization team in collaboration with TU/e interns to match Office Depot Europe’s operating environment. The development and implementation of this model and research done in other TU/e student theses have shown multiple quantifiable effects for Office Depot Europe. All findings within these studies contributed to the profitability and success of the company. Especially during disruptive events such as Brexit, warehouse closures and the COVID-19 crisis, the impact of the Inventory Transaction Model was significant for Office Depot Europe.

KEY TERMS

Inventory Control, Inventory Planning, Demand Forecasting, Multi-Item Inventory System, Stock Breakdown

RELEVANT FOR

Companies in the area of fast moving goods; companies generally interested in new insights in inventory management
Introduction

The process of selling consumer products or services to customers through a supply chain is an indispensable part of society. As the supply chain of companies becomes more complex over time, an increasing need occurs for advanced inventory control and replenishment policies. Retail companies often aim to guarantee a particular availability of their products or services to their customers. One major retail company that is well known is Office Depot Europe (ODE) which was acquired by Aurelius Equity Opportunities in 2017. ODE focuses on the sale of office products and services to businesses and consumers throughout whole Europe. They offer everything from daily stationery essentials to the latest technology supplies (source: www.officedepot.eu/nl/products-and-services/). Within Europe, ODE sells products mainly in the business-to-business market under two main brand names: Viking Direct, and Office Depot. The Viking Direct brand (i.e. the direct channel) serves customers characterized as small to medium enterprises as well as private customers. The Office Depot brand (i.e. the contract channel) serves large businesses that order their products via predefined conditions anchored in contracts.

Like many other companies, ODE deals with the classical inventory dilemma. The dilemma is that the inventory value is too high, the product availability too low, and that there are too many inbound activities. To guarantee high availability, trade-offs have to be made between keeping vast amounts of stock to maximize the availability and minimize costs. This trade-off in combination with challenging market developments asked for a greater understanding of their stock-availability. ODE wanted to know which variables are of influence on the stock-availability, and what components compile their inventory. Moreover, different departments exercised their own wishes and goals in the inventory dilemma. To begin with, several internal improvements have been made but on top of that the collaboration with Eindhoven University of Technology (TU/e) started in 2016. This collaboration consisted of five successful student theses after which three students even continued to work permanently at ODE. The following paragraphs elaborate on the background information and the impact of four student theses executed in the collaboration between ESCF and ODE around the inventory control topic. Overall, ODE experienced a significant decrease in inventory while
the service increased. These effects are illustrated in Figure 1, stock reduced by 30% and service went up by 25 basis points.

Figure 1: The effects of the collaboration between TU/e and ODE
Inventory Management

Understanding the components of inventory, also called stock breakdown, and the different demands on the inventory is the input for what we call inventory management. As mentioned before, retail companies often aim to guarantee a particular availability of their products to their customers. Therefore, inventory management is of great importance for these companies. One approach to achieve high availability is to keep vast amounts of stock. Though, keeping more stock could be very expensive in comparison to accepting a degree of non-availability (Akkerman, 2020). Good inventory management asks for a good balance of the trade-off between maximizing availability and minimizing costs. To measure product availability the fill-rate is often used. The fill-rate is defined as the fraction of demand delivered straight from inventory.

The basics of inventory management come down to three key questions (De Kok, 2015): (1) what is the review period, (2), when should a replenishment order be placed, and (3) what size should the order have. Answering these questions results in a set of inventory policies that are appropriate to achieve targets with respect to the availability of products. The parameters of the inventory policies are, in turn, input for an inventory control process. A typical inventory control process consists of the collection of historical data, the calculation of inventory policy parameters, the uploading of these parameters to the replenishment system, and the management of the stock levels and ordering decisions. Figure 2 shows an example of a typical inventory control process used by many companies. The replenishment system sends out signals when the inventory drops below a certain threshold. A combination of these signals and expert knowledge leads to the management of stock levels, and when needed, the placement or an order. Furthermore, the inventory control process is repeated after a specific period. In every repetition the inventory policies are updated to cope with the ever-changing environment in which companies such as ODE operate.

Figure 2: Example of an inventory control process (Akkerman, 2020)
Inventory Transaction Model (ITM)

ODE manages its supply chain with a comparable inventory control process as shown in Figure 2. Currently, the inventory policy parameters of most items are optimized through the Inventory Transaction Model (ITM). This model is built in Excel and can be used to calculate four inventory control parameters, namely the review period (enforcing joint replenishment), re-order level, order up to level and rounding value. ITM uses a combination of the P(s,S)-policy of Viswanathan (1997), the (R,s,S)-tool of De Kok (2015), and the EOQ sensitivity analysis of Durlinger (2013). The first version of the model is developed by Op ‘t Veld (2016) during his research at ODE. Hereafter, the ITM is implemented and further improved by the supply-chain optimization team in collaboration with TU/e interns to match ODE’s operating environment. After determining the four inventory control parameters using the ITM, these are interfaced in the inventory replenishment system PrimeOne. PrimeOne, in turn, helps the demand and supply planners in their day-to-day work.

The data which can be retrieved from PrimeOne can be used for the ITM. The ITM requires thirteen input values which are either manual input or data that can be retrieved from the existing systems. Subsequently, the four output values are calculated by the model, namely the review period, re-order level, order-up-to level, and the rounding value. As mentioned, the ITM is based on the (R,s,S) logic which means periodic reviewing R, ordering when the inventory position is below the reorder level s, and ordering up to the order-up-to level S. The review periods per sub-vendor and targeted service levels per class of items are determined by a solver function which minimizes the expected annual costs.
Improving Inventory Performance in France

In 2016, Op ‘t Veld (2016) kicked off the collaboration between ESCF and ODE with an in-depth investigation into the inventory performance of a DC in France. Within his research the main question was how to increase product availability and reduce on-hand inventory value without increasing inbound delivery lines in this specific DC in France. With the empirical part of the research, root-causes of the classical inventory dilemma were determined. Op ‘t Veld (2016) proved that the improvement of the conflicting symptoms of the classical inventory dilemma (i.e. too high inventory value, too low product availability, too many inbound activities) is achievable. It was confirmed that there is a need for safety stock because of demand and lead-time variation, and that even when this safety stock is considered there is room for improvement. Consequently, bottlenecks were identified that explained the current performance of ODE. The impact on the inventory performance of these bottlenecks is quantified and thus used in the design phase of the model requested to improve the inventory policy.

A lot of inventory policies are based on stock-out penalty cost as an input variable and service levels being the result of the optimal cost. ODE, however, wanted the service level to be a control variable rather than an output result. Because no such academic literature could be found to satisfy that demand, Op ‘t Veld (2016) designed a combined policy, namely the earlier described Inventory Transaction Model (ITM). This solution can be seen as an enhancement of the (R,s,S)-tool designed by De Kok (2010). The inventory policy was implemented in 2017 following the outcome of Op ‘t Veld. In 2018, the rollout completed in three main DC’s on core assortment and from there to rollout continued to sub-product categories (i.e. furniture, own brand, retained).

All in all, with the implementation of the new ITM a foundation was laid to build further upon in the years after. The model is still used in daily operation and continuously improved by the supply-chain team in collaboration with TU/e interns. The foundation created led to newly developed tools and functionalities. These tools utilize the earlier described ITM and increased insight and understanding of ODE’s stock breakdown. In particular, ODE has a better understanding of how
their inventory is build up (i.e. safety stock, cycle stock, excess stock) as can be seen in Figure 3. The model leads to more data driven decisions with respect to the inventory. In addition, ODE now works steer based on inventory targets, DC capacity and service level targets. They understand why their inventory performance was too low. Subsequently, ODE obtained a reduction of 12% for the expected inventory costs while the fill-rate improved by 1.4%. Finally, the foundation of Op ’t Veld (2016) gave direction for further optimizations such as balancing the DC inbound activity and order rounding based on box, layer and pallet quantities. Moreover, Op ’t Veld was followed up by Heijnen (2019) in 2018. He continued the collaboration between ESCF and ODE with the redesign of the inventory control model for the least performing SKUs which will be elaborated on in the following paragraphs.

Figure 3: Insights in the stock breakdown at ODE
Redesign of the Inventory Control Model for the Least Performing SKUs in a Reselling Environment

Approximately two years after the start of the implementation of the Inventory Transaction Model (ITM) as delivered by Op ‘t Veld (2016) and multiple improvements from the supply-chain optimization team, Heijnen (2019) proceeded with the in-depth investigation of the inventory performance of ODE. He tended to improve the implemented ITM for the least performing items and further improved the output and profitability of the ITM. After the implementation, he analyzed the practical results of the model, both KPI, and process driven. Table 1 shows the impact of each of the topics he considered during his research. Eventually, Heijnen (2019) reviewed the least performing items, and suggested model improvements to drive process harmonization.

<table>
<thead>
<tr>
<th>Topic name</th>
<th>% SKUs influenced (not on (R,s,S) model)</th>
<th>% SKUs influenced (on (R,s,S) model)</th>
<th>Expected impact of improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forecasting and way of using</td>
<td>65,9</td>
<td>Not known*</td>
<td>High</td>
</tr>
<tr>
<td>Determination</td>
<td>Not known</td>
<td>100,0</td>
<td>Average</td>
</tr>
<tr>
<td>RP &amp; TFR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human intervention</td>
<td>Not known</td>
<td>93,0</td>
<td>Average</td>
</tr>
<tr>
<td>Reorder levels with rounding</td>
<td>0,0</td>
<td>82,1</td>
<td>Average</td>
</tr>
<tr>
<td>Low value density SKUs</td>
<td>0,1</td>
<td>Not known**</td>
<td>Average</td>
</tr>
<tr>
<td>Retained SKUs</td>
<td>33,3</td>
<td>0,0</td>
<td>Low</td>
</tr>
</tbody>
</table>

* = Total demand is showing a seasonal pattern, so probably impacts a big part of the SKUs
** = Making a redesign by changing inventory holding costs can also influence SKUs already planned with the (R,s,S) model

Table 1: Summary (re)design topics
Heijnen (2019) found that some SKUs are not planned with the inventory model when planners have a grounded reason to use another method. The first group of items not planned with the model are items that contained contracted planning actions. Second, items of ODE’s brands were not planned with the model. The third group is low-value density items. Finally, seasonal items were also not planned with the present model because it did not use proper forecast models for seasonal items. Furthermore, he found that items with a long lead time were not effectively planned with the present ITM. Altogether, Heijnen (2019) was able to identify valuable characteristics for products that performed the least on ITM.

Consequently, Heijnen (2019) proposed model and process improvements to increase the performance of the least performing products. He concluded that the present ITM could fit all items, even those that were not-, or not effectively managed. The way of determining the parameters makes the difference for these items. Especially the determination of the reorder level is adapted by Heijnen (2019). First, Heijnen gives a heuristic that calculates the reorder levels based on the rounded order quantities. In that way, the reorder level calculations are based on the \((R,s,S,nQ)\)-logic (Van Donselaar & Broekmeulen, 2015). Second, Heijnen proposes a concept of optimizing target service levels on item level. Both proposals aim to improve the overall accuracy and performance of the ITM. The proposed concept of optimizing target service levels sparked TU/e’s interest and the developed heuristic by TU/e resulted in a published paper. Finally, other proposed models and process improvements by Heijnen (2019) ensured order cycle optimization to align with vendor order restrictions and improve inventory performance. Accordingly, the annual order line was reduced by 2%. Furthermore, the adaption in calculations ensured that the inventory holding costs and order costs are correctly balanced. The products, therefore, are planned based on their specific characteristics. The inventory was reduced by 4% as a result of the optimized safety stock based on the reorder level calculated with the rounded order quantities, and the ITM was rolled out to the contract retained product category.

Another element Heijnen (2019) highlighted was that human interventions occurred more often than needed. According to Heijnen (2019) the performance of items planned with a specific inventory control model can not only be measured by the achieved service level but also by the amount of human intervention needed to achieve the service level. Effectively managed items achieve the targeted service level without needing human interventions. Therefore, the findings of Heijnen (2019) increased the focus on items that require manual interventions by planners. In that way, ODE could internally improve the presence of human interventions and thus optimize their current model.
Multi-Echelon Inventory Control

ODE possesses multiple locations in the supply chain of office supplies. Therefore, their supply chain is a multi-echelon. The current ITM designed by Op ‘t Veld (2016) and further developed by the supply-chain optimization team and Heijnen (2019) serves as local distribution center (LDC) inventory control policy. The central distribution center (CDC), in turn, uses a periodic review dynamic base-stock policy (R,S) where the base-stock level is adjusted with the forecast. As these are two separate replenishment policies ODE wanted to know how much the company could save after centrally optimizing the policy parameters within the entire supply chain. This interest was the reason for the next collaboration between ODE and ESCF.

In 2019, Brugmans (2019) quantified the benefits of multi-echelon inventory control at ODE. Multi-echelon inventory control was integrated into the current inventory policies. Brugmans (2019) used the ITM logic as a baseline for a multi-echelon planning module. He developed a simulation tool to retrieve the supply chain performance. His analysis led to the recommendation of using actual lead times instead of agreed vendor lead-times because agreed lead-times deviate too much. Moreover, Burgmans (2019) found that forecast information sharing between the LDCs and CDC leads to the same stock value and a disservice reduction of 46.6% compared to the scenario without information sharing.

In addition, Brugmans (2019) used ChainScope to centrally optimize the control parameters of the already implemented installation stock control policy with information sharing. ChainScope is a tool developed by De Kok that optimizes safety stock levels independent of the implemented policy. For ODE, it optimizes the safety stock values in the multi-echelon which are translated to the control parameters. In general, Brugmans (2019) found that the multi-echelon inventory control scenario dominated the current control scenario. Therefore, the results of his research were that ODE could gain by centrally optimizing the policy parameters within the entire supply chain. In other words, implementing multi-echelon inventory control would be benefiting.
Where the implementation of multi-echelon inventory control needs to be investigated, the developed ITM simulation model is already in use. Currently, the developed ITM simulation model has been used extensively during the current COVID-19 crisis. The simulation methodology developed has already been extensively used during disruptive events like, for example, the COVID-19 crisis, Brexit and DC mergers. The methodology allows ODE to estimate the outcome of multiple strategies that could potentially be used to tackle these disruptive events. Better understanding the effect of your strategies will, consequently, lead to better decision-making, but also to better manage and execute the agreed strategy. Altogether, the ITM simulation model allowed ODE to see short- and long-term effects of needed interventions in the replenishment policy.
Non-Stationary Demand

Like many companies, ODE uses its inventory control process to guarantee a particular availability of its products to its customers. One aforementioned approach to achieve high availability is to keep a vast amount of stock. However, keeping more stock can be expensive for ODE.

As mentioned before, three questions are central for balancing the trade-off between maximizing availability and minimizing costs. The answers to these questions result in a set of inventory policies that are input for the inventory control process as shown in Figure 2. For ODE it was found that this process did not suffice for their products. ODE recognized a mismatch between the assumption that is made in their ITM and reality, namely the demand was assumed to be stationary. In reality, however, a significant percentage of the demand follows a seasonal or trending pattern. Moreover, the assumption of stationary demand is often violated due to the shortening of product life cycles. The result of this assumption is a misalignment of the realized and targeted fill rate, holding inventory at the wrong moment, and unnecessary manual labor.

In order to manage this misalignment, the collaboration between ESCF and ODE was continued with the thesis of Akkerman (2020). It was proposed to redesign the inventory control system for non-stationary demand. The present ITM used a flat forecast signal for replenishment. Though, applied algorithms classified demand patterns and identified the presence of seasonal products. Table 2 shows the identified demand classes including their share in the Cost of Goods Sold (CoGS). As a consequence of these findings, Akkerman (2020) proposed model changes to improve the performance of products with seasonal demand patterns. He developed a novel method to account for non-stationary demand. The ITM was amended such that it could function with time-phased forecasts. This method reduced the misalignment of the realized and targeted fill rates. It allowed ODE to manage their inventories more effectively. Furthermore, the applied algorithms also support planners to focus the human intervention on SKUs that need it.
Akkerman (2020) tested the performance of multiple forecasting algorithms and their impact on the inventory and service levels. He simulated two-time phased model proposals with different levels of implementation complexity. The analysis performed on seasonally identified products showed that the method proposed by Akkerman (2020) could adapt stock levels when changes in demand are forecasted. In addition, it was found that simple forecasting methods outperform the more complicated ones. Altogether, it could be concluded that the developed model is an improvement for the seasonal SKUs Akkerman (2020) considered. The developed model leads to a reduction of the misalignment of the actual and target fill rates, and therefore, allows ODE to manage their inventories more effectively. Furthermore, an increase of 1% service level without human intervention is achieved which is a desired result.

<table>
<thead>
<tr>
<th>Classes</th>
<th>%</th>
<th>% of CoGS 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stationary</td>
<td>40%</td>
<td>25%</td>
</tr>
<tr>
<td>Trending</td>
<td>14%</td>
<td>17%</td>
</tr>
<tr>
<td>Seasonal</td>
<td>20%</td>
<td>54%</td>
</tr>
<tr>
<td>Intermittent</td>
<td>26%</td>
<td>3%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Table 2: Identified demand classes and their CoGS
Impact at Office Depot and a Future Vision

The student theses in collaboration with the TU/e have shown multiple quantifiable effects for ODE which all contributed to the profitability and success of the company. But especially during disruptive events such as Brexit, warehouse closures and the COVID-19 crisis the impact of the ITM was significant. Without the ITM, ODE would have had no data-driven methodology to make informed decisions which could have had far-reaching consequences for a company that is re-defining itself. The data-driven methodology ensures the identification of areas for improvement where well-considered decisions are made. Inventory is now approached as a science instead of a given which gives a better understanding of its breakdown and what decisions are wise. ODE is now able to optimize its supply planning in terms of stock value, customer experience and inbound activities.

Currently, ODE is working hard to improve the business by modernizing the IT infrastructure, optimizing the business operations, and improving the profitability of (contract) customers. This effort will eventually lead to a major shift in the utilization of the ITM. During the transition, the ITM will be the leading platform to manage all ODE’s inventory complexities. The model’s flexibility allows the business to have tailor-made solutions during the modernization of the business. Simultaneously, the knowledge regarding inventory management and awareness of shortcomings has grown. This required knowledge of the current application provides an informed consideration when choosing a new package. Encompassing the complete inventory process in a package removes the risk of manual processes, but the downside is that the package will never reveal the underlying logic and heuristics. Therefore, ODE faces the choice between the benefits of the ITM and the benefits of the new software chosen. Though, even if the ITM would be replaced, the insights created by the model will significantly contribute to optimizing the new software. In addition, ODE recognizes that no single software provider can provide all capabilities that are available with the present ITM. Examples of these capabilities are simulations, descriptive statistics on inventory lines, fill rate optimizations on both category and item level.
Hence, the lessons learned with the ITM will be used to evolve these capabilities again within future software development. The operational model and simulation tool might be further developed as long as the current ITM is in operation. The performance will be improved, and the model becomes more robust. Finally, the time required to manage the system should be reduced to make decisions faster.
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Editorial
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