

# Optimizing inventory management at steel service centers : using advanced theory for inventory management to improve the performance of the steel supply chain

***Citation for published version (APA):***

Wiers, V. C. S., Bertrand, J. W. M. (Ed.), Houtum, van, G. J. J. A. N. (Ed.), & van Weele, A. J. (Ed.) (2015). *Optimizing inventory management at steel service centers : using advanced theory for inventory management to improve the performance of the steel supply chain*. (eSCF operations practices : insights from science). Technische Universiteit Eindhoven.

***Document status and date:***

Published: 01/01/2015

***Document Version:***

Publisher's PDF, also known as Version of Record (includes final page, issue and volume numbers)

***Please check the document version of this publication:***

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
- The final author version and the galley proof are versions of the publication after peer review.
- The final published version features the final layout of the paper including the volume, issue and page numbers.

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**ESCF Operations Practices:  
Insights from Science**

**Optimizing Inventory Management  
at Steel Service Centers**

# Optimizing Inventory Management at Steel Service Centers

Using advanced theory for inventory management to improve the performance of the steel supply chain

## Concise summary of this best practice

Small and medium sized metal service centers are facing complex inventory management issues. Such companies typically do not have enough scale to acquire and maintain experts that can help optimize stock levels. At the same time, there is a large pressure on such companies to keep inventory costs under control. With the help of INAD, a company that supplies Enterprise Software to these service centers, a best practice has been developed using the latest insights in inventory management. The method that was developed by Eindhoven University of Technology (TU/e) has been implemented by INAD as a cloud service, and is thereby available to all companies, independent on what Enterprise Management System they are using.

## Key Terms

Inventory Management, Steel Service Center, Stock Control, Stock Optimization, Stock Sharing.

## Relevant for

Companies in the steel supply chain, or other companies that deliver products with volatile demand from stock.

# Service centers in the steel supply chain

Steel products, such as coils, sheets, tubes and bars, are used in a large variety of processes and industries. The steelmaking process is extremely capital intensive and has a large number of process steps. At the same time, steel comes in many varieties regarding grades, dimensions and forms. This means that the leadtime of one particular product at a steelmaking plant can be quite large – typically 6 weeks or more. Furthermore, the minimum order size is derived from the quantity produced by the steel plant's critical resources, such as one hot rolled coil, which can be 10 tons or more.

Where some companies consume large volumes of steel that they procure directly from steel producers, such as car producers or companies with high volume packaging processes, other companies need many different products in small quantities, with multiple requirements on shape, dimensions, surface, and the like. For example, a medium-sized construction company that produces steel constructions for building projects typically needs a large variety of steel products that will be assembled to a steel construction. A short leadtime is needed for materials, as the time between getting the order and the actual construction is quite short. Furthermore, during execution, changes are often made in the construction, which means that materials must be available within a few days to the construction company. There are many of such small and medium size companies in The Netherlands. Such companies are too small to order materials directly from steel producers.

Hence, they are being served by *service centers* – companies that act as a supply chain intermediary. Contrary to the large steel producers, these service centers keep a stock of a large variety of steel products and they accept relatively small order sizes. The steel service centers fulfill an important function in the steel supply chain by reducing both the leadtime and the order quantity for its customers. Companies that produce steel are large in size and because of the large setups involved in their processes, the delivery time for a specific alloy or size can be long. Where large steel producers typically work with lead times measured in weeks, the service centers are capable of delivering orders within a few days. Moreover, service centers are capable of delivering a large variety of different steel products – that are needed together at the client – in one order or delivery.

# The need for cost reduction

The construction industry is an important end customer for the service centers. During the financial crisis, the construction industry has suffered a large decline in demand volume – a reduction of 30 to 40% was not exceptional. Demand for steel in The Netherlands has declined in the period from 2008 to 2012 from 5.7 million ton to 2.6 million ton. Obviously, this had a direct impact on the turnover of the service centers. Therefore, the need to reduce costs became imminent. For a service center, inventory is an important part of the costs. Therefore, stock reduction programs are a logical step in making the service centers more financially robust.

However, the medium sized service centers, which are the subject for this best practice, do not have the critical mass in their organization to maintain state-of-the-art knowledge on advanced inventory control models. Because the companies are relatively small, it is difficult for one company to systematically analyze inventory control problems and apply the right models – especially when the most commonly used models do not fit, and more advanced solutions are needed. Furthermore, there is typically no experience with working with academics, and skepticism towards the application of theory. Most inventory control strategies used by small companies are a mix of simplified theoretical models and heuristics, whereas in situations with dynamic and irregular demand, more advanced models are required.

## Software supplier taking the initiative

An initiative to improve inventory control was taken by a company that was able to oversee the common issues of small and medium sized steel service centers. This company is called INAD and it supplies a specialized ERP (Enterprise Resource Planning) solution to metal service centers and technical wholesalers. As INAD aims to improve the performance of its customers, they started thinking about an approach for their clients to reduce inventory costs using the software tools provided by the company. The INAD solution could perhaps be extended with more advanced inventory management, leading to lower costs for the users of the solution and hence a stronger relationship between the software supplier and its customers. As the company was founded – and still is led – by a graduate from the Eindhoven University of Technology, they approached TU/e to assist them with developing advanced inventory control models for INAD's clients. Subsequently, a project was started by an Industrial Engineering designer, to tackle the optimization challenges in practice using academic insights.

# Inventory control challenges

Managing inventory at a steel service center means one has to deal with some special challenges. The demand for specific products can be very dynamic – for many consecutive periods there can be no demand at all, which is then followed by a series of periods with demand. The following picture illustrates this, as peaks in demand clearly occur at irregular intervals.

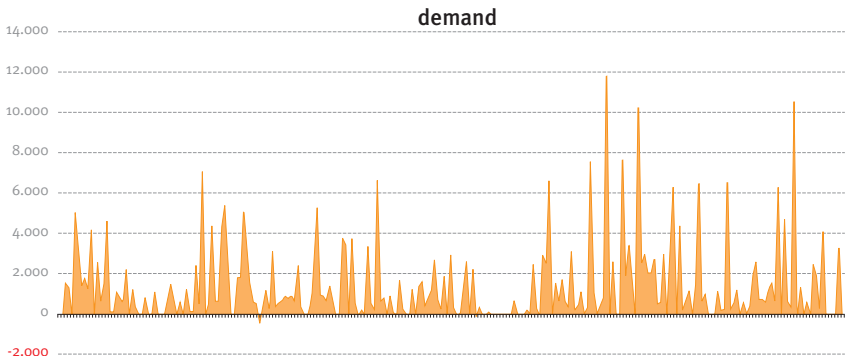


figure 1  
Typical Demand Pattern for one SKU

This kind of demand pattern makes the application of inventory control techniques assuming a normal distribution for demand infeasible. The normal distribution assumption is not met in the service center environment. Furthermore, most inventory control techniques assume a backorder strategy, where customers will simply wait until the out of stock item has been replenished. Whereas in the case of steel service centers, the lost sales approach is more valid – i.e. where customers will simply not buy when there is no stock. In practice, this means that the service center will procure the item at another supplier, which incurs higher costs.

As achieving a good fit between inventory control theory and the steel service centers appeared to be a challenge, INAD, the supplier of ERP software to many of these service centers, called in the assistance of the Eindhoven University of Technology. With the help of academic insights, INAD hoped to develop an inventory control mechanism that would have a good fit with the special requirements of the service centers.

## Bleeders

Most inventory control techniques focus on optimising the inventory for one specific item at a time. The underlying assumption is that when companies set the right inventory policy item by item, this will lead to optimal overall inventory control costs and performance. However, for metal service centers – and also for other companies, such as retail – reducing the inventory on an item-by-item level will not lead to a good overall performance. For service centers, another complicating matter regarding inventory control is that items in the catalogue are interrelated: it is not feasible to simply remove an item from stock when no profit is made on that specific item, as the profitable items will only be sold when the service center is able to supply a wide variety of items. Service centers typically supply many different materials to a customer in one order, which are needed for a single use, such as one construction project. This means that some of the service centers products are fastmovers, whereas other products are slowmovers. The business model of the service center is based on delivering all requested materials, as customers will not buy fastmovers when certain items, which are slowmovers for the service center, are not available, as this would mean that customers would be forced to order materials at multiple suppliers. To keep complexity under control, customers are typically not willing to procure materials for one project at different suppliers.

This characteristic of the market for small and medium service centers has a large impact on their inventory levels. As the 80/20 rule applies to the fast- and slowmover items – 20% of the items generate 80% of the demand – the service centers are forced to keep a relatively large amount of inventory of slowmovers. Items that have a low demand relative to their inventory, and therefore have relatively high inventory costs, are referred to as ‘bleeders’. Reducing inventory costs might be possible by reducing the inventory for bleeders – however, existing inventory control techniques do not provide a solution to this problem. This posed an additional challenge for the project initiated by INAD and the Eindhoven University of Technology.



## In search of a suitable model

As the inventory control problem at INAD's customers was rather specific, the Industrial Engineering technology designer from TU/e started investigating which inventory control techniques would be suitable to apply to the service centers. One of the first selection criteria for potential techniques was the assumption about customer behaviour when no stock is available when an order is placed. Most inventory models assume a backorder customer behaviour, mainly because for such situations, optimal values for the reorder level and the order-up-to level can be determined. However, the backorder assumption is not valid in many environments, including the steel service centers. When a backorder model is applied to a non-backorder situation, there can be large error between the expected and actual costs generated by the model. For the service centers, a model assuming lost sales needed to be found, as customers will not wait until the missing item has been procured. For the service center, not delivering is not an option and the missing items are procured at competitors, which means that the costs for such items will be higher for the service center.

Therefore, the designer, in search of a model that was able to deal with the lost sales assumption, did an exploration of the available literature. A suitable model was found in the PhD thesis of Bijvank (2009) who describes inventory models for the service industry. The demand characteristics for the service centers were judged to be comparable to those of service supply chains. To assess whether the expected costs given by the models were accurate, a simulation study was carried out.

# Inventory costs

The total costs of inventory management are determined by three factors, as shown in the figure below.



Holding costs relate to the capital costs of the items stored in the warehouse and the warehouse costs themselves. Ordering costs cover the administrative process of ordering items. Stockout costs relate to the penalty when running out of stock, which means that the item needs to be procured at a competitor at a higher price. The objective of inventory management should be to have the right stock against minimal costs. The inventory policy that was selected is a continuous review, order-point, order-quantity ( $s, Q$ ) policy. This is illustrated by the following picture.

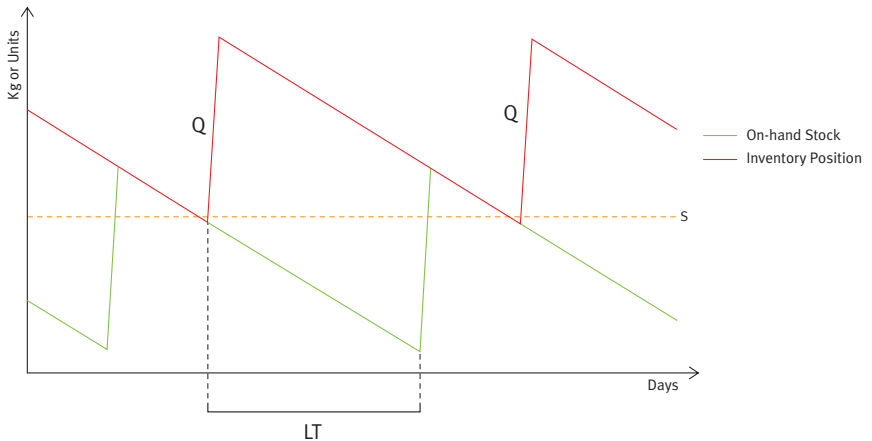


figure 3  
The ( $s, Q$ ) Policy for Inventory Control

The green line indicates the on-hand stock, and the red line indicates the inventory position. The difference between the two is the inventory that has been procured, but which needs a leadtime ( $LT$ ) to arrive at the warehouse.

The  $(s,Q)$  policy is illustrated by the fact that a quantity  $Q$  is ordered whenever the inventory position drops below the reorder point  $s$ .

The inventory control method has been implemented in a software module called StockOp, and recalculates the parameters for the  $(s, Q)$  model every day, taking the following as an input:

1. Total year demand
2. Ordering cost
3. Inventory holding cost
4. Product price per unit
5. Shortage fractional charge – a surcharge on the price of a unit, which represents the additional costs of procuring the unit at a competitor.

The typical result of applying this method to a service center is that there is a significant reduction in holding cost due to reduction of the average inventory. However, a lower stock level implies that more orders are needed, and therefore the ordering cost increases. Furthermore, stock-out costs increase substantially, but the total cost (holding + ordering + stock-out) is reduced. One of the reasons of this increase in stockout costs is that the main objective of stock policy proposed is to minimize the total cost. This means that sometimes it is cheaper to have a stock-out – i.e. to have to deliver the requested item against a higher procurement cost. In other words, the inventory control method reduces costs by shifting priorities from one cost factor to another. Such results might be counter-intuitive, but ultimately generates a better result from a cost perspective. This is illustrated by the following picture for one stock-keeping unit.

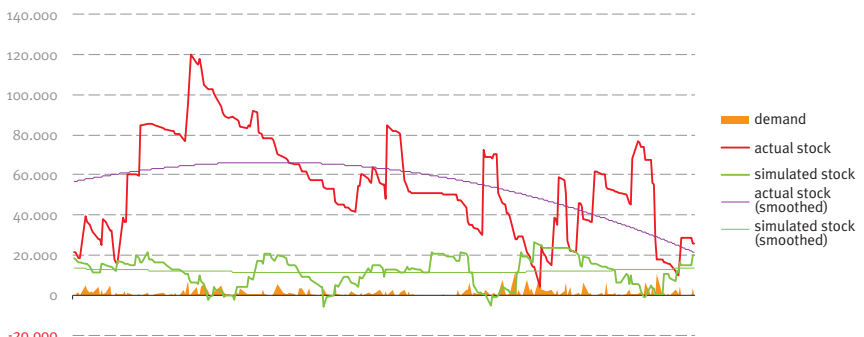


figure 4

Typical Result of Application of StockOp

## Dealing with bleeders

Items that are bleeders for one service center may not be a bleeder for the other; however, research has shown that 60% of the bleeders for a specific service center are also bleeders at other service centers. In some cases, companies do not hold inventory for certain items which would otherwise be bleeders, but they order such products at competitors. However, this means that the margin of the order, containing such products, will consequently suffer, as these products have to be procured at high cost. There is a trade-off to be made against holding bleeder inventory and ordering specific items at competitors.

The costs associated to bleeders can be reduced by pooling the inventory for such items together with other service centers. Obviously, such an approach can only work when there is trust between the cooperating parties. The inventory pooling is facilitated by the StockOp software and companies are free to decide with whom to share stocks. The software supports the companies in three ways: 1) identification of bleeders, 2) determining the maximum price to buy and 3) determining the minimum price to sell.

When a bleeder has been identified, the stockholder has either the option to remove the item from stock – and thereby choose to buy the item from a competitor when needed, or keep additional stock to fulfil not only their own demand, but also the demand of interested competitors. Because the sales of such an item might increase as a result of the second option, the item might not be a bleeder anymore, but become profitable. The seller determines a minimum selling price for the item, and the buyer determines a maximum buying price. When the latter is higher than the former, the parties can come to an agreement.

Currently, there is no coordination between the service centers which bleeders are kept on stock by whom – recall that the service centers are competitors of each other. However, another project has been initiated between INAD and TU/e to investigate whether bleeders should be stocked centrally or decentrally.

# Implementation

The developed inventory management model has been implemented in the StockOp module of INAD's software suite. Apart from the stock optimisation that is carried out by StockOp, it also supports inventory pooling to reduce the number of bleeders. Moreover, the StockOp module compares the actual buying behaviour with a simulation using the optimisation model over the same period. By performing the simulation, the service center gets a good view on the possible savings that can be achieved when the StockOp model is used. Simulations using data of INAD clients have shown that the following results are achievable using the model:

- Yearly cost reduction of stock 19-31%
- Inventory reduction 38-47% (when measured in total number of production units)
- The Bleeder Identification tool showed that on average 30% of the inventory consists of bleeders and that more than 60% of the bleeders can be pooled with other stockholders.

Lastly, it should be noted that an important criterion for success is the amount of trust between the competitors, as pooling bleeders relies on exchanging potentially sensitive information.

## References

Bijvank, M. (2009). *Service Inventory Management solution techniques for inventory systems without backorders*. PhD Thesis Vrije Universiteit Amsterdam.

## Colofon

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ISBN: 978-90-386-3819-5

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