European Journal of Operational Research 259 (2017) 917–925

Contents lists available at ScienceDirect

European Journal of Operational Research

journal homepage: www.elsevier.com/locate/ejor

Production, Manufacturing and Logistics

Stock keeping unit fill rate specification

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ARTICLE INFO

Article history:
Received 24 April 2015
Accepted 6 November 2016
Available online 12 November 2016

Keywords:
Inventory
Service level
Fill rate
Safety stock

ABSTRACT

The fill rate is the most widely applied service level measure in industry and yet there is minimal advice available on how it should be differentiated on an individual Stock Keeping Unit (SKU) basis given that there is an overall system target service level. The typical approach utilized in practice, and suggested in academic textbooks, is to set the individual service levels equal to the targeted performance required across an entire stock base or a certain class of SKUs (e.g., in ABC classification). In this paper it is argued that this approach is far from optimal and a simple methodology is proposed that is shown (on real life datasets) to be associated with reductions in stock investments. In addition, the new approach is intuitive, very easy to implement and thus highly likely to be positively received by practitioners and software manufacturers.

1. Introduction

For inventory control, service levels constitute arguably the most important performance measures (Silver, Pyke, & Peterson, 1998). The fill rate in particular (which determines the percentage of demand satisfied directly from stock-on-hand) is the most commonly used measure in industry, as it translates directly to the customer service level achieved (e.g., Guijarro, Cardós, & Babiloni, 2012). This measure, also known as the volume fill rate, is to be distinguished from the order fill rate which represents the fraction of complete orders that can be filled directly from inventory (Larsen & Thorstenson, 2008, 2014). Another, somewhat less common, service measure is the ready rate, specified as the fraction of time during which the stock-on-hand is positive. It is well known (e.g., Axsäter, 2006; Silver et al., 1998) that for pure Poisson and normally distributed demand the (volume) fill rate is equivalent (although only approximately in the case of the normality assumption) to the ready rate. Other service level measures used in inventory systems are reviewed by Schneider (1981) and Silver and Bischak (2011).

Service level targets drive the determination of safety stocks and thus inventory investments and the responsiveness of the system to market (step) changes. Such targets should relate explicitly to individual Stock Keeping Units (SKUs). From an analytical perspective, safety stock and ordering calculations are performed at the individual item level. It is also intuitively appealing that different items must receive different treatment based on their characteristics. However, the considerable number of SKUs that modern organisations deal with often implies that targets are being set at the aggregate/*system* level, be that the entire stock base or a category of SKUs following a particular classification approach (e.g., ABC classification) (Teunter, Babai, & Syntetos, 2010). The target service level then assigned to individual SKUs is simply that at the system level. One would expect that this approach is far from optimal when contrasting it to looking at each item separately and yet there are no guidelines in the literature as to how the latter could be done to differentiate service levels for individual SKUs in order to meet an overall system target service level. The specification of the 'right' service level on an individual SKU basis constitutes the purpose of this research.

1.1. Practical and research background

The authors have encountered a great number of companies that use the ABC classification to set service levels, by assigning the same service level to each SKU in a particular class. This is in line with findings from Lee (2002) from NONSTOP solutions (a provider of demand-chain optimization services) and Pflitsch (2008) from SLIMSTOCK (a provider of forecasting and inventory management software, including *Slimstock ABC* for inventory classification). Both confirm from their extensive experience of implementing inventory control software that the standard approach is to fix service levels per class.

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http://dx.doi.org/10.1016/j.ejor.2016.11.017
0377-2217/

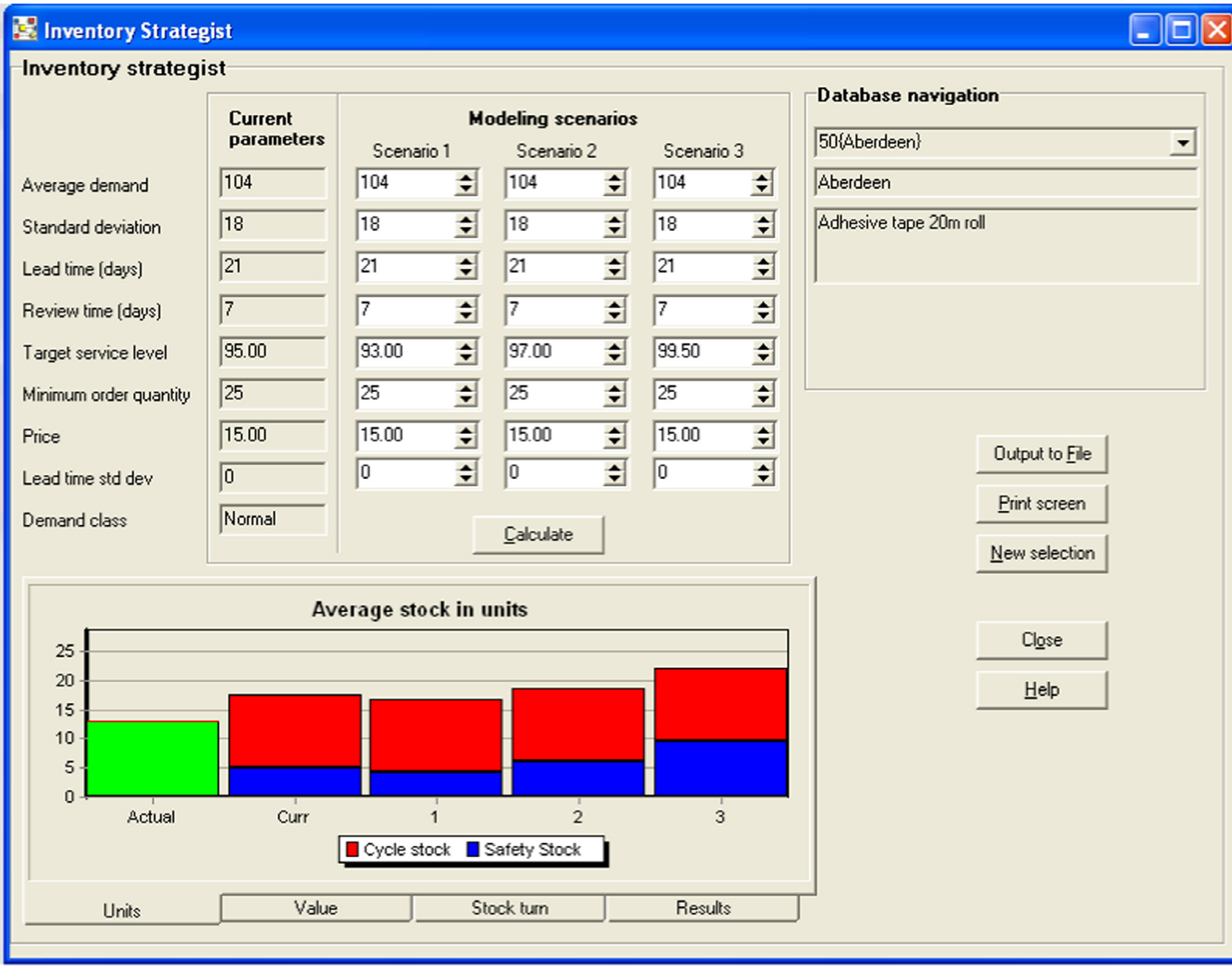

Fig. 1. Inventory strategist screenshot from RightStock software (presented with permission granted from DBO services limited).

Consideration of the individual SKU requirements and the assignment of a service level that is thought to be appropriate for a specific SKU occurs only on an exceptional basis. Companies are known for example to do so for what are often termed the '*super A*' items (in an ABC type classification), i.e. items of exceptional contribution to the profit margin or revenues.

State-of-the-art inventory planning software does offer manual (trial-and-error) experimentation to trade-off service levels and cycle/safety stock on an individual SKU basis. Inventory examination capabilities of that nature are supported by most specialized inventory control solutions, for example, *RightStock* from DBO SERVICES (Dawson, 2013) as well as supply chain planning software packages, for example, the *Inventory Planner* of ARKIEVA (Singh, 2013). In Fig. 1 we depict the *Inventory Strategist* function of *RightStock*.

For the example considered in Fig. 1, the system target service level is set to 95% and managers may experiment with the implications of altering the target for a particular SKU in terms of the average inventory required to sustain such a target. Inventory is controlled by a continuous re-order point, order quantity policy. This results in the cycle inventory being half of the order quantity; the average inventory equals the cycle inventory plus the safety stock (determined in this example based on the normality assumption). The implications of altering the service target, ceteris paribus, are automatically recalculated and managers may experiment to reach a decision as to what is the 'best' service level for a specific SKU.

Obviously, manual exploration of the effect of service level variation on the system cost and the system service level can only be done for a small selection of SKUs. Furthermore, lack of insight into why one SKU gets a higher service level than another may prevent managers from following such advice. Making such evaluations across the entire range of SKUs requires a system optimization approach that, to the best of our knowledge, is not available in any commercial inventory planning tool.

Although the majority of the inventory literature is also concerned with single SKU systems, the literature *does* suggest some multi-SKU approaches for setting service levels. Most of these approaches are rather complex and may therefore be difficult to implement. We refer interested readers to Thonemann, Brown, and Hausman (2002) for a discussion of key findings, and will only discuss the relatively simple approaches here.

Motivated by the absence of simple multi-SKU approaches, despite their great practical relevance, Thonemann et al. (2002) set out to derive an "easy-to-use model to estimate the benefit of using a system approach". Their model is restricted to a spare parts environment with Poisson demand and base stock ordering policies (with order quantities equal to one), where all parts have the