CIPS KNOWLEDGE

Economic production quantity (EPQ)

Holding too much inventory is costly to carry and holding too little can incur stock outs, lost sales, and perhaps in rare cases production plant shutdowns.

This knowledge paper is supportive of Procurement professionals operating at tactical level of the CIPS Global Standard

01 CPD HOURS

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Economic production quantity EPQ

Introduction

Profit maximisation is a central aim of any competitive organisation around the world. One of the ways firms strive to achieve this goal is to effectively use their resources and reduce costs related to production (Shamsi et al., 2009). Thus, understanding economic production quantity is important from the inventory management side of things because holding too much inventory is costly to carry and holding too little can incur stockouts, lost sales, and perhaps in rare cases production plant shutdowns (Wisner and Stanley, 2008: 192).

In this light, a fundamental task for organisations is to determine the quantity of a given item to order from suppliers to minimise overall inventory costs. One of the first attempts at devising a mathematical model to aid firms to achieve this came in the form of the economic order quantity (EOQ) model (Zipkin, 2000). The EOQ model has received a considerable amount of scholarly attention and in 1918 was advanced by E.W. Taf who developed the classical economic production quantity (EPQ) model (Biskup et al., 2003). The EPQ model is better suited to being used by a company manufacturing end items as opposed to (or in addition to) purchasing them from suppliers (Wisner and Stanley, 2008). A distinguishing feature of the EPQ model vis-à-vis the EOQ method is that in the former orders are received progressively throughout the manufacturing process (Dolgui et al., 2010). In addition, the EPQ model seeks to balance inventory holding and average order costs (Dolgui et al., 2010). This means that inventory gradually builds up over time at a rate equal to the daily production rate less the daily rate of demand (Shamsi et al., 2009; Wisner and Stanley, 2008).

There are a set of assumptions the EPQ essentially relies on. For example, the set-up cost for the year (rather than the annual order cost in the EOQ model) is set at equal to the annual inventory holding cost to solve for the optimal production lot size or ‘economic production quantity’ (Wisner and Stanley, 2008). The average inventory level is the maximum level less the minimum level (zero), divided by two (Wisner and Stanley, 2008).

Definition

The economic production quantity (EPQ) model is used to determine the optimal order quantity that an organisation should place with a supplier to minimise inventory costs, while balancing inventory holding and average fixed order costs (Dolgui et al., 2010).

Successful Application

When implementing the EPQ model, it is important to consider the assumptions that underpin its use: (1) no safety stock is needed because demand is known and constant; (2) lead time is known and constant; (3) no quantity discounts are available; (4) ordering costs are constant; (5) all demand is satisfied and there are no shortages; and (6) inventory is delivered in a single shipment (Reid and Sanders, 2007).

Hints and Tips

- Remember that the EPQ model is often associated with items produced inhouse. For this reason, the term ‘setup cost’ is typically preferred to ‘ordering cost’ (Wisner and Stanley, 2008).
- As the focus of much research and debate, there are several variants on the EPQ in circulation. Evaluate which version to use in the organisation and check periodically to see if there have been noteworthy

advancements on the model (or whether better alternatives exist) (Wisner and Stanley, 2008; Zipkin, 2000).
- Calculating the EPQ need not be a daunting task: consider investing in some quality software to handle inventory management with built-in EPQ functions, or alternatively use one of the many free EPQ calculators available online (Wisner and Stanley, 2008).

Potential Advantages

- EPQ is well-known and has been a commonly implemented inventory control method for decades (Shamsi et al., 2009).
- Although the EPQ model and (previously the EOQ) have a number of assumptions to simplify real life scenarios, they offer a solid basis for tackling more sophisticated problems (Dolgui et al., 2010).
- Utilising models such as EPQ is important because it shows a commitment to ordering in a stable manner from suppliers. It can help minimise the risk of being in a position of not being able to supply a key customer's order which might result in stock outs for that customer (Wisner and Stanley, 2008).

Potential Disadvantages

- The classical EPQ model assumes that all units produced are of perfect quality and shortage is not allowed. In practice, however, this could underestimate the actual number required because non-conforming product or scrap items are possible (Shamsi et al., 2009).
- In traditional EPQ models, set-up (or ordering) cost is treated as a constant. In reality set-up cost can be controlled, for example, through worker training, procedural changes, as well as specialised equipment acquisition (Ouyang et al., 1999: 1272).
- The traditional EPQ model is based on single product lot scheduling algorithms, thus giving rise to problem of multiproduct lot scheduling (Dolgui et al., 2010; Schrage, 1982).

Note
It must only be used for "independent demand items ", that is inventory whose demand is not directly linked to the level of production.
Inventory which is "dependent demand", must use techniques such as a Material Requirements Planning System (MRP).
Narrowly defined, MRP consists of a set of logically related procedures, decision rules and records designed to translate a master production schedule into time-phase 'net requirements,' and the planned 'coverage' of such requirements for each component inventory item needed to implement this schedule. . . . An MRP system re-plans net requirements and coverage as a result of changes in either the master production schedule, inventory status or product composition.

Performance Monitoring

- Control charts: frequently used as a means of monitoring production processes (Ohta et al., 2001).
- Error rates: evaluate the accurateness of parameter estimates in the lot-size model (for detailed information see Lowe and Schwarz, 1983).
- Sensitivity analysis: measures the difference between the average cost rate incurred by the company and the average cost rate that would have been incurred had there been no errors during the estimation (Yavuz, 2010).

Case Studies

- Swift and Co., an abattoir and processing company in the US, uses advanced scheduling and capable-to-promise (CTP) solutions to effectively manage the customer side of its supply chain. These solutions provided a 200% ROI in their first year (Bixby et al., 2006).
- Hewlett-Packard cut printer supply costs by 25% using inventory models to analyse the effect of different inventory locations in its supply chain. It also realised net savings of US$80m through moving transocean freight lanes from air to sea (Billington et al., 2004).
- Intel Corp., in collaboration with its key supply partners, developed production facility capacity models along the semiconductor supply chain to which it holds access in strict confidence. Suppliers benefit from more accurate requests and forecasts from Intel, while Intel is better able to handle bottlenecks and can potentially achieve savings of tens of millions of US dollars (Shirodkar and Kempf, 2006)

Further Reading/Reference

Web Resources

- What Is Economic Production Quantity? http://www.wisegeek.com/what-is-economic-production-quantity.htm

Books

- Procurement Principles and Management Baily, P., Farmer, D., Jessop, D., Crocker ,B and Jones, D.(2015) .11th ed. Pearson
- Business Ratios and Formulas, Steven M Bragg, ISBN 978-0470055175
- Operations Management, R.Dan Reid & Nada R Sanders, ISBN 978-0471794486
- Principals of Supply Chain Management, Joel D Wisner, Keah-Choon Tan & G Keong Leong ISBN 978-0324657913
- Integrated Models in Production Planning, Inventory, Quality and Maintenance, M.A. Rahim & Ben Daya, ISBN 978-0792373476
- Managerial Decision Making, Barry Render, Ralph M Stair Jr, Nagraj Balakrishnan & Brian Smith ISBN 978-0131237292

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Video

Inventory control
https://www.youtube.com/watch?feature=player_embedded&v=j7nahUoEmaE