# Economic Order Quantity (EOQ): Optimising order quantities economically

Economic Order Quantity (EOQ) denotes the most economical order quantity at which the sum of procurement and inventory holding costs per year is minimised. This classic model originates from production and inventory planning and gives buyers a mathematical basis for systematically deriving order quantities, order frequencies and safety stock levels. In practice, the EOQ serves as a starting point for volume planning, negotiations with suppliers and the design of lean procurement processes.

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### Key facts at a glance

01 The EOQ is the order quantity at which annual ordering costs and inventory holding costs combined are at their lowest.

02 The classic formula is EOQ = square root of (2 × annual demand × ordering cost / inventory holding cost rate × unit price).

03 The model assumes constant, known demand and no quantity discounts – real-world deviations must be accommodated.

04 Typically, the inventory holding cost rate in industry is set at around 15 to 30 per cent of the value of goods per year.

05 Sensitive demand forecasts, vulnerable supply chains and rapidly obsolescing items require adjustments such as dynamic safety stock.

06 The EOQ is a business management heuristic and does not replace comprehensive procurement planning or negotiation strategy.

## Definition: Economic Order Quantity (EOQ)

The Economic Order Quantity is the order quantity per order at which the sum of frequency-related ordering costs and tied-up inventory reaches its minimum. It balances two opposing cost drivers:

frequent small orders reduce inventory costs but increase ordering and processing effort; large consolidated quantities reduce ordering costs per unit but tie up capital and storage space.

### Basic formula and components

The Harris formula is: EOQ = (2 · K · B / (h · p)). Here, K stands for the cost per ordering process, B for annual demand in units, h for the inventory holding cost rate (in practice often 15–30% p.a.) and p for the unit price. The result is a reference value, not a rigid stipulation – it is regularly adjusted to reflect changed demand, prices and cost rates.

- K (ordering cost): processing, approval, transport organisation, inspection
- B (annual demand): forecast or actual consumption from the ERP system
- h (inventory cost rate): capital tie-up, rent, insurance, shrinkage, obsolescence
- p (price): net procurement value, ideally from a current fast-track price enquiry

### Distinguishing it from related concepts

The EOQ answers the question of 'how much', not 'when'. The point in time for ordering follows from the reorder point model, which takes replenishment lead time and a safety stock into account. The EOQ differs from contract ordering or call-off contracts in that it provides an optimising quantity logic, while framework contracts simplify the procurement process. Both approaches can be combined.

## Methods and approach for determining the EOQ

The practical benefit of the EOQ arises not from the formula alone but from a rigorous approach: verify the data basis, agree cost rates, extend the model to reflect real-world constraints and readjust results periodically.

### Establishing the data basis and cost rates

First, annual demand, unit price and ordering cost are determined for each item. Data quality is crucial: quantities from consumption feedback, demand plans or bills of material must be plausible; a data quality report helps identify outliers and outdated master data here. The inventory holding cost rate is defined internally and used consistently, as it strongly influences the result.

- Derive annual demand from ERP history and planned demand
- Determine ordering cost per transaction step by step along the process (including technical invoice verification)
- Agree the inventory cost rate with controlling and document it

### Extensions: quantity discounts and batch sizes

Where a quantity discount applies, the EOQ is compared with the discounted price tier: is the larger order quantity worthwhile because the saving exceeds the additional holding costs? A clean-sheet calculation can replicate the supplier's pricing logic and reveal negotiation leeway. Batch size requirements, pallet sizes, minimum order quantities and shelf life are factored into the decision as

boundary conditions.

### Integration into the reorder point system and demand planning

The EOQ is typically stored in the ERP system as a fixed order quantity and combined with the reorder point. With volatile demand, a dynamic safety stock is recommended, which mathematically accounts for fluctuations in demand and lead time. An overarching procurement plan also incorporates item strategies, supplier risks and technical changes such as the Engineering Change Notice (ECN), which can render existing stock worthless.

## Key KPIs and effects of the EOQ

Whether the EOQ is working shows up in key figures relating to inventory, costs and delivery reliability. Buyers should measure developments before and after implementation and track them systematically.

### Inventory and cost key figures

Key performance indicators are inventory coverage, inventory turnover, capital tie-up and total ordering costs per year. The EOQ deliberately shifts inventory and order frequency – the target state shows itself in falling total costs, not necessarily in falling inventory alone.

### Supply and process key figures

Because smaller, more frequent orders put a strain on the procurement process, suppliers' delivery performance and the expedite rate (proportion of accelerated priority orders) are important control parameters. A rising priority order rate indicates safety stocks that are too tight or unreliable replenishment lead times – in that case, a bottleneck analysis in the procurement chain helps.

- Supplier delivery reliability as a leading indicator for the reorder point and safety stock
- Order rate per catalogue as an indicator of process automation in the C-parts area

## Risks and controls in applying the EOQ

The EOQ rests on simplifications. Anyone who adopts it uncritically risks shortfalls, capital tie-up or costly expedited purchases. Controls and clear responsibilities reduce these risks.

### Model risks: incorrect assumptions

Constant demand, stable prices and unlimited warehouse capacity are rarely fulfilled in reality. For seasonal items, long lead times or fluctuating commodity prices, the model distorts the result. Supplementary scenario analyses, regular recalculations and an agreed procurement plan are therefore standard in practice.

### Supplier and contractual risks

Large order quantities increase concentration risk vis-à-vis individual suppliers. Supplier evaluations,

an ESG risk rating and contractual rights of recourse – e.g. a retention for defects or a right of termination for cause – protect against failures. In international procurement, trade terms such as Incoterms DDP or CFR should be clearly agreed, since the delivery date and transfer to stock influence the effective inventory holding costs.

### Process and coordination risks

Changed demand due to design changes (ECN), increased in-house production depth for critical components or returns via the credit procedure (ERS) alter the basis of calculation. Fixed review dates, clear approval routes and coordination with sales, engineering and controlling ensure the parameters remain up to date.

## Current developments: the EOQ in digital procurement

Classic formulas are now supplemented by data-driven planning approaches. The core logic and cost thinking of the EOQ remain fully relevant – only the calculation is automated and made dynamic.

### Automation and AI-supported quantity planning

Modern ERP and inventory systems calculate order quantities continuously from actual consumption data and forecasts. Methods such as automatic spend classification pre-sort items by value and criticality, so that the EOQ is applied where it delivers the greatest leverage: on high-value, repeatedly procured items.

### Sustainability, resilience and total cost considerations

Increasingly, supply chain risks, CO balances and environmental aspects are factored into quantity decisions. A supplier energy audit may show that a higher inventory level at a supplier with energy-intensive production buffers risks in the short term. In strategic partnerships with a Joint Business Plan (JBP), quantities, price tiers and delivery performance are planned together – the EOQ provides the objective computational basis.

## Typical metrics

| Metric | Typical value |
|---|---|
| **Holding cost rate** | typically 15–30% p.a.<br>*Key parameter of the EOQ formula, to be agreed with controlling* |
| **Order frequency** | Annual demand / EOQ<br>*Number of ordering processes per year per item* |
| **Delivery Performance** | > 95%<br>*Basis for the reorder point and safety stock* |

| | |
|---|---|
| **Expedite Rate** | < 5%<br>*A high proportion of priority orders indicates stock levels that are too low* |
| **Inventory coverage** | item-dependent, often 2–12 weeks<br>*Effect of the EOQ on inventory and capital tie-up* |

## Practical example

A mid-sized mechanical engineering company sourced standard small parts (screws, bearings, seals) based on rules of thumb: sometimes every two weeks, sometimes in annual quantities all at once. Following the introduction of a material master with EOQ calculations, procurement was reorganised.

- Ordering costs per transaction were determined step by step along the process, and the inventory cost rate was set at 22% in agreement with controlling.
- EOQ and reorder point were calculated for around 600 recurring items and transferred to the ERP system.
- For critical A-parts, a dynamic safety stock was additionally introduced to cushion supply fluctuations.
- C-parts were bundled via catalogue orders; the order rate per catalogue rose significantly, while processing effort fell.

## Conclusion

The Economic Order Quantity is a proven, simple instrument for setting order quantities objectively rather than by gut feeling. Its value only emerges with sound data, realistic cost rates and the addition of safety stock, discount logic and supplier risks. Buyers also use the EOQ as an argumentative basis in price negotiations and when designing framework agreements. Regular reviews ensure the parameters remain up to date in the event of demand and price changes. Used in this way, the model measurably reduces total costs without jeopardising security of supply.

## Frequently asked questions

### ? What is Economic Order Quantity in simple terms?

The EOQ is the order quantity at which ordering costs and holding costs combined are at their lowest. Ordering too frequently makes the process more expensive, while large quantities tie up capital and warehouse space. The formula finds the compromise between the two types of cost.

### ? How do you calculate the EOQ?

EOQ = (2 × annual demand × ordering cost / (holding cost rate × unit price)). Example: annual demand of 12,000 units, €60 ordering cost, 20% holding cost and €25 unit price result in approximately 490 units per order. It is important to use consistent, plausible input values.

### ? What are the disadvantages of the EOQ model?

The model assumes constant demand, fixed prices and no quantity discounts or capacity limits. With seasonal demand, price fluctuations or impending obsolescence, it distorts the result. In practice, the EOQ is therefore combined with scenario analyses, safety stock and periodic reviews.

### ? What is the difference between EOQ and the reorder point?

The EOQ answers the question of how much to order; the reorder point determines when to order. The reorder point is derived from demand during the replenishment lead time plus safety stock. Both parameters are stored together in the ERP system and together form the reorder point method.

### ? How are quantity discounts taken into account in the EOQ?

The EOQ is calculated separately for each price break, and the total costs (material plus ordering plus holding costs) are compared per tier. The selected quantity corresponds to the tier with the lowest total costs, provided it is above the discount threshold. A clean-sheet calculation helps to understand the supplier's pricing logic.

### ? When is the EOQ not appropriate?

With high-value individual projects, highly fluctuating demand, rapidly obsolescing items or strategic procurement involving negotiation, a case-by-case analysis wins out. Where warehouse capacity is tight or customs and transport costs are high, additional costs must also be factored in. In such cases, comprehensive procurement planning delivers better decisions.

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