

Traceability of Materials: Systematically Building Traceability in Supply Chains

Traceability of materials (material traceability) refers to the ability to document the origin, processing route and point of use of materials along the entire supply chain without gaps. For technical buyers, it is a prerequisite for quality management, product compliance and evidence obligations in the sustainability field. The following article explains terms, methods, KPIs and practical implementation steps.

Key facts

- Traceability covers the batch, lot, serial number and origin of a material from the raw material source through to the installed product.
- It is required by standards in many industries such as automotive, medical technology and aerospace, for example via IATF 16949 or ISO 13485.
- Typical identification carriers are barcodes, data matrix codes, RFID and digital material passports.
- The traceability level (batch, lot or individual part) should be determined on a risk-based basis along the ABC analysis and critical commodity groups.
- Traceability is the foundation for recalls, 8D reports, Product Carbon Footprint (PCF) and CSDDD due diligence evidence.
- In practice, the costs of a traceability system are often in the low single-digit percentage range of the affected procurement volume; the benefits become apparent above all in complaints and audits.

Definition: Traceability of materials

Traceability of materials is the documented ability to prove, for every material or component, its origin, all processing steps and its whereabouts in the production and supply process. It covers both trace-back (where does the material come from?) and trace-forward (where is it installed?).

Distinction: batch, lot and serialisation

The depth of traceability is determined by the identification level. Batch traceability groups material of the same origin and production, lot traceability refers to a specific production release, and serialisation identifies every individual part. In mass production, batch traceability is typically sufficient, while in aerospace and medical technology serialisation is often mandatory. The choice of level significantly determines the effort and data volume and should be aligned with the risk of the material.

Single- and two-tier traceability

Single-tier traceability means that a company knows its suppliers and customers directly. Two-tier or multi-tier traceability also covers sub-suppliers, for example the origin of raw materials at a Tier-2 or Tier-3 supplier. Especially for conflict minerals, timber, food authenticity or CO2 data, the multi-tier view is required. It requires contractual obligations and data deliveries from suppliers, which must be actively demanded and verified in procurement.

Methods and approach: building traceability in procurement

Building material traceability follows a risk-based approach: critical materials first, standard parts later. Procurement plays a key role here, as requirements must be contractually agreed with suppliers, anchored in specifications and verified at first sample submission (PPAP).

Prioritise critical materials

At the outset, the material portfolio should be segmented by risk relevance. The ABC analysis or ABC-XYZ analysis provides valuable indications: high-value A materials, single-source items and safety-critical parts generally take priority. For safety-critical parts in the automotive industry, the special characterisation process is the established standard. The result is a traceability roadmap that specifies which commodity groups are traced at which level.

Anchor requirements with suppliers

Traceability requirements belong in supply contracts, specifications and drawings. Usual anchor points are: marking requirements on packaging and parts, supplier manufacturer numbers and manufacturer codes, delivery of batch data in electronic format, and evidence obligations upon material changes. In tendering processes, traceability capability should already serve as a selection criterion. At first sample submission (PPAP), it is verified whether the supplier can actually deliver the agreed marking and documentation.

Select identification technologies

In practice, barcodes and data matrix codes dominate, as they are cost-effective and readable across industries. RFID offers advantages for contactless capture and reuse, for example on returnable containers or in logistics. Digital material passports and product passport data models are gaining importance, particularly through regulatory initiatives such as the Digital Product Passport. It is important to uniquely link the physical carrier with the master data, which is why parameter maintenance (MRP) and the procurement data model should be closely interlinked with traceability.

Key KPIs: making traceability measurable

Without measurable KPIs, traceability remains a paper concept. The following indicators have proven themselves in practice and can be regularly evaluated in quality and procurement reports.

Operational KPIs

The core KPI is trace coverage: the proportion of critical materials for which complete traceability is documented. In addition, trace duration (time from the complaint to the complete isolation of affected batches) and the accuracy of master data count. Typical benchmarks: trace coverage above 95 per cent for critical parts, trace duration under 24 to 48 hours, marking quality above 98 per cent error-free labels at goods-receipt checks.

Economic evaluation

The benefit of traceability shows in avoided costs: shorter blocked stock, smaller recall scopes and faster 8D processing. A cost-benefit analysis should weigh the effort for marking, software and data maintenance against avoided quality costs and risk positions. Measurable benefits also arise for sustainability requirements: only with traceable materials can Product Carbon Footprint (PCF) and Scope 3 emissions be credibly substantiated. The ROI in procurement can then be quantified through

avoided penalty payments, audit findings and speed in the event of complaints.

Risks and controls: typical pitfalls

In practice, traceability fails less often due to technology than due to process and organisational issues. The main risks can be addressed with clear control mechanisms.

Data gaps in the depths of the supply chain

The biggest weak point lies with sub-suppliers whose data the direct supplier does not pass on or only incompletely. Countermeasures are contractual disclosure obligations, supplier self-disclosures and sample audits. For high-risk commodity groups, such as raw materials with a sustainability relevance, multi-tier safeguarding is recommended. Exception management helps to systematically identify and follow up data gaps instead of handling them ad hoc.

Marking and process errors

Frequent sources of error are incorrect or duplicate batch numbers, missing labels on intermediate packaging and missing links between production order and material issue. Effective controls are goods-receipt scans with automatic plausibility checks, MSA-capable measurement and inspection processes for relevant material properties, and training in production and warehousing. Changes to material or process must run through change management processes with a documented transition between old and new batches.

Supplier changes and change of control

In the event of supplier changes, the sale of suppliers or change-of-control situations, traceability chains can break: archived data, tools and process documentation change ownership or are lost. Procurement contracts should therefore contain provisions on data handover, retention periods and transition phases. This applies particularly to single-source items, where a change without documented history poses a high quality and liability risk.

Current developments: regulation and digitalisation

Traceability is transforming from a pure quality instrument into a compliance and sustainability topic. New regulations and digital standards significantly increase the requirements for procurement organisations.

Sustainability and due diligence obligations

The Corporate Sustainability Due Diligence Directive (CSDDD) and existing due diligence laws require companies to identify human rights and environmental risks along the supply chain. Without material traceability, such evidence can hardly be provided, for example when verifying the origin of raw materials or making statements on Scope 3 emissions. Reporting frameworks such as the GRI Standards also rely on a verifiable data basis. Procurement should therefore interlink traceability with sustainability reporting and continuously increase the classification rate of requested sustainability data.

Digital material passports and data exchange

The Digital Product Passport in the EU and industry-specific standards are driving the digitalisation of traceability. The goal is machine-readable, standardised material data along the value chain. For buyers, this means: data requirements towards suppliers are becoming structured and increasingly part of the

sourcing pipeline. Those who systematically request, evaluate and integrate supplier data into their own procurement data model gain early-warning effects and a better negotiating position. In addition, approaches such as lean procurement are gaining importance, which keep the administrative burden of data collection lean.

Typical metrics

Trace coverage of critical materials: > 95 %

Proportion of risk-relevant materials with documented end-to-end traceability

Trace duration: < 24–48 h

Time until complete isolation of affected batches after a complaint

Marking error rate: < 2 %

Incorrect or missing labels at goods receipt

Suppliers with traceability agreement: > 90 %

Proportion of relevant suppliers with contractually anchored marking and data obligations

Practical example

A medium-sized mechanical engineering company with around 300 actively procured materials received a customer complaint demanding that all affected assemblies be identified within 48 hours. The manual search through paper records took several days and strained the customer relationship. The company thereupon introduced a seamless traceability concept, starting with safety-critical components.

- Risk segmentation of the portfolio using ABC-XYZ analysis; starting with 40 materials classified as critical
- Anchoring of marking and data delivery obligations in new supply contracts and verification at first sample submission (PPAP)
- Introduction of data matrix codes and goods-receipt scanning with automatic assignment to the production order
- Monthly reporting of trace coverage and trace duration as part of the quality review

Conclusion

Traceability of materials is a cross-cutting topic that connects quality, compliance and sustainability. It only succeeds when requirements are contractually anchored, technically implemented unambiguously and lived processually. Procurement plays a shaping role here, from specification through first sample submission to supplier management. A risk-based start with measurable KPIs keeps the effort manageable. Those who build traceability early and systematically reduce complaint costs, accelerate responses to quality incidents and meet growing regulatory evidence obligations.

Frequently asked questions

What does traceability of materials mean?

Traceability means that the origin, processing steps and whereabouts of a material are documented and reconstructable along the entire supply chain. It covers both trace-back to the origin and trace-forward to the installed product. The depth required ranges from batch to lot through to serialisation of every individual part, depending on the requirement.

Which industries mandate material traceability?

Binding requirements exist above all in the automotive industry (IATF 16949 with special characterisation), medical technology (ISO 13485), aerospace and aviation, as well as in the regulated food and pharma sectors. Structural engineering and plant engineering also require evidence of material origin. The specific requirements should be examined on a case-by-case basis according to the relevant standards and customer specifications.

How is material traceability implemented in procurement?

A proven approach is a risk-based step-by-step plan: first identify critical materials, then anchor requirements in contracts and specifications, verify them at the PPAP stage and define the marking technology. This is complemented by goods-receipt scanning, master data maintenance and regular audits. KPIs such as trace coverage and trace duration ensure effectiveness.

What does a material traceability system cost?

Costs consist of software, marking (labels, printers, scanners), process adaptation and data maintenance. In practice they are often in the low single-digit percentage range of the affected procurement volume, strongly dependent on the traceability level and the number of suppliers. A cost-benefit analysis should include avoided recall and complaint costs.

What is the difference between batch and serial traceability?

With batch traceability, a group of identically produced materials is identified together, whereas with serialisation every individual part is unique. Batch traceability is more cost-effective and sufficient for many industries. Serialisation is required when every part must be individually verifiable, for example in aerospace and aviation or for safety-critical components.

What role does traceability play in sustainability reporting?

Without traceable materials, origin evidence, PCF data and Scope 3 emissions can hardly be credibly substantiated. Statutory due diligence obligations such as the CSDDD also require evidence along the supply chain. Traceability therefore provides the data foundation for sustainability reporting and audit evidence.