VDA | Verband der Automobilindustrie

Quality Management in the Automotive Industry

Quality-related costs

- Failure costs and failure prevention costs, scope and implementation –

1st Edition, April 2015

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This publication will also be issued in other languages. The current status must be requested from VDA QMC.

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Berlin, November 2014

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1 Object and purpose

Before this VDA volume was published, no standardized definitions of terms regarding quality-related costs in the automotive industry existed. However, in order to be able to manage quality processes – even in the supply chain – defined standardized understanding is essential.

By defining the term ‘quality-related costs’ and establishing a method to report quality failure costs in a practicable way, this VDA red volume closes this gap.

The concept of quality failure cost reporting enables companies to extend their quality reporting in a targeted manner, as well as to optimize the management of their improvement measures; the obligation to disclose failure costs in cooperations between companies is excluded.

Current business cost calculations do not generally allow failure prevention costs to be isolated or ascertained.

2 Quality-related costs

Quality-related costs comprise the costs of failure prevention as well as failure costs. Costs are quality-related costs if

- they are concerned with the quality of the product, including alignment with the manufacturing process (conformity of production) or product safety
- they are concerned with processes having a direct influence on product quality

The following diagram illustrates the correlation between failure costs and failure prevention costs as an essential element of quality-related costs:

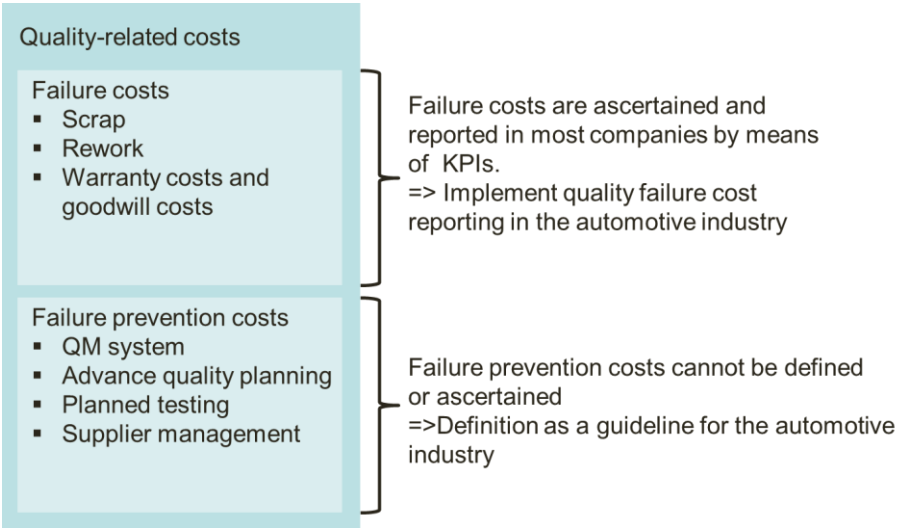

Fig. 1: Scope and implementation of quality-related costs

At this point, it is to be noted that literature describes different concepts for structuring quality-related costs. However, these are rarely applied in current cost calculation systems.

The following diagram shows how quality-related costs are categorized in the product lifecycle:

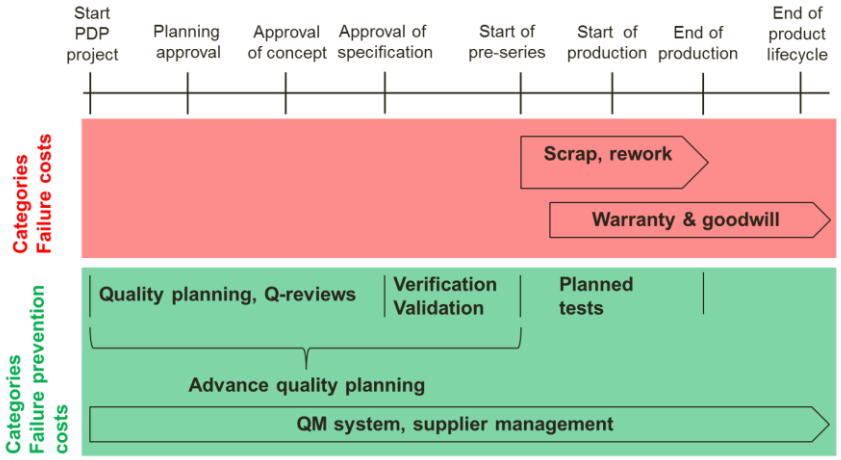

Fig. 2: Quality-related costs in the product lifecycle

3 Failure costs and quality failure cost reporting

Failure costs are costs that arise when specified quality requirements are not fulfilled.

Quality failure cost reporting according to VDA is a management-orientated approach for ascertaining, categorizing and consolidating costs relevant to failure into reportable key performance indicators.

This results in a further indicator-based quality control loop on a monetary basis which is shown in Figure 3. The loop is implemented operatively via the companies´ standard processes.

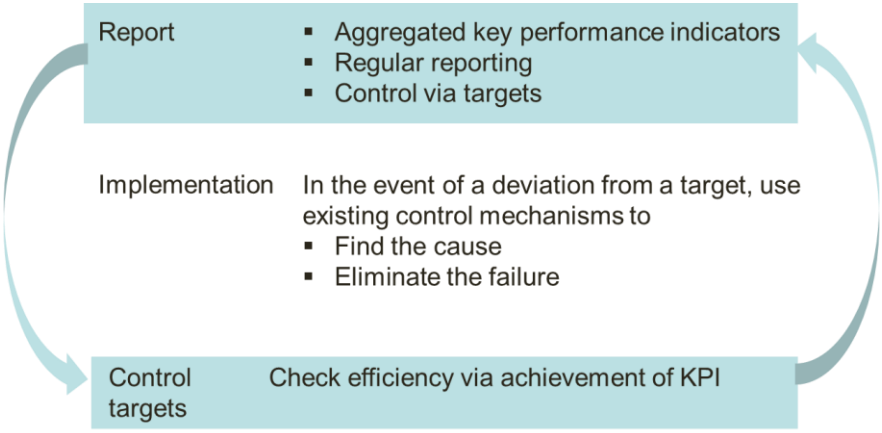

Fig. 3: Quality control loop of quality failure cost reporting

3.1 Aim / benefits

Quality failure cost reporting is a supplement to quality reporting. It aggregates failure costs in key performance indicators. Regular reporting opens up the possibility of management via monetary targets.

This additional perspective identifies potentials and offers a mechanism for achieving a further objective focus of quality improvement measures.

3.2 Assumptions

The concept of quality failure cost reporting is based on practicability. It has been developed under the following assumptions:

- The use of existing cost calculation for cost recording
- Profits or cash inflows from settlements, scrapping, insurances, etc. are never calculated against failure cost indicators but are still shown separately
- There is no obligation to disclose failure costs in cooperations between companies

3.3 Categories of failure costs

Failure cost categories are applied equally to OEM or Tier X. Categories of failure costs are used for planned sellable products along the entire value chain.

Failure costs comprise the failure cost categories described in the following.

3.3.1 Scrap

These are materials, components and products that are unusable because of quality defects. For technical, economic or legal reasons, it is impossible or makes no sense to further process or rework them, with the consequence that they have to be scrapped or recycled.

A reject may occur at any time during the production process and the respective object is removed as soon as the defect is recognized. This therefore prevents it from being utilized in the manufacture of the end-product.

Scrap refers to processes for planned sellable products. Furthermore, during the project / product ramp-up phase, scrap may not be assigned to quality-related costs.

Products that are scrapped subject to inventory adjustments, stock clearance or surplus stocks are only considered to be scrap if due to a quality flaw.

Start-up parts, warm-up parts and test parts specified during process planning that require scrapping do not count as scrap. However, if these components cannot be identified separately, they are treated as scrap.

3.3.2 Rework

Rework costs are the financial expense incurred by a faulty product in order to retroactively fulfill quality requirements. They also include any necessary disassembly steps.

In such cases, the manufacturing process no longer corresponds with the planned target standard manufacturing process.

The production steps introduced for reworking products are not counted as failure costs in production process planning or work schedule, respectively – even after process approval. However, they need to be investigated and evaluated within the scope of continuous process improvement in order to find out if there are any potentials for optimization.

Rework can be carried out:

at the supplier / Tier X

at the OEM before the end-of-line

at the OEM before delivery of the product to the end-customer

3.3.3 Warranty costs and goodwill costs

These are failure costs provided they are granted within the scope of legal (country-specific) liability for material defects, a guarantee, a warranty or a case of goodwill. In consequence, they arise after delivery of the product to the end-customer in order to correct product defects, or to remedy potential defects as part of a preventive measure.

It is to be noted that actual liabilities in the customer-supplier relationship only arise as a result of contractual or legal provisions.

Goodwill is only taken into consideration if the respective costs are covered by the product manufacturer as a result of serial losses.

Warranty services expressly agreed in a contract, such as mobility warran-

ties and warranty extensions, are taken into account in warranty costs and goodwill costs.

Additional sales goodwill, which is often determined individually, is not taken into consideration.

Settlements are made on the basis of legal (country-specific) / contractual provisions. Where necessary, settlement costs are accounted per individual case.

Warranty costs and goodwill costs may arise as a result of:

- exchange
- modifications
- repairs
- software update
- replacement materials / parts
- field / recall actions

If arranged in the contract, services such as breakdown recovery, bearing follow-up costs, administrative costs, the processing of measures driven by warranty/goodwill are also taken into account.

3.4 Sub-categories of failure costs

3.4.1 Special tests with parts selection

A test ascertains whether the product corresponds with the stated specifications/given target value.

Special tests are non-scheduled tests initiated by complaints about quality, for example 100% tests.

The testing steps, introduced in production process planning or the work schedule – even after process approval - are not counted as failure costs. However, they need to be investigated and evaluated within the scope of continuous process improvement in order to determine any optimization potentials. As is the case with all other planned testing, these costs also form part of failure prevention costs, see Chapter 4.3.

Parts selection tests are special tests that are followed by a qualified decision regarding their further use.

3.4.2 Failure analysis

The scope of failure analysis within the context of a root cause analysis is taken into account in failure costs.

A failure analysis may include the following activities:

- Installation tests
- Laboratory tests
- Expert reports
- Test drives
- Test bench trials

In cases where costs concerning isolated failures are ascertained as part of the failure analysis, e.g. for settlement purposes, all failure cost categories need to be considered and the resulting costs ascribed proportionately to the failure case.

3.5 Cost types

The following cost types can be correctly assigned to failure cost categories:

- Staffing costs
- Material costs
- Traveling costs
- Costs for exceptional freight and transport
- Costs for external services
- Costs for machines and equipment
- Disposal

3.6 Key performance indicator model

3.6.1 Cost calculation

In order to calculate costs, first of all an analysis has to be made to determine into which cost centers or cost objects the failure categories and subcategories are grouped.

Once the relevant cost centers / cost objects have been identified, the different cost types listed in Chapter 3.5 are then allocated appropriately.

The failure sub-category costs ascertained in this way are then assigned to the correct failure category.

All cost types and failure (sub-)categories are converted to units of currency. The following diagram illustrates the process:

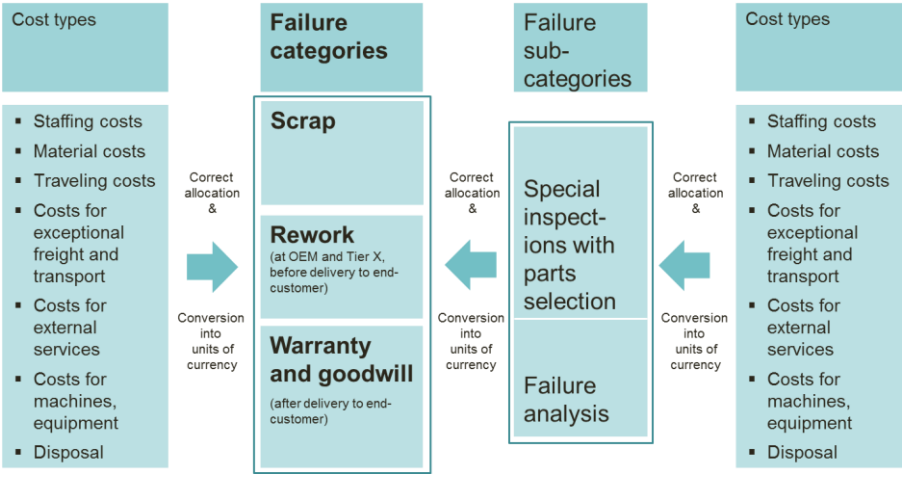

Fig. 4: Grouping cost types into failure categories

3.6.2 Key performance indicators

The failure cost categories of scrap, rework and warranty / goodwill also represent measurable values of the KPI system. By aggregating the failure costs categories, the main indicator ‘failure costs’ can be generated.

The following can be used as a benchmark for a relative value:

1) Turnover

2) Piece numbers

3) Manufacturing costs

The following can be used as additional sub-categories:

a) Works / production unit

b) Product series / product category

c) Isolated failure cases.

The benchmark depends on the company unit to be managed by the key performance indicator.

The following diagram summarizes the KPI model:

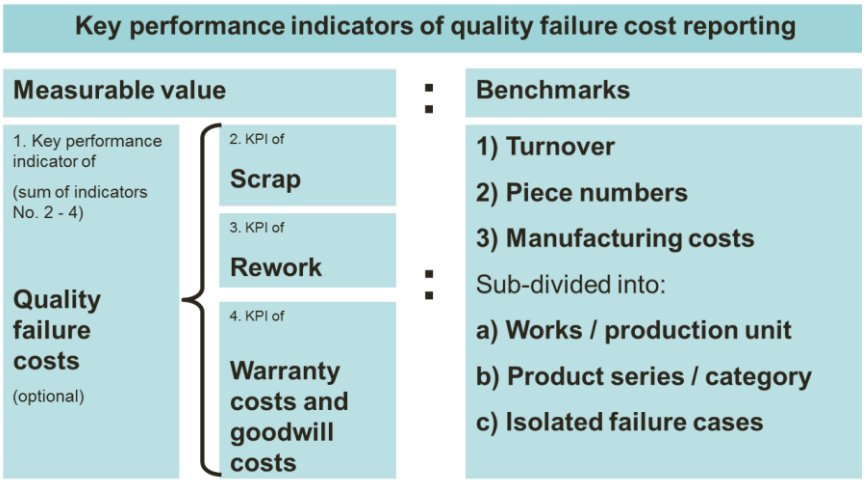

Fig. 5: Key performance indicators of quality failure cost reporting

4 Quality-related failure prevention costs

Failure prevention includes all measures, activities and process steps that take place before a failure occurs in order to protect internal / external customers from experiencing failures. Failure prevention costs can be divided into the following four sub-categories:

- Quality management system
- Advance quality planning
- Planned testing
- Supplier management

As explained in the introduction, failure prevention costs cannot be ascertained in a KPI model because they cannot be isolated. These costs are managed using conventional cost control instruments, such as planning overheads (headcount, budget) or value stream analyses.

The two examples described below illustrate the problem in more detail:

a) Execution of an FMEA as part of risk management:

Today's business practices do not allow the staffing costs of FMEA teams to be identified solely as FMEA activities and thus to be assigned to failure prevention costs.

b) Execution of testing steps in the factory / production:

Tests are often carried out inside a machine to verify process stability and often form "an inherent part" of the machine. This process step can only be recorded separately as machine investment and operating costs in exceptional cases and the respective costs thus be assigned to failure prevention costs.

The following diagram shows the correlations between the various categories of quality-related failure prevention costs:

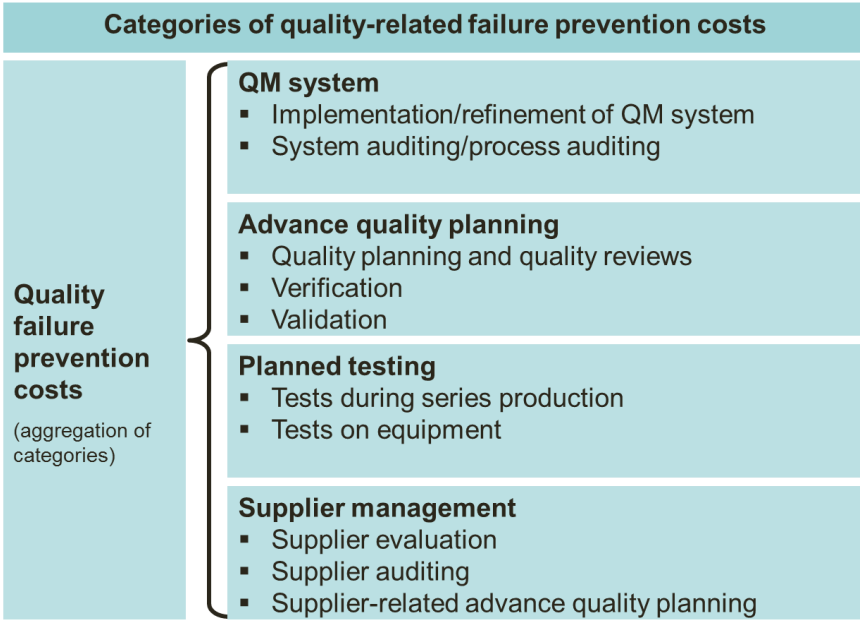

Fig. 6: Quality-related failure prevention costs

Costs associated with improving process stability, such as higher-quality machines, are not assigned to quality-related failure prevention costs. Quality-related failure prevention costs apply primarily to advance planning and testing activities.

4.1 Quality management system

As opposed to the definition given in DIN EN ISO 9000:2005, the term ‘quality management system’ needs to be defined more precisely in the context of quality-related costs. Consequently, the quality-related costs of those organizational quality management tasks which cannot be grouped assigned to the categories of advance quality planning, planned testing, supplier management or failure costs are grouped into the category ‘quality management system’.

Among others, these include:

4.1.1 Implementation / development of the quality management system

- Quality improvement programs and maintenance of the quality management system
- Management and organization of quality management
- Costs associated with organizing procedures and standards
- Quality reporting
- Field observation

4.1.2 Auditing

- System audits (internal, external)
- Process audits
- Certification costs

4.2 Costs of advance quality planning

Advance quality planning includes quality assurance measures in product development process. It includes:

- Quality planning / reviews
- Verification
- Validation

The application of quality methods is assigned to failure prevention costs if they are implemented within the scope of quality processes such as advance quality planning.

Planned trials / tests, which are carried out in the product development process in order to develop a specification from a concept, are not assigned to failure prevention costs but instead to development costs.

4.2.1 Quality planning and quality reviews

Quality planning encompasses the planning of quality assurance measures in the product development process. A quality review evaluates whether previously-addressed quality issues, such as quality specifications and lessons learned, have been put into practice.

Among others, quality planning includes the following activities:

- Implementation of lessons learned
- Scope of quality-related feasibility studies
- Compilation of quality specifications, e.g. with product lifetime targets
- Risk assessments, including FMEA, forecasts such as the probability of a failure occurring
- Planning of verifications, validations and tests
- Quality review of packaging planning
- Quality review / quality approval of product/process concepts
- Maturity validation
- Planning of product audits
- Assurance of functional safety (see ISO 26262)

4.2.2 Verification

Verification is a check / examination which is carried out to assess whether defined specifications have been met.

Among others, verification includes the following activities:

- Commissioning and acceptance tests, for example machine capability
- Functional tests
- Construction, technical feasibility and telematics of electrical systems and electronic functions
- Material approval tests
- Sampling using the production part approval procedure (PPAP) or production process and product release (PPF**)**

4.2.3 Validation

Validation is the declaration of validity / assurance of serial suitability under normal conditions of use.

Specifications are assessed to ensure that they comply with realistic conditions of application.

Among others, validation includes the following activities:

- Measures to confirm specified product features, for example by means of a test drive
- Preliminary process capability tests, such as 2-day production or Run@Rate
- Analysis of measuring systems
- Internal and external trials and laboratory analyses

4.3 Planned testing costs

Testing confirms whether the product corresponds with the stated specification / target value.

Testing is planned if it

- forms part of process / test planning or is defined in the production control plan
- is not performed subsequent to a concrete failure
- cannot be isolated, measured or its costs ascertained, for example as a random sample or dedicated process step,

Planned pre-series or series testing is assigned to failure prevention costs.

Tests that are inseparable from assembly, production or machine processes and which cannot be considered individually are assigned to manufacturing costs.

Tests that are performed to ensure process stability (for example by monitoring process parameters such as temperature, humidity, etc.) and which are not carried out primary to safeguard product quality aspects are assigned to manufacturing costs.

The following cost areas are assigned to planned testing costs:

4.3.1 Tests during serial production and pre-production tests

Among others, tests carried out while serial production is running include:

- Inspection of incoming goods
- Series ramp-up tests

- Product audits
- Re-qualifications
- In-line tests
- Statistical process control (SPC)
- End-of-line inspections / final inspections

4.3.2 Test equipment management

Among others, the category of test resource management includes:

- Procuring test equipment
- Monitoring test equipment
- Calibrating test equipment
- Maintaining test equipment

4.4 Supplier management

Among others, supplier management includes:

- Supplier selection, including approvals
- Supplier assessment
- Supplier development in cases where the supplier has no other alternatives and is unable to carry out development independently

4.5 Cost types

The following types of costs can be clearly assigned to failure prevention costs categories:

- Staffing costs
- Material costs with test components, test scrap subsequent to destructive testing
- Traveling costs
- Costs for external services
- Costs for machines, equipment, testing resources, laboratory equipment, Q-IT systems
- Disposal
- Training and further education

The following diagram illustrates the correlation:

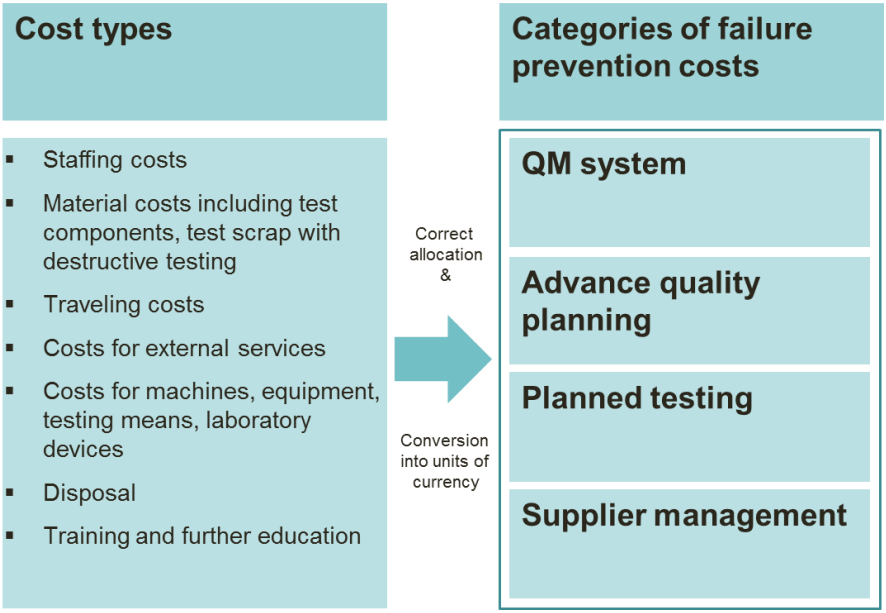

Fig. 7: Assignment of cost types to failure prevention costs

5 List of abbreviations

8D:	Standard method for resolving a problem between the supplier and the customer arising due to a complaint
FMEA:	Failure Mode and Effects Analysis
KPI:	Key Performance Indicator
OEM:	Original Equipment Manufacturer
PDP:	Product Development Process
PPAP:	Production Part Approval Process
PPA:	Production Process and Product Approval
Q-failure cost reporting:	Quality failure cost reporting
QM-System:	Quality Management System
Q-Planning:	Quality Planning
Q-Review:	Quality Review
SPC:	Statistical Process Control
Tier X:	Position of a supplier in the supplier chain; the number “X” denotes the level below the OEM
VDA:	Verband der Automobilindustrie (German Association of the Automotive Industry)

Quality management in the Automotive Industry

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