British Standard

BRITISH STANDARD

BS 6143-2: 1990

Guide to the economics of quality —

Part 2: Prevention, appraisal and failure model

UDC 65.011.4:658.56

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Quality, Management and Statistics Standards Policy Committee (QMS/-) to Technical Committee QMS/2, upon which the following bodies were represented:

Association for Consumer Research (ACRE)
BEAMA Ltd
British Quality Association
British Railways Board
British Shipbuilders
British Telecommunications plc
British Valve and Actuator Manufacturers' Association
Ceramic Industry Certification Scheme Ltd
Chemical Industries Association
Computing Services Association
Consumer Policy Committee of BSI
Contract Flooring Association
Defence Manufacturers Association
Department of Trade and Industry (National Weights and Measures Laboratory)
Department of Trade and Industry (Standards and Quality Policy Unit — Quality, Design and Education Division)
Electricity Supply Industry in England and Wales
Electronic Engineering Association
Energy Industries Council
GAMBICA (BEAMA) Ltd
Home Office
Institute of Clerks of Works of Great Britain Inc
Institute of Quality Assurance
Institute of Trading Standards Administration
Institution of Civil Engineers
Institution of Electrical Engineers
Institution of Mechanical Engineers
Institution of Production Engineers
Lloyd s Register of Shipping
Medical Sterile Products Association
Ministry of Defence
National House Building Council
Production Engineering Research Association of Great Britain
Society of British Aerospace Companies
Telecommunication Engineering and Manufacturing Association

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

Association of Consulting Engineers
Association of Consulting Scientists
British Cement Association
British Coal Corporation
British Gas plc
British Industrial Fasteners Federation
British Maritime Technology
British Non-ferrous Metals Federation
British Nuclear Forum
British Nuclear Fuels
British Steel Industry
British Welded Steel Tube Association
Business Equipment and Information Technology Association
Cable and Wireless plc
Chartered Institute of Management Accountants
Department of Trade and Industry (National Physical Laboratory)
Engineering Equipment and Materials Users Association
Guildford County College and Technology
Institute of Maintenance and Building Management
Institute of Purchasing and Supply
London Regional Transport
National Association of Plumbing, Heating and Mechanical Services Contractors
PIRA
Post Office
Power Generation Contractors Association (BEAMA) Ltd
Rotating Electrical Machines Association (BEAMA) Ltd
Society of Motor Manufacturers and Traders Ltd
Solvents Industry Association Ltd
Steel Casting Research and Trade Association
Transmission and Distribution Association (BEAMA) Ltd

This British Standard, having been prepared under the direction of the Quality, Management and Statistics Standards Policy Committee, was published under the authority of the Board of BSI and comes into effect on 31 May 1990

First published as BS 6143, July 1981
Second edition as BS 6143-2, May 1990

The following BSI references relate to the work on this standard:
Committee reference QMS/2
Draft for comment 89/97322 DC

ISBN 0 580 18729 2

Amendments issued since publication

Amd. No.	Date of issue	Comments

Contents

Foreword

This Part of BS 6143 has been prepared under the direction of the Quality, Management and Statistics Standards Policy Committee. It is a revision of BS 6143:1981 "Guide to the determination and use of quality related costs" which is withdrawn.

This edition has been extensively revised and expanded in order to satisfy the developing requirements of both manufacturing and service industries. It is for this reason that the standard is now published in two Parts.

— *Part 1: Process cost model (to be published)*;

— *Part 2: Prevention, appraisal and failure model*.

Part 1, the process cost model, sets out a method for applying quality costing to any process or service. It recognizes the importance of process measurement and process ownership. The categories of quality costs have been rationalized to the cost of conformance and the cost of non-conformance. This serves to simplify classification. The method depends on the use of process modelling and the standard gives guidelines on useful techniques. The application of the process control model is compatible within the concept of total quality management.

Part 2, the prevention, appraisal and failure model, is a revised version of the traditional method of product quality costing in manufacturing industries. Improvements have been made in the light of experience and it is recognized that successful practitioners may wish to continue with this approach. Continuation of this approach does not preclude the simultaneous development of the process cost model.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 12, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

0 Introduction

Traditionally quality performance has been reported to management in terms of rejection and defective material reports. This vital information is often difficult to analyse and interpret in terms of costs. As a result, cost saving opportunities may be overlooked. Successful business requires financial planning and control. It is advisable that quality failures be presented in financial terms.

Initially, the following two important facts should be appreciated:

a) failures, however caused, reduce profits;

b) preventive quality control activities and the appraisal of quality standards cost money to operate.

These costs can be regarded as quality related costs and in simple terms can be classified as follows:

1) prevention costs;

2) appraisal costs;

3) internal failure costs;

4) external failure costs.

Investment in prevention can substantially reduce internal and external failure costs. Furthermore, reductions in external complaints are important not only to reduce costs but to maintain purchaser goodwill and company morale. This is illustrated in Figure 1.

The pattern of quality cost varies from company to company and the relationships shown in Figure 1 are schematic representations of the trends to be expected in quality costs as awareness of quality and improvement activities increase.

Figure 1 illustrates how an increased awareness of the cost to the organization of quality failure leads first to an increase in appraisal of product quality. Then, as appraisal together with investigation points to features/elements where improvement can be made to product design/process/systems, more is spent on prevention. Finally as preventive action takes effect the prevention appraisal and failure proportions of the costs realign and all costs reduce.

Additional resources are usually allocated for quality related activities if it can be clearly demonstrated that by so doing profitability will be increased. Effective quality management can provide a significant contribution to profit, and evidence shows that resources deployed to identify, reduce and control failure costs gives a benefit in terms of improved quality, increased profitability and enhanced competitiveness.

However it cannot be expected that unlimited resources will be available and there should be supporting financial information to demonstrate that action to improve quality is justified and to direct attention to the most urgent (i.e. cost effective) improvements.

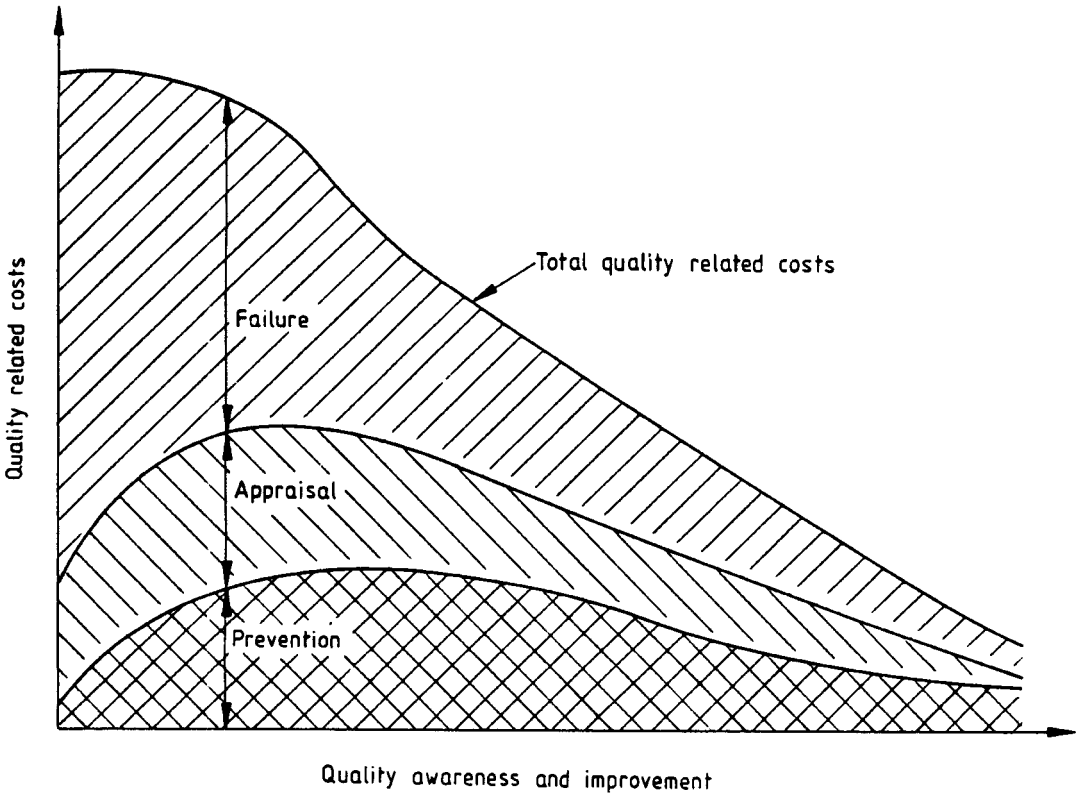

Figure 1 — Increasing quality awareness and improvement activities

Quality cost elements (see appendix A) differ from company to company and industry to industry. Management should decide which costs are to be attributed to day-by-day manufacturing control and set against production costs, and which are to be identified as quality related costs.

1 Scope

This Part of BS 6143 provides guidance on the determination of costs associated with defect prevention and appraisal activities, internal and external failures, and on the operation of quality related costs systems for effective business management.

NOTE The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this Part of BS 6143, the definitions given in BS 4778 apply, together with the following.

2.1
payroll cost

the total cost to an organization, of employing a person, including, for example, gross pay, social security cost and company pension cost

2.2
memorandum account

a financial statement, subsidiary to and not part of the actual accounts of an organization, relating to a particular activity or for a purpose not available in the actual accounts

2.3
quality related cost

cost in ensuring and assuring quality as well as loss incurred when quality is not achieved

NOTE Some frequently used subdivisions are as follows.
Prevention cost. The cost of any action taken to investigate, prevent or reduce the risk of nonconformity or defect.
Appraisal cost. The cost of evaluating the achievement of quality requirements including e.g. cost of verification and control performed at any stage of the quality loop[1)].
Internal failure cost. The costs arising within an organization due to nonconformities or defects at any stage of the quality loop such as costs of scrap, rework, retest, reinspection and redesign.
External failure cost. The cost arising after delivery to a customer/user due to nonconformities or defects which may include the cost of claims against warranty, replacement and consequential losses and evaluation of penalties incurred.

3 Identification of cost data

Quality related cost appropriate to the organization should be identified and monitored.

It is essential that the classification of cost data is relevant and consistent with other accounting practices within the company so that comparisons may be made between costing periods or related activities.

Quality related costs are an identifiable subset of business costs and accountants may find it useful to mantain a subsidiary ledger or memorandum account for this purpose.

For control purposes, it is necessary to allocate quality cost to an activity and the use of account codes within cost centres is one convenient method. The allocation of cost is important to the analysis and prevention of failures. This allocation should not be made solely by the accountant; advice by a technical person may be needed.

4 Quality related cost reporting

In order to have sufficient impact, the report detailing quality costs should be presented in a similar style to other management accounts, and should be supported by financial ratios and trend analysis related to the business of the organization.

The achievement of the required levels of quality involves much more than the inspection and test functions in the manufacturing stages of production. Every department of a company bears some responsibility for ensuring that the quality requirements are met (see BS 4891 for further guidance in this respect).

The collection and analysis can be used to establish the total cost to the organization and/or to the separate divisions or departments responsible for the quality related cost.

5 Operating the quality costing system

Quality related cost should be collated and reported based on data collected by the accounts department. The separate roles most likely to be established for operation of the system are as follows.

a) *Accounting department:*

1) collection of quality cost data;

2) allocation of quality cost to agreed activities;

3) provision of comparative bases for quality cost assessment;

4) production of an operating report for the accountancy period.

b) *Quality management:*

1) analysis of quality related cost, taking appropriate controlling action by investigating causes and making recommendations for improvement;

[1)] See BS 5750-0.1.

2) coordination of inter-departmental activity to achieve quality related cost objectives;

3) pursuance of a continuing policy for cost reduction and control;

4) arbitration on the responsibility for quality failure costs.

6 Pilot study

6.1 Procedure

It may be helpful to establish preliminary figures from a small department or a single product line to gain management approval and commitment to a total quality costing system. The pilot study should define the quality related cost categories and the cost elements to be used.

6.2 Quality costs elements

A list of categories and elements for operating quality related costs are shown in tabular form in appendix B and it is included as a basis for development to meet the specific requirements of the user's own organization.

During the pilot study, it is important that all possible cost sources be covered by an explicit and definitive element. When experience is gained with a new costs system, it will become apparent where elements can be combined or eliminated, but this should not be done too early in the development.

6.3 Time period

The time period covered by the pilot study should be the same as that to be used for routine reports. This procedure permits establishment of an efficient collection system and detects potential trouble spots before a company commits itself to a full-scale quality costs programme.

7 Cost data

7.1 Collection of cost data

When the list of cost elements has been identified (see appendix A), the collection of cost data can begin. More analysis may be needed in an organization that does not already have a departmental costing system than in one that has. The guidance that follows, however, gives all organizations enough information to see what depth of analysis will be needed.

The following steps refer to a "quality" function as being an existing budget centre. It is for this reason that the term is placed within inverted commas.

The costs identified in steps one to two should be mainly concerned with prevention and appraisal, and those in steps three to five with failure costs.

The analysis may require all of the following five steps to identify the quality related costs.

Step 1 calculates those costs that are directly attributable to the "quality" function. These will normally include:

a) payroll cost of people specifically controlled by the quality function or department;

b) a proportion of building occupation costs related to the quality function, e.g. rents, rates, insurance, heating, lighting and security;

c) a proportion of canteen costs, office services and other administration costs;

d) the cost of depreciation of specialized quality control and assessment equipment;

e) the cost of quality training;

f) the cost of smaller items that the organization does not capitalize.

Step 2 identifies costs that are not directly the responsibility of the "quality" function but which should be counted as part of the total quality related cost of the organization. These costs are usually incurred by other departments. It is not necessary to make a formal accounting transfer to the "quality" function costs centre, but they should be included in a memorandum account. A number of departments may incur these costs, e.g. purchasing, stores, planning. Costs in this category should be apportioned to quality on an equitable basis.

Step 3 identifies and enters the memorandum account the internal costs of "budgeted failures". For example it may be normal practice to make a product in batches of 100. To be certain of completing 100 it may be a matter of routine to plan 110 starts. Only experience will eventually tell whether it is worth calculating the cost of the additional 10, but the costs should be calculated, at least for a trial period.

Step 4 identifies the internal costs of failures not allowed for in step 3. Related costs may include materials that have been scrapped or the cost of reworking to put the non-conforming item right, or even of completely remaking. The costs usually lie either in the accounts of the department causing the failure or in the department carrying out the rectification. Wherever they lie, the costs should be noted in the memorandum account.

Step 5 identifies the cost of failures after change of ownership. Costs include the time spent by the quality department in investigations (these need to be offset against the costs in Step 1, to avoid a double count) and those costs of other departments such as marketing, customer servicing, and accounts. These costs are rarely identified in existing systems. An initial estimate should be made and the results entered in the memorandum account. Where the customer is eventually charged for the investigation and any costs of rectification, the income should be noted in the memorandum account.

7.2 Cost data sources

It is advisable to confer with the management accountants to review the list of elements and data sources. A good percentage of the desired information is usually available in one form or another, though this might not appear to be the case at first.

Although there are no established rules for searching out data, the following are recommended as valuable source documents:

a) payroll analysis;

b) manufacturing expense reports;

c) scrap reports;

d) rework or rectification authorizations/reports;

e) travel expense claims;

f) product cost information;

g) field repair, replacement and warranty costs reports;

h) inspection and test records;

i) nonconformance reports.

Data extracted from source documents should be transposed by appropriate collection work sheets and coded for easy tabulation. The aim is to have all cost data reported by code. The use of coding permits consistency of collection regardless of the source or size of the costs.

Each department should report its costs. Data from all sources should then be accumulated by code. Where actual costs cannot be directly associated with specific elements it may be necessary to make an expense allocation by arbitration. If these costs are significant it is recommended that the necessary records be established in order to record the data factually.

7.3 Data tabulation

After all costs have been collected they should be tabulated to give a breakdown by element code. An example of a proforma for periodic quality costs reporting is shown in appendix B.

8 Quality cost trend analysis and reporting

The report format and frequency depends upon the nature of the business and the level of management to which the information is presented. For example, tabulations, graphs, histograms and written text may be included. The reports should be relevant to the business objectives and should therefore have a consistent basis against which true comparisons can be made. It is recommended that at least three measurement bases be related initially to quality costs. They should represent the business from different viewpoints and be sensitive to business changes. The following are examples.

a) *Labour base,* e.g. internal failure costs related to total labour or direct labour

$$\frac{\text{internal failure cost}}{\text{direct labour}}$$

b) *A cost base,* e.g. total failure costs related to shop cost, manufacturing cost or total material labour

$$\frac{\text{total failure cost}}{\text{manufacturing cost}}$$

c) *Sales base,* e.g. total quality cost related to nett sales billed or value of finished goods transferred to inventory

$$\frac{\text{total quality cost}}{\text{nett sales}}$$

d) *A unit base,* e.g. test and inspection costs related to the number of units produced. Quality cost per unit produced has many advantages, but it is necessary to take into account the effect of product mix, volume and value

$$\frac{\text{test and inspection cost}}{\text{units of production}}$$

e) *A value added base,* e.g. total quality related cost related to a measure of manufacturing activity unaffected by fluctuation in sales and the cost of purchased goods and services

$$\frac{\text{total quality related cost}}{\text{value added}}$$

As a matter of caution, measurement bases are only as good as the methods for keeping them consistent. Consideration should be given, and adjustments made when bases are affected by the following:

1) direct labour replaced by automation;

2) manufacturing cost changes due to the use of alternative materials, methods or processes;

3) changes in gross margins, selling prices, distribution costs and market demand;

4) changes in product mix;

5) time scale of numerator that differs from time scale of denominator.

These factors should be considered and understood when comparing trends.

The charting of quality costs aids analytical work. However, it may be necessary to take account of the cyclic effects and short term fluctuations by moving average, or cusum techniques (see BS 5703).

9 Application of business management to quality related costs

9.1 Introduction

Quality costs alone do not provide sufficient information for management to put them into perspective with other operating costs, or to identify critical areas in need of attention.

An effective method for establishing the significance of quality costs is to provide a comparison with other costs that are normally reported regularly within the organization.

9.2 Identification of critical areas

Where more than one product is being investigated, care should be taken to ensure that the manufacturing costs of the product and the quantity produced are both taken into consideration when priorities are being allocated to the use of resources.

It is important that products be separately recorded and ranked in order of their total internal failure cost. (See example 1.)

Example 1

From Table 1 it can be seen that:

product A may yield the highest amount of saving but may be the most difficult to achieve;

product D has the largest percentage failure cost but the amount of money involved is relatively small;

product B has both high failure cost and high percentage failure cost and may be the most rewarding area for cost reduction.

9.3 Cost comparison

It should be possible to derive relationships between the total quality costs (TQC) and the costs of prevention, appraisal and failure, and to include elements of these segments.

Over set time periods, changes in established relationships may indicate an increase in quality costs in a certain department warranting further investigation, e.g.

a segment to TQC comparison,

$$\frac{\text{prevention cost}}{\text{total quality cost}}$$

an element to segment comparison,

$$\frac{\text{cost of supplier assessment}}{\text{prevention cost}}$$

an element to element comparison,

$$\frac{\text{cost of incoming test and inspection}}{\text{value of purchased parts}}$$

A comparison between quality costs elements can reveal an imbalance between the costs of controls and their effectiveness in controlling quality. Appraisal does not in itself improve quality. Prevention activities serve to improve the quality of the product and reduce the incidence of defects. It follows that as prevention is increased the need for appraisal decreases.

A typical quality cost comparison is shown in Table 2. The figures given in the table are not unusual in those manufacturing industries where reliance is placed upon inspection for the purpose of quality assurance.

Table 1 — Example of quality costs comparison with product mix

Product	Failure costs	Manufacturing costs	$\frac{\text{Failure costs}}{\text{Manuf acturing costs}} \times 100\ \%$
	£	£	
A	44 500	1115 000	4
B	30 000	400 000	7.5
C	5 000	100 000	5
D	5 000	50 000	10
E	3 000	300 000	1

9.4 Ranking

Application of the Pareto method [2] for separation of the "vital few" from the "trivial many" will single out the highest contributor to any collection of figures. The results may be ranked and charted to gain better understanding of what is happening in the business. (See examples 2 and 3.)

Example 2

Figure 2 illustrates the relative costs of defects found in domestic appliances of a particular type. The Pareto distribution reveals the pressure switch malfunction as the most serious problem. It is apparent that to achieve significant cost savings, a reduction in the incidence of malfunctioning of pressure switches has to be made.

Table 2 — A typical quality cost element comparison

Segment	Element	Percentage of total quality cost
Failure	Scrap	35
	Rework	11
	Reinspection	9
	Additional operations	8
	Warranty	5
	Downgrading	2
	Others	2
	Total failure cost	72
Appraisal	Inspection and test	26
Prevention	Control of preventive activities	2
	Grand total	100

The first step is to locate the cause of the pressure switch defect. A group is assigned to identify the causes and to place them into one of the following five chosen categories:

a) design/specification;

b) material;

c) operator;

d) machine;

e) method;

A completed list of possible causes is suggested and appended to each category heading.

Dependent upon the results of further study, action may be taken to improve method of manufacture, make changes based on experimentation or simply to make the process foolproof if the remedies applied are economically unattractive.

Example 3

Table 3 shows the presentation of data where departments judged responsible for quality costs origination are ranked.

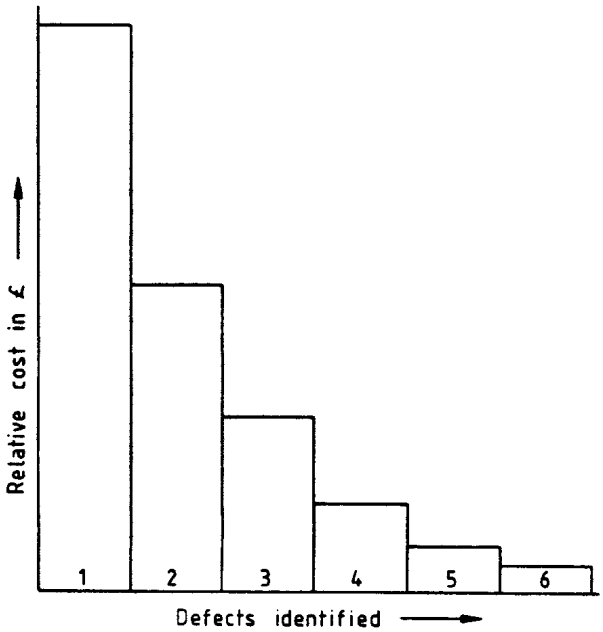

Figure 2 — Example of ranking

Table 3 — Quality cost data by department as percentage of total quality cost

Department	Percentage total quality cost
Processing	30
Subassembly	18.5
Product planning	12.5
Design	10
Final assembly	8
Inspection	7
Production control	4
Maintenance	4
Purchasing	2.5
Marketing	2
Service	0.5
Others	1
Total	100 %

[2] See Quality Control Handbook, J.M. Juray, F.M. Gryna & R.S. Bingham.4th Edition. McGraw — Hill.

10 Setting up a programme

Quality improvements and quality cost reduction should be earned through problem solving.

Quality problems should be identified and a problem in this context is defined as an area of significantly high quality cost. Every problem so identified provides an opportunity for greater customer satisfaction and profit improvement.

The procedures adopted by each organization will depend on many factors. These include the following key elements.

a) *Management commitment*. The commitment of management to attaining acceptable quality levels in the most economical way.

b) *Quality related costs procedures*. The devising and implementation of procedures for the identification reporting and analysis of quality costs.

c) *Quality related costs action team*. The formation of a quality cost action team responsible for overall direction, coordination, and for ensuring that quality cost savings targets are set and met.

d) *Training*. The inclusion of quality and quality costing as an integral part of all induction and training schemes. Everyone should understand from the outset the financial implications of quality and recognize that achieving and maintaining a reputation for quality is vital to the success and growth of an organization and to everyone within it.

e) *Quality related cost awareness promotion*. The presentation of significant quality cost in readily understandable terms to all personnel. This might include displays of defective products carrying price tags, or charts of rework or defective costs per section per day indicating a possible course of remedial action.

f) *Quality related cost participation*. It should be accepted that ideas for the reduction of quality related cost can emanate from any part of the organization. The introduction of a suitable scheme for achieving maximum participation of employees in this activity is advocated including means of promoting, initiating, receiving, discussing, appreciating and actioning new ideas. Quality related cost action groups or "quality circles" organized throughout the company may well meet this purpose.

Appendix A Guidance notes on cost elements of prevention appraisal and failure model

A.1 Prevention costs

These costs are incurred to reduce failure and appraisal costs to a minimum. The usual categories include the following.

a) *Quality planning*. The activity of planning quality systems and translating product design and customer quality requirements into measures that will ensure the attainment of the requisite product quality. It includes that broad array of activities that collectively create the overall quality plan, the inspection plan, the reliability plan and other specialized plans as appropriate. It also includes the preparation and vetting of manuals and procedures needed to communicate these plans to all concerned. Such quality planning may involve departments other than the quality organization.

b) *Design and development of quality measurement and test equipment*. Included are the costs of designing, developing and documenting any necessary inspection, testing or proving equipment (but not the capital cost of the equipment in question).

c) *Quality review and verification of design*. Quality organization monitoring activity during the product's design and development phase to assure the required inherent design quality. Quality organization involvement with design review activities and in verification activity during the various phases of the product development test programme including design approval tests and other tests to demonstrate reliability and maintainability.

This includes quality organization effort associated with that part of process control which is conducted to achieve defined quality goals.

d) *Calibration and maintenance of quality measurement and test equipment*. The cost of calibration and maintenance of templates, jigs, fixtures and similar items should be included.

e) *Calibration and maintenance of production equipment used to evaluate quality*. The costs of calibration and maintenance of templates, jigs, fixtures and similar measurement and evaluating devices should be included but not the cost of equipment used to manufacture the product.

f) *Supplier assurance*. The initial assessment, subsequent audit and surveillance of suppliers to ensure they are able to meet and maintain the requisite product quality. This also includes the quality organization's review and control of technical data in relation to purchase orders.

g) *Quality training*. Includes attending, developing, implementing, operating and maintaining formal quality training programmes.

h) *Quality auditing*. The activity involving the appraisal of the entire system of quality control or specific elements of the system used by an organization.

i) *Acquisition analysis and reporting of quality data*. The analysis and processing of data for the purpose of preventing future failure is a prevention cost.

j) *Quality improvement programmes*. Includes the activity of structuring and carrying out programmes aimed at new levels of performance, e.g. defect prevention programmes, quality motivation programmes.

A.2 Appraisal costs

These costs are incurred in initially ascertaining the conformance of the product to quality requirements; they do not include costs from rework or reinspection following failure. Appraisal costs normally include the following.

a) *Pre-production verification*. Cost associated with testing and measurement of pre-production for the purpose of verifying the conformance of the design to the quality requirements.

b) *Receiving inspection*. The inspection and testing of incoming parts, components and materials. Also included is inspection at the supplier's premises by the purchaser's staff.

c) *Laboratory acceptance testing*. Costs related to tests to evaluate the quality of purchased materials (raw, semi-finished or finished) which become part of the final product or that are consumed during production operations.

d) *Inspection and testing*. The activity of inspecting and testing first during the process of manufacture, and then as a final check to establish the quality of the finished product and its packaging. Included are product quality audits, checking by production operators and supervision and clerical support for the function. It does not include inspection and testing made necessary by initial rejection because of inadequate quality.

e) *Inspection and test equipment*. The depreciation costs of equipment and associated facilities; the cost of setting up and providing for maintenance and calibration.

f) *Materials consumed during inspection and testing*. Materials consumed or destroyed during the course of destructive tests.

g) *Analysis and reporting of tests and inspection results*. The activity conducted prior to release of the product for transfer of ownership in order to establish whether quality requirements have been met.

h) *Field performance testing*. Testing is performed in the expected user environment, which may be the purchaser's site, prior to releasing the product for customer acceptance.

i) *Approvals and endorsements*. Mandatory approvals or endorsements by other authorities.

j) *Stock evaluation*. Inspecting and testing stocks of products and spares which may have limited shelf life.

k) *Record storage*. The storage of quality control results, approval and reference standards.

A.3 Failure costs

These are subdivided into internal and external failure costs: internal costs arising from inadequate quality discovered before the transfer of ownership from supplier to purchaser and external costs arising from inadequate quality discovered after transfer of ownership from the supplier to the purchaser.

The internal failure costs include the following.

a) *Scrap*. Materials, parts, components, assemblies and product end items which fail to conform to quality requirements and which cannot be economically reworked. Included is the labour and labour overhead content of the scrapped items.

b) *Replacement, rework and repair*. The activity of replacing or correcting defectives to make them fit for use including requisite planning and the cost of the associated activities by material procurement personnel.

c) *Troubleshooting or defect/failure analysis*. The costs incurred in analysing non-conforming materials, components or products to determine causes and remedial action, whether non-conforming products are usable and to decide on their final disposition.

d) *Reinspection and retesting*. Applied to previously failing material that has subsequently been reworked.

e) *Fault of subcontractor*. The losses incurred due to failure of purchased material to meet quality requirements and payroll costs incurred. Credits received from the subcontractor should be deducted, but costs of idle facilities and labour resulting from product defects should not be overlooked.

f) *Modification permits and concessions*. The costs of the time spent in reviewing products, designs and specifications.

g) *Downgrading*. Losses resulting from a price differential between normal selling price and reduced price due to non-conformance for quality reasons.

h) *Downtime*. The cost of personnel and idle facilities resulting from product defects and disrupted production schedules.

The external failure costs include the following.

1) *Complaints*. The investigation of complaints and provision of compensation where the latter is attributable to defective products or installation.

2) *Warranty claims*. Work to repair or replace items found to be defective by the purchaser and accepted as the supplier's liability under the terms of the warranty.

3) *Products rejected and returned*. The cost of dealing with returned defective components. This may involve action to either repair, replace or otherwise account for the items in question. Handling charges should be included.

NOTE While loss of purchaser goodwill and confidence is normally associated with external failure costs, it is difficult to quantify.

4) *Concessions*. Cost of concessions, e.g. discounts made to purchasers due to non-conforming products being accepted by the purchaser.

5) *Loss of sales*. Loss of profit due to cessation of existing markets as a consequence of poor quality.

6) *Recall costs*. Cost associated with recall of defective or suspect product from the field including the cost of preparing plans for product recall.

7) *Product liability*. Cost incurred as a result of a liability claim and the cost of premiums paid for insurance to minimize liability litigation damages.

Appendix B Example of a quality cost report

An example of a quality cost report is given in Table 4.

Table 4 — Example of a quality cost report

Group:				**Division:**		
Unit:				**Period:** **Year:**		
Current period				**Year to date**		
Budget £	**Actual costs** £	**Difference** £		**Budget** £	**Actual costs** £	**Difference** £
			Prevention costs Quality planning Design and development of quality measurement, test and control equipment Quality review and verification of design Calibration and maintenance of quality measurement, test and control equipment Calibration and maintenance of production equipment used to evaluate quality Supplier assurance Quality training Quality auditing Acquisition, analysis and reporting of quality data Quality improvement programme			
			Total prevention cost			
			% **of total quality cost**			
			Appraisal costs Pre-production verification Receiving inspection Laboratory acceptance testing Inspection and testing Inspection and test equipment Materials consumed during inspection and testing Analysis and reporting of test and inspection results Field performance testing Approvals and endorsements Stock evaluation Record storage			
			Total appraisal cost			
			% **of total quality cost**			

Table 4 — Example of a quality cost report

Group:				**Division:**		
Unit:				**Period:**	**Year:**	
Current period				**Year to date**		
Budget £	**Actual costs** £	**Difference** £		**Budget** £	**Actual costs** £	**Difference** £
			Internal failure costs Scrap Replacement, rework and repair Troubleshooting or defect/failure analysis Reinspection and retesting Fault of subcontractor Modification permits and concessions Downgrading Downtime			
			Total internal failure cost			
			% **of total quality cost**			
			External failure costs Complaints Warranty claims Products repeated and returned Concessions (deviations) Loss of sales Recall costs Product liability			
			Total external failure cost			
			% **of total quality cost**			
			Total quality cost (TQC)			
Typical ratios **TQC as a percentage of:**						
$\frac{\text{TQC} \times 100}{\text{Sales revenue}}$ %			Sales revenue	$\frac{\text{TQC} \times 100}{\text{Sales revenue}}$ %		
$\frac{\text{TQC} \times 100}{\text{Value added}}$ %			Value added	$\frac{\text{TQC} \times 100}{\text{Value added}}$ %		
$\frac{\text{TQC} \times 100}{\text{Direct labour costs}}$ %			Direct labour costs	$\frac{\text{TQC} \times 100}{\text{Direct labour costs}}$ %		
Distribution:						
Issued by:				Date:		

blank

Publications referred to

BS 4778, *Quality vocabulary.*
BS 4778-1, *International terms.*
BS 4778-2, *Quality concepts and related definitions.*
BS 4891, *A guide to quality assurance.*
BS 5703, *Guide to data analysis and quality control using cusum techniques.*
BS 5750, *Quality systems.*
BS 5750-0, *Principal concepts and applications.*
BS 5750-0.1, *Guide to selection and use.*

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: 020 8996 9000. Fax: 020 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: 020 8996 9001. Fax: 020 8996 7001.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: 020 8996 7111. Fax: 020 8996 7048.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: 020 8996 7002. Fax: 020 8996 7001.

Copyright

BSI
389 Chiswick High Road
London
W4 4AL