



## Quality costing: A study of manufacturing organizations. Part 1: Case studies and survey

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**Abstract** *A four-stage investigation into the use of quality costing in the small and medium manufacturing industry has been made and is reported. The first stage looked at previously published work, noting the opinions of the quality experts (the so-called 'gurus') and identifying a pattern in the various methods of implementing quality costing. The next stage looked at how the existing methods had been used or adapted in local small manufacturing companies with actual case studies. This raised some questions about the company attributes that affected the use of quality costing which, in turn, led to the third stage of a pilot survey of the small/medium manufacturing companies in the North East of England. This yielded some interesting trends in how the use of quality costing was related to the extent and sophistication of quality management in the companies. The final stage was a large survey conducted using a stratified sample of 1000 manufacturing organizations in the North East of England region and the development and results of this are reported in Part 2.*

### Introduction

Whilst a common subject in the quality literature, quality costing has usually focused on large organizations from a particular industry and with case study-type investigations. In addition, the prevalence of published work tends to detail best practice with very little detail on what was actually being done in industry as a whole. The present work aims to fill this gap by taking a much more overall view of the role and practice of the cost of quality in industrial organizations of varying type and size.

The overall aim of the research was to establish what is actually happening in industry. A main objective was to identify how the sophistication of quality management systems varies with respect to organization size and industry type. This should provide a useful insight into the present practice. The other main objective was to develop a model highlighting how quality costing is used and how it relates to company size, industry type and the sophistication of the quality management system present in the individual manufacturing organizations. This would be essentially descriptive and would provide a contrast to the 'best practice' and 'how to guides' prevalent in the literature. In the present study, the cost of quality is considered to be the process of collecting quality-related financial information, the analysis of the data and the insight this provides for the organization.

The methodology used was a four-stage combination of surveys of previous work: case

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studies of two manufacturing organizations in the North East of England, a pilot survey and a main survey. This was used to provide an insight into the sophistication of quality management in the North East England region (and the UK), how this is affected by industry size and type and the manner in which quality costing is used. This has also enabled the development of a model which can be used to indicate how organizations can get the most benefit from using quality costing. The outcomes of the study of previous work, case studies and a pilot survey are described in this paper.

### Previous work

In recent years, competition has increased dramatically in all business sectors. This competition has changed purchasing behaviour from buying whatever is offered to buying only products which meet the purchaser's specifications; taking account of functional requirements and price. This has led to a 'paradigm shift', as described by Bounds *et al.* (1994), in how businesses are managed. This is the much talked about 'quality revolution'. The paradigm shift is essentially a move from traditional management philosophies and practices to management leading a company-wide strive for continual improvement in all activities with the aim of increasing customer satisfaction (Miller, 1993). Organizations which are undergoing this management 'paradigm shift' or which have successfully adopted the new paradigm are those that can claim to be implementing and practising total quality management (TQM).

The present work focuses on the role of quality costing in providing useful insight into company operation and in driving quality management development within the described paradigm shift. Quality costing has essentially been used to-date as a management tool by which to support the organizational change associated with the paradigm shift (Belasco, 1991).

A major portion of the key literature on the subject of TQM has been written by or about a relatively small number of individuals who are collectively known as the 'quality gurus' (e.g. Bendell, 1992). The quality gurus have, between them, very differing perspectives on the issues involved in TQM. Owing to these differing perspectives, it is not easy for a particular organization to understand how to apply the ideas and strategy of the gurus to their own individual situations. Common current advice is for each organization to select carefully appropriate ideas from among the plethora of advice available through the gurus in order to solve particular organizational issues (Flood, 1993). A difference in the approaches of the main quality gurus has been identified in the present work in the stage in the paradigm shift to which their ideas are most applicable. To this end, it is of interest to consider the quality gurus to be put loosely into three groups: those who describe the new management paradigm after the transition has occurred (this group includes Deming (1986) who describes the change that needs to occur but provides little in the way of assistance on how to achieve it, Ishikawa (1982, 1985) and Peters (1982, 1985, 1988, 1992)); those who describe how to initiate the paradigm shift (this group includes Crosby (1979, 1984), Feigenbaum (1991) and Juran (1988, 1993)) and those who provide tools that facilitate problem-solving either during or after the paradigm shift (this group includes Taguchi (1986) and Shingo (1986)). Most of the other gurus have ideas which could be included in this section, but this is not the main thrust of their work.

Of particular interest is the observation from published work that all the gurus associated with initiating the paradigm shift advocate the technique of quality costing, whereas those who describe the end result of the paradigm shift do not. One reason for this may be the relationship between quality and cost. Three theoretical views of this relationship are

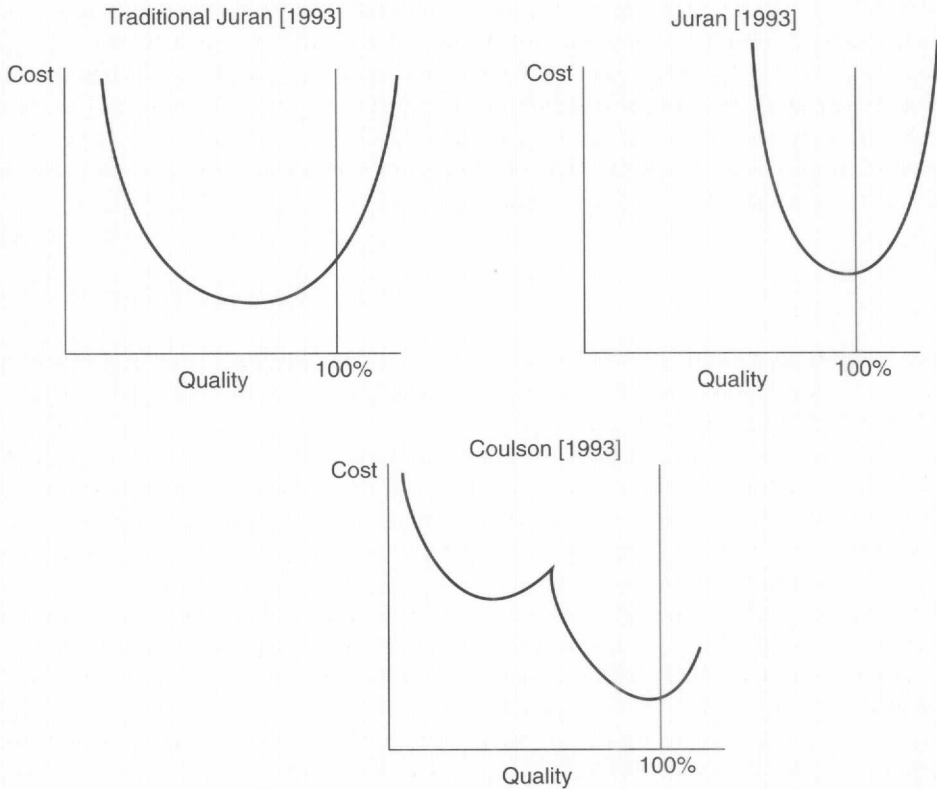


Figure 1. Relationships between cost and quality.

illustrated in the plots in Fig. 1. Although these plots are different in shape they all imply that financial returns will diminish at some stage in the quality improvement process. This further implies that the utility of quality costing will decrease as improvement progresses. There appears to be a shift in thinking on the importance of quality costing in that when initializing TQM the quality costing technique appears important, but as progress is made the technique becomes less important.

The quality costing technique could, however, still be of use as a control mechanism to maintain progress in quality improvement programmes. The third plot in Fig. 1 shows, additionally, that quality management practices can be used to increase quality and reduce quality costs beyond a certain point. The first set of benefits could result from improving procedures, the second from improving the relationship with suppliers and so on. This highlights the need to use quality costing within an ongoing TQM process where new techniques are more likely to be used to gain further improvement or are applied to more areas within the company. If quality costing is used as a separate initiative in its own right it is usually less effective, as gaining action on the data provided usually becomes more and more difficult.

There are a variety of schemes by which quality costing can be implemented and practised in organizations, including those described in Feigenbaum (1991), Juran and Gryna (1988), ASQC (1977, 1979, 1987, 1991) and BSI (1990, 1992). These schemes tend to adopt the following broad pattern:

- (1) Verifying the benefit of a quality programme by 'broad brush' cost of quality estimates or some other method.

- (2) Ensuring upper management is receptive to the principles involved as their commitment is considered essential.
- (3) Developing an overall plan for the quality costing programme while simultaneously running a pilot programme within the company to prove its applicability within the organization.
- (4) Sell the programme to the rest of management using the obvious need for measurement to gain control and hence improvement alongside the results of the pilot programme. The information gained from the pilot programme should be used to support the case.
- (5) Start the quality cost programme proper. This is carried out through the following steps:
  1. Define quality cost categories (from all of the key processes performed in the organization) and allocate responsibilities for the costs.
  2. Collect the relevant data.
  3. Analyse the data to establish problems or areas of poor performance and initiate quality improvement projects to deal with the problems or improve the situation. This will involve a variety of problem-solving techniques, such as brainstorming, Pareto analysis, fishbone diagrams, SPC, etc. as is relevant to the problem domain.
  4. Remeasure the data to show that the situation has improved.

To assist in the definition of quality costs there are two principal models which have been developed and are widely applied in organizations:

- (1) The Prevention Appraisal Failure Model (PAF model) (ASQC, 1977).
- (2) The Process Cost Model (ASQC, 1991).

A number of refinements (e.g. ASQC, 1977, 1979, 1987, 1991; Coulson, 1993; Dale & Plunkett, 1991; Feigenbaum, 1991; Juran, 1993; Kanji & Asher, 1993) have been made to these generic models which make them applicable to a wide range of manufacturing organizations.

From the previously published work these existing models and refinements are mainly discussed in relation to large organizations. Small and medium-sized organizations appear to have been largely ignored in the literature. Whether these existing schemes and models are applicable to the use of quality costing in small and medium-sized organizations was a question that the present work was aimed at investigating and answering.

### Case studies

In an effort to gain a practical insight into quality costing and determine how well the existing cost of quality theory and systems would adapt to smaller organizations, two case studies were made based on small local companies. The choice of the two types of organizations was to gain a representative view of how quality costing could be used to provide benefit in industry. A printing firm was chosen since the nature of its process route was a simple one-route process. This was thought to represent a specific set of challenges. An electrical tool manufacturer was also chosen, since this organization was a job-shop with far more complex and variable product routes. The challenges for a quality costing system in this environment were significantly different from those of the printing firm. Together, the two types of organizations provided insight into how quality costing could be used in industry.

*Case study 1: Printing company**Approach.*

- (1) Quality costing categories were defined with quality manager and training manager. The company had registered for BS 5750 and had some elementary quality costing.
- (2) Data were collected from the organization's records to calculate the value of the categories of quality costs.
- (3) Time analysis of employee effort was performed and salary figures collated to allow estimates to be calculated for figures which were not available.
- (4) Quality cost was estimated.

*Summary of findings.* A lower than expected figure for quality costing resulted (7% of turnover). This, however, was only a pilot estimate and the company had relatively simple processes which may have had an effect. The organization initially appeared to be inspection-dependent. However, most of the root causes of the most expensive problems could be traced to incorrect specifications by the sales department. This was due to lack of communication between the shopfloor and sales and lack of technical knowledge on behalf of the sales team.

*Action taken.* Communication was formalized and the sales team received technical training.

*Case study 2: Electrical tool manufacturer**Approach.*

- (1) A list of quality cost categories was drawn up in a meeting between the Managing Director, Quality Manager, Industrial Engineer and Financial Director. The company had registered for BS 5750 and had some elementary quality costing.
- (2) The quality costing values that could be obtained directly from the organization's accounts were allocated into these categories with the aid of the Financial Director.
- (3) The cost categories that were not directly obtainable from the accounts or directly measurable were estimated by the individuals closest to the activities.
- (4) The measurements from step (3) were then given financial values with the aid of the accountant.
- (5) A spreadsheet of the quality cost system was then developed and supplied to the Financial Manager and the Quality Manager for their own use.

*Summary of findings.* Quality cost was again smaller than expected (1.6% of net sales) even though in this organization a large amount of quality management work had been undertaken, e.g. the use of SPC throughout the main manufacturing process. The two largest costs were: patrol inspection; and receiving inspection.

*Action taken.* Operators were trained in defect categorization, patrol inspection was reduced and it was planned to initiate vendor rating.

*Overall analysis*

- (1) Quality costing did provide useful information in the organizations investigated.
- (2) The quality costing technique was straightforward to apply in the organizations investigated.

- (3) The gains that existed were not as substantial as some of the literature would suggest.
- (4) The models that exist for both defining quality costs and implementing them appear to be applicable to small and medium-sized organizations.
- (5) The use of a spreadsheet simplified the process significantly.
- (6) Some changes to both accounting and measurement systems were required to gain even an estimate of the overall quality costing figures.
- (7) In both cases improvement was gained via 'investing' in prevention activities. This suggests that all focuses should be examined to gain full benefit from quality costing.

Both organizations had a quality management system of a similar sophistication, i.e. both had registered for BS 5750 but had little active ongoing improvement. This may have been why the results were less substantial than expected from some elements of the literature.

From these cases studies and the literature survey the following two questions were raised:

- (1) How is the use of quality costing affected by the complexity of organizations? It could be hypothesized that because of the prevalence of the literature towards large organizations, it would be the larger organizations that would tend to use quality costing more. Alternatively, from the case study work, it could also be hypothesized that the manner in which quality costing was used would be independent of organization size.
- (2) How is the use of quality costing affected by the 'maturity' of quality management systems? This was of interest as it appeared from the literature that quality costing was a technique that in most cases became less useful as company quality management developed. Hence, it could be hypothesized that as the sophistication of quality management increased, the usage of quality costing would first increase and then fall off.

### **Pilot survey**

The third stage was the development of a pilot survey that would attempt to answer the above two questions and give an insight into the effectiveness of this method for the planned fourth stage, large sample survey. The questionnaire was designed to measure organization complexity in terms of turnover and number of employees and the stage of development of any quality management system by a metric developed from the model by Flood (1993) and Kanji and Asher (1993). The questionnaire also assessed the sophistication of the organization's quality costing system in terms of:

- (1) the business support roles quality costing was used for;
- (2) what elements of the literature or other support (e.g. consultants, conferences, etc.) were used in the initial establishment of the quality costing system and are still being used;
- (3) the focus of quality costs, including whether all of the PAF elements were measured or just failure costs, etc.;
- (4) the breadth of the quality costing system, e.g. how far across the organization the system had extended;
- (5) whether information technology was used to assist the calculation of quality costs;
- (6) the reasons for not using quality costing if this was the case.

The survey was sent to 130 manufacturing organizations of varying sizes and industry type throughout the North East of England region, selected at random from the list of companies

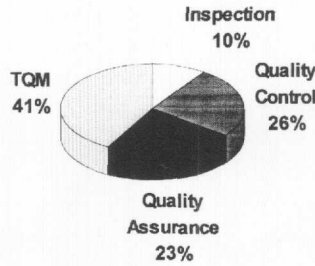


Figure 2. Stages of development of quality management.

in the ‘North East Purchasing Initiative’. Thirty comprehensive replies were received, which produced a number of interesting results:

- (1) The metric for the development of quality management worked. The distribution of the stages of development of the organization’s quality management systems is shown in Fig. 2. The quality management systems of the organizations were slightly more advanced than may have been expected from a truly random distribution of companies because of the mailing list used. The organizations on this list had an interest in supplier development and were therefore perhaps more likely to have some form of quality management system. Another issue that was pointed out by some of the respondents was that the metric used was focused on activities and that culturally-based indicators could give another interesting insight into the development of quality management. It is, however, believed that any survey that aims to measure sophistication of quality management will end up being slightly biased as the organizations with more sophisticated quality management systems will tend to understand any terminology used in the survey better and hence will be more likely to respond. It is, however, believed that this bias will be slight as long as the questionnaire remains simple to complete.
- (2) The ‘use made of quality costing’ depending on ‘stage of quality management’ was an interesting trend. This is illustrated in Fig. 3, which shows that organizations tend to use quality costing more as the sophistication of quality management increases. The expected drop in use does not appear to occur, except perhaps slightly with organizations at the quality assurance stage.
- (3) A third interesting result was the manner in which the focus of quality costing changes as the sophistication of quality management systems develops. This is shown

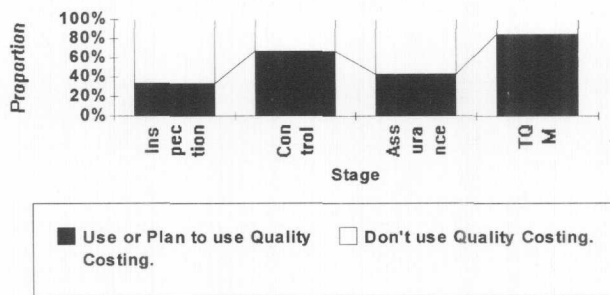
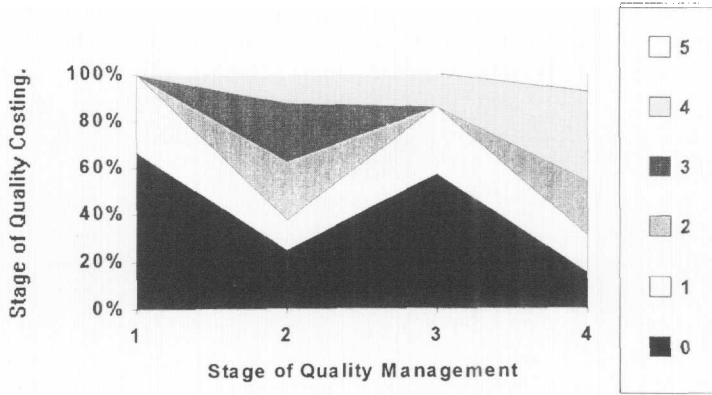


Figure 3. Variation of the use of quality costing with management stage.



The stages of Quality Costing in this model were defined as:

0. Record no Quality related costs.
1. Record the costs of Internal Failures.
2. Record the costs of Internal and External Failures.
3. Record the costs of Internal and External Failures and Appraisal.
4. Record the costs of Internal and External Failures, Appraisal and Prevention.
5. Record the costs of Internal and External Failures, and Prevention. This assumes that ultimately organizations will wish to remove Inspection as a separate activity making it part of the individual tasks within the organization.

The stages of Quality management are defined as:

1. Inspection.
2. Quality Control.
3. Quality Assurance.
4. TQM.

**Figure 4.** Variation of the stage of quality costing with the management stage.

in Fig. 4, which suggests that organizations may well measure the costs of some aspects of quality regardless of the sophistication of quality management. However, the model used for quality costing does appear to become more sophisticated as the sophistication of quality management increases.

These results have, therefore, gone some way towards answering the questions raised by the literature survey and case studies.

## Conclusions

This study has highlighted a number of interesting aspects of the cost of quality in the manufacturing industry. First of all, from previous work, quality costing was expected to have some function in the earlier stages of the management paradigm shift from traditional methods to those based on customer satisfaction but less so in the latter stages. Case studies of small and medium-sized enterprises has shown a lower than expected cost of quality. The data required, however, were relatively straightforward to obtain, so that setting up a quality costing in these companies was considered to be quite feasible.

A pilot survey conducted in the North East of England showed an encouragingly high proportion of companies involved in quality assurance and TQM (over 70%), even taking into account that the companies were selected from a list of those particularly interested in



supplier development. There was a clear trend of an increasing use made of cost of quality as the stage of quality management became more advanced, which is perhaps not what might be expected from the published work. However, the detail of this showed, as may be expected, an initial increase in taking external failures and inspection into account, then an increased interest in prevention and downgrading of inspection with those companies involved in the final, TQM, stage.

The overall results are encouraging and underline the need for a large sample survey of manufacturing companies to establish properly the current extent and maturity of quality-based management systems, focusing in particular on the role and use of cost of quality. Statistical analysis of the data could then be used to obtain a new cost of quality-based model for driving continuous improvement. This is the focus of Part 2 of this study.

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