

# Quality costs in building

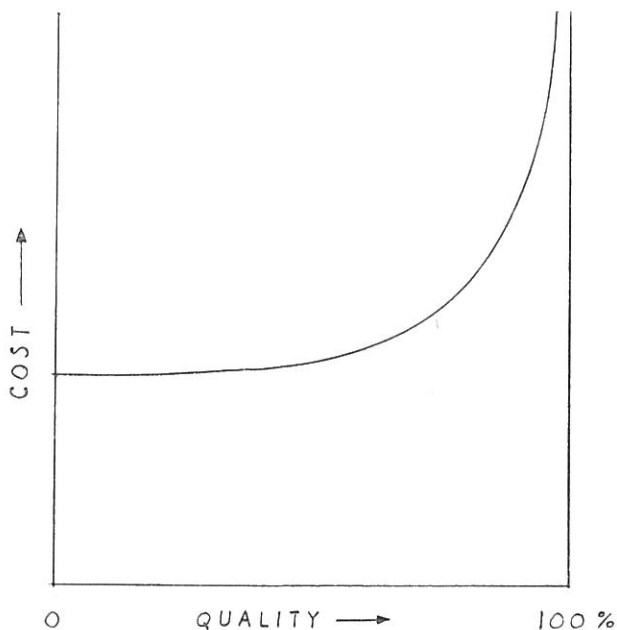
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The author is Principal Lecturer in the Department of Civil Engineering and Building at Lanchester Polytechnic, Coventry. In this paper he discusses workmanship and site supervision by contractors as important factors influencing the degree to which a building conforms to the requirements of the client in terms of the specification conveyed to the contractor. Quality of design is not discussed.

It is a generally held view that there is a direct relationship between cost and quality. Phrases such as "if you want quality you must pay for it" are common. It is also widely believed that the cost of perfection must be exceptionally high. Graphs such as that in Figure 1 are given as a means of representing this relationship.

FIGURE 1

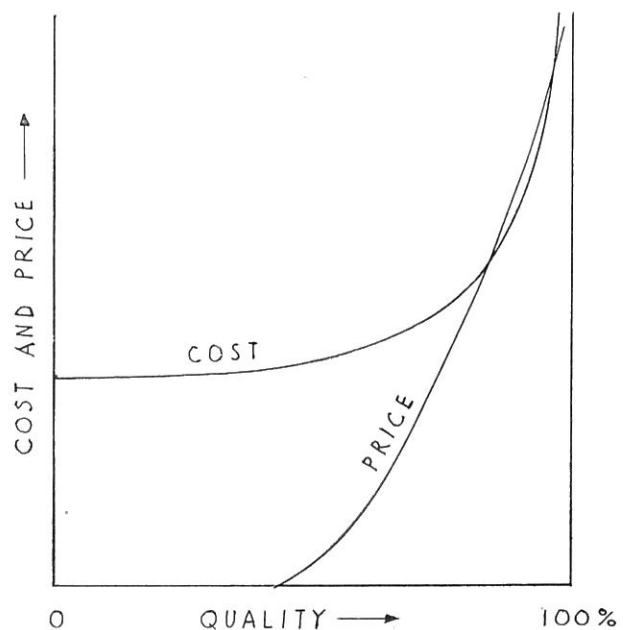
HYPOTHETICAL RELATIONSHIP BETWEEN QUALITY AND COST



A more sophisticated representation is given in Figure 2. This shows one curve representing the relationship between the cost of production at different levels of quality, and the other, the price that the client is prepared to pay for the work. Normally, the client will not accept work of a quality below that specified, nor will he pay extra for an excess of quality. The contractor aims to achieve an optimum level of quality which gains acceptance with minimum cost.

FIGURE 2

HYPOTHETICAL RELATIONSHIP BETWEEN QUALITY, COST AND PRICE



The costs associated with quality of work are considerable. In manufacturing industries it is estimated that these costs can be as high as 12 per cent of turnover.<sup>1</sup> In the Building Industry in this country, approximately 4 per cent of the annual turnover of the industry is expended on rectifying defects that have come to light during the defects liability period.<sup>2</sup> An increasing proportion of building contracts end in dispute<sup>3</sup> and most of the disputes turn on questions of workmanship and delay.<sup>4</sup> This situation seems a far cry from the case of a large hospital built in 1934-35 where the inspecting architect found virtually no defects requiring rectification.<sup>5</sup>

The total costs of quality in a productive enterprise may be analysed as follows:—

- (a) Prevention costs:— These are expended for the purpose of preventing the occurrence of defects and include such factors as time spent on selection and checking the previous experience of operatives, checking the quality of materials before use, specifying correct methods of working, planning the allocation of supervisory time and arranging special training for operatives.
- (b) Appraisal costs:— These are expended in appraising the quality of work during progress and on completion. For example, inspecting and testing.
- (c) Failure costs:— These are caused by substandard workmanship and defective materials which have not been eradicated by prevention or appraisal and include the following:— Cost of materials which have to be scrapped; additional materials to replace those scrapped; cost of remedial work; extra supervision, labour and material to allow remedial work whilst maintaining planned production; cost of delays, stoppages, arguments and disputes; loss of future business by failure to complete on time and reduction of client goodwill; losses in productivity due to low morale and friction between individuals and departments.

In highly industrialised production, the contributions of these categories (a), (b) and (c) to total quality cost are in the order of 5, 30 and 65 per cent respectively.<sup>6</sup>

In the Building Industry, quality achievement is normally integrated with many other activities, and it is difficult to separate quality costs from others. However, there is some evidence which indicates that an analysis of total quality cost would show similar proportions in respect of prevention, appraisal and failure.<sup>7</sup>

The causes of quality failure are many and varied, some, of course, outside the control of the contractor, but it is widely believed that the most important factors influencing quality are the skills and motivation of craftsmen, operatives and supervisors.

The criteria for acceptance of building work fall into three main groups:—

- (a) Appearance:— Where the product is non-load bearing or is over designed for its structural purpose and is also visible in the completed building, appearance of the finished surface will be the main criterion for its acceptance. The assessment is of course, to some extent subjective and influenced by opinion and argument.
- (b) Dimensions:— This criterion can be assessed by accurate measurement and if tolerances are specified the product can be judged acceptable or not acceptable, quite objectively. In many cases, particularly where the element is non structural, or where there is a considerable safety factor in design, very accurate dimensions are not essential.
- (c) Performance:— Although influenced to some extent by appearance and dimensions, this criterion is largely a matter of durability and reliability, which are also dependent on the quality of materials and design.

The criterion most frequently used for acceptance or rejection of work, is appearance of finished surfaces.

The building craftsman or operative spends a considerable amount of his working time during an operation

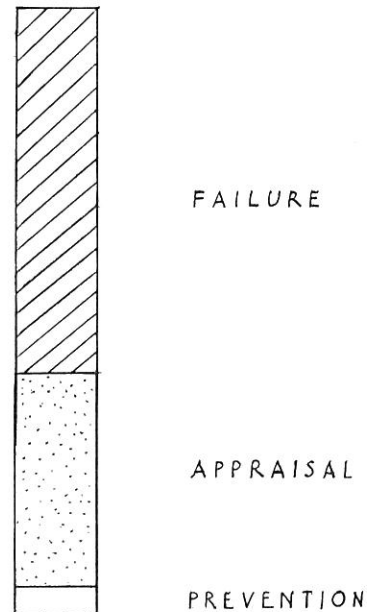
carrying out activities which are not critical to acceptance of the work. An elemental analysis of an operation will indicate the proportions of total time spent on activities affecting the finished surface appearance. For instance, in the case of a brick wall, the proportion could be about a third, depending on the thickness.

Typical costs of labour (including subcontractors) in building projects may be about 40 per cent of the total cost. If only a third of this is spent on activities critical to acceptance, the effective quality cost element for labour will be 13 per cent.

The supervisor also spends only about 20 per cent of his working time on supervision and inspection for quality. Typically, supervisory costs are about 5 per cent of total project costs and so the effective quality cost element for supervision at present is about 1 per cent of total project costs.

An analysis of the average overall situation is represented graphically in Figure 3.

FIGURE 3  
ANALYSIS OF  
TOTAL QUALITY COST



Workmanship may be defined as a combination of skill and motivation. A highly skilled person who, for whatever reason, has at a particular time, little motivation to produce acceptable quality, will find it easy to produce better quality work when compatible motivating conditions are present. Those possessing minimal skill and yet are well motivated, will need more time to achieve the higher levels of quality.

Production bonus schemes tend to produce conflict between time and quality, and it is often difficult for the skilled man to satisfy both expectations. Many have left the industry. The ending of bonus schemes may well significantly improve quality.

However, it is clear that skills are generally in short supply and there is a need for selective instruction and training on those activities which are critical to quality. Gilbreth doubled the output of his bricklayers to 3000 per day per man by training and the assistance of equipment designed as a result of detailed motion study, without causing undue fatigue.<sup>8</sup> It should be possible to increase the pace of work generally, so that more time can be spent on activities critical to quality, which may represent only 30 per cent of the total time, depending on the operation.

Inspection of work either by craftsmen or supervisors, can be made much more effective by knowing exactly what to look for, adopting the Pareto approach and separating the vital few criteria from the trivial many. A short period of instruction can improve the reliability of inspection by as much as 40 per cent.<sup>9</sup>

The costs of improving the workmanship of craftsmen and the effectiveness of supervision so that quality can be significantly improved, may be classified as follows:—

- (a) The cost of selective instruction and training in those relatively few activities critical to acceptance.
- (b) The cost of increasing the prevention and planning content of the relatively small quality element in supervisory costs.
- (c) The cost of increasing motivation to produce quality.

Clearly, in many cases the results could be achieved by more effective use of existing resources at all levels, and the additional cost would be negligible.

Where additional resources are necessary, further expenditure on prevention and planning rather than on inspection will be of most benefit, and assuming that the additional resources are at least as effective as those existing, a small expenditure on prevention could result in substantially reduced failure costs.

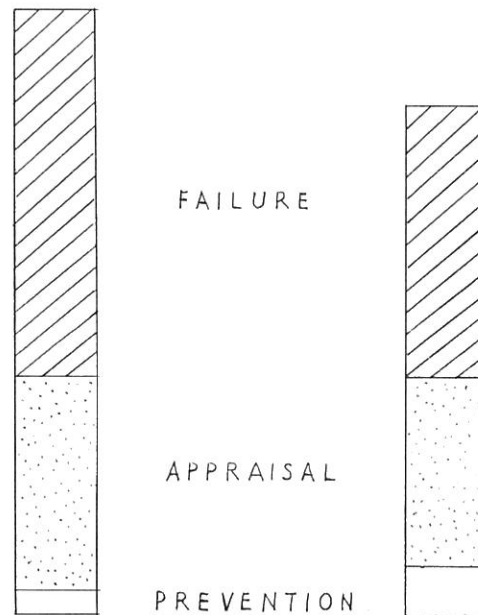
The comparison of the improved situation with that represented in Figure 3, is shown in Figure 4.

The above discussion has been limited to the workmanship and supervisory aspects of quality achievement. It is recognised that these are only the more important influences on quality. Other contributory factors to unacceptable quality include ambiguity or errors in design information, inappropriate specification of materials, inefficient estimating or buying, unrealistically short contract periods and lack of communications.

Quality is dependent on individuals and is susceptible to changes in personnel. Some contractors would say that as they employ very few men other than sub-contractors, the problem is one for subcontractors. Responsibility for quality of course, remains with the general contractor and belated disputes and litigation are no substitute for prevention.

FIGURE 4

COMPARISON OF QUALITY COST BEFORE AND AFTER INCREASING EFFECTIVENESS OF PREVENTION



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