QUALITY MEASUREMENT IN CONSTRUCTION PROJECTS

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Alongside time and cost, quality has remained as the most important parameter, which is the concern of the key players in the realisation of a typical construction project. Yet, the subjectivity surrounding the definition of quality has made it very difficult for a concrete method of quality measurement to be developed. Subsequently, the establishment of a trade-off between time and cost against quality has remained largely unexplored.

The paper reviews quality from various perspectives and lays the foundation for the development of a concrete definition of quality, in terms of its constituent attributes, and its measurement in quantified manner. Through a comprehensive literature review and validation through a questionnaire, the work brings together a series of attributes associated with quality and groups them under a number of categories.

It is contemplated that the constructor and the client have varied perspectives on quality and that a third party point of view can bridge the gap and help to develop a unified perceptive on the subject.

The work develops a methodology for a more objective measurement and quantification of quality encompassing measurable as well as subjective attributes of quality. This is carried out through a bi-directional ranking system applied to the attributes of quality. Also, triangulation is applied by cross-comparing the three perspectives on quality from client, constructor and third party.

This research contributes towards the development of a three dimensional project strategy space, which can be used for the evaluation of project performance.

Keywords: project strategy, quality, quality measurement, quality management.

INTRODUCTION

Quality, cost and time have long been recognised as the main factors concerning the client. However, for the majority of projects, the cost and time parameters are the main preoccupying factors (Rwelamila and Hall 1995). Project quality is often taken for granted and inadequate attention has been given to this parameter. Rounds (1985) has noted that the attainment of acceptable levels of quality in the construction industry has long been a problem. Subsequently, in the absence of effective quality management procedures, considerable time, and resources are wasted every year (Round and ASCE 1985). This is due to the high level of uncertainties surrounding the definition of quality and the subjectivity associated with the assessment of quality as well as the large number of variables involved in its assessment (Hughes and Willimas 1991).

According to Latham (1996), the client is the core of the construction process and his satisfaction, which is closely linked with the quality of the project, forms the central aim of all projects. To this end, various attempts have been made to encapsulate the definition of project quality. These include the following:

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1. Pleasing to look;
2. Free from defects on completion;
3. Delivered on time;
4. Fit for the purpose;
5. Supported by worth while guarantees;
6. Reasonable running costs;
7. Satisfactory durability.

The above definitions are largely subjective and vary with the knowledge and judgement of the individual. Further, in contrast with, for example, the car inustry, construction clients are not always fully aware of their needs and what they ask for (Rimmer 1993).

QUALITY

The need for quality management systems has long been recognised and many systems and methodologies have been developed and put into practice. These are often compatible with the quality policies of the company (BS5750), though, British Standards Institution cautions that the comprehensiveness of the quality system should be balanced against company's quality objectives (BS5750).

The complications relating to the precise definition of quality is also a reflection of the problems associated with quantification and measurement of quality. Therefore, any attempt to measure quality should commence with the definition of quality and determination of the attributes of quality. As noted earlier, the definition of quality in the construction industry is linked with client's satisfaction and the implementation of a quality management system is a key tool in consistently and reliably managing the goal of client satisfaction (Rwelamila and Hall 1995).

Latham (1996) has noted that "value for money" is a commonly accepted meaning for quality. This can be interpreted as 'the best for the client, for a given money'. This is articulated in BS4778-Section 2, Part 2:1991, Concept of Quality (BSI Part 2 1991) as follows:

1. The best fitness (fit for the purpose) for the given money.
2. The best Material Quality for the given money.
3. The most reliable design for the given money.
4. The highest design durability allowance for the given money.
5. The best look or prestigious product for the given money.

From a different perspective, Part 1 of BS 4778, defines quality of product and service as the totality of the features and characteristics that reflect on its ability to satisfy stated or implied needs (BSI part 2 1991).

The word quality has been used for several distinct purposes. These can be grouped into the following three categories:

1. Comparative sense: as a degree of excellence, whereby, products may be ranked on a relative basis, sometimes referred to as grade (BSI part 1 1991).

2. Quantitative sense: as in manufacturing, product release and for technical evaluations, sometimes referred to as quality level (BSI part 2 1991).
3. Fit-for-purpose sense: which relates the evaluation of a product or service to its ability to satisfy a given need.

It is evident from the above that the prime direction of quality systems is to satisfy the internal needs of the organisation and its quality policies. Therefore, while these policies need to be cost-effective, they should comply with the good practice that is acceptable within construction industry (Quality Measurement for Builders 1990).

PERPECTIVES ON QUALITY

In order to reach a better understanding about quality, it must be examined from different perspectives and usage. The latter is within the boundaries of the following three uses:

1. Quality of production: here, the main aim is the satisfaction of the internal needs.
2. Quality of product: this is primarily concerned with ‘client satisfaction”, ‘value for money’ and ‘fit for the purpose’.
3. Quality of process: here, the aim is to get it right the first time.

The above indicates that, for a given project, the quality has two major ‘maintainer’ - the client and the constructor. For the most part, the former is the recipient and the latter is the deliverer. However, there is a need for a third point of view in order to bridge the gap between the two perspectives on quality. Subsequently, quality assurance institutions have been established and standards have been developed. These have emerged in response to client’s prolonged dissatisfaction in achieving value for money (Quality Assurance in Building 1989). Quality standards such as ISO 9000 series or BS 5750 force the producer to maintain a required level of quality. For instance, supplier’s management is required to produce a document on its policy and objectives on quality. The management is also responsible for the implementation of the policy at all levels of the organisation (Oliver 1991).

In this paper, the three perspectives on quality have been examined in order to facilitate the development of a unified definition of quality and the identification of the attributes of quality.

Client’s Perspective on Quality

The majority of research work in this area indicate that clients’ main concern boils down to ‘value for money’ and ‘fit for the purpose’. However, these objectives are rather broad in definition and encompass a vast variety of factors. Because of the subjectivity associated with these definitions, their objective assessment is very difficult. Below an outline definition is provided.

- Value For Money: Basically, value for money means the best available for the client, for a given money. This is a measure of how well the product is and the level of satisfaction it creates. Different buildings have different characteristics, however, it may be possible to use statistical techniques in order to develop a quantified method for measuring value for money.
- Fit for Purpose: This parameter, from client’s point of view, is a reflection of the degree to which the product satisfies his requirements as defined, as early as, the briefing phase.

As part of the above, the client is also keen about the static (prestige and fashion) values of the product, but these vary for different clients and projects.

Constructor's Perspective on Quality
The prime concern of the constructors are 'client's satisfaction' and 'fashion' (prestige) yielded by the project.

- Client's Satisfaction: How pleased the client is with the final product is a matter of concern to the constructor. This can be divided into subjective and measurable parameters. Therefore, perception of the client about the subjective parameters, such as design features and finishing, is a matter of concern to the constructor. For the measurable parameters, such as the quality of materials, a form of scaling system can be adopted.
- Fashion: Although fashion lies within the category of subjective parameters, nevertheless, an evaluation system can be used to allocate a scaling system for each product. The system can be based on experience (in form of knowledge) and should be adaptable to varying circumstances. To this end, a method of quantification should be developed for each type of building.

Third Party Perspective
Normally, the third parties in the construction industry, consist of quality assurance companies or local authorities. The standards adopted by the third parties often measure 'fit for the purpose' and 'material quality level' (Oliver 1991).

QUALITY MEASUREMENT

For a successful project quality measurement, the following three separate but interdependent components must be integrated (Round and ASCE 1985):

1. Strategy and structure: this is concerned with 'what' the project is and 'how' it functions.
2. The technical component: this relates to project organisation skills, practices, tools and methods used throughout the project organisation for the product and process development.
3. Culture: this includes the norms and behavioural exceptions the project organisation has set for itself and the people involved in the organisation.

When these components are properly integrated, significant, measurable and observable improvement will be achieved. Therefore, these parameters can facilitate measurement of quality.

The measurement of quality denoted by Quality Level, reflects the comparison between what is observed in relation to what is required. This degree of conformity, specially for specification or sampling inspection purposes, can be expressed numerically. However, where possible, a more precise term should be used such as proportion of conformity and acceptable level (BSI Quality sec 8.1.7 1991).

It's worth nothing that quality level can change in time and the change is a reflection of the changes in the attributes of quality (Glagola 1995).

Table 1: The list and scores of quality attributes for 3 perspectives

Constructor Point of View:

Section B2	Average	Std Div	Min	Max	Average Ranking	
Client Satisfaction						
External Factors						Rank A-H
Building Access	4.5		3	5	1	
External Finishing Quality (Please fill section B2.1 for details)	3.8		2	5	4	
Parking Area	4.1		2	5	2	
External Lights	2.8		1	4	6	
Building Security	3.5		1	5	3	
Green Field Design	2.7		1	4	5	
External Walls	2.1		1	4	8	
External Doors	2.5		1	4	7	
Internal Factors						
Design	4.1		3	5	5	
Superstructure	2.8		1	4	13	
Substructure	2.7		1	4	14	
Floors	2.1		1	3	12	
Walls	3.5		1	5	10	
Doors	3.1		1	5	11	
Windows	4.1		2	5	9	
Internal Access	4.5		3	5	1	
Internal Finishing (Please fill section B2.2 for details)	4.3		2	5	2	
Lights (Please fill section B2.3 for details)	3.2		1	5	8	
Air Conditioning	3.5		1	5	4	
Services (Please fill section B2.4 for details)	3.8		1	5	3	
Internal Decoration	2.9		1	4	6	
Fashion						
External View						
Artistic Design	3.5		2	5	3	
Harmony with Area	4.1		2	5	1	
Self Harmony	3.8		2	5	2	
Invention	3.1		1	5	4	
Internal Factors						
Internal Artistic Design	3.5		2	5	2	
Internal Artistic Decoration	3.1		1	4	3	
Internal Harmony	3.9		3	5	1	
Section B2.1						
External Finishing						
Material Quality	3.5		2	5	1	
Product Quality	3.1		1	5	2	
Section B2.2						
Internal Finishing						
Painting	3.8		2	5	1	
Carpeting	3.4		1	5	2	
Tiling	2.8		1	4	3	
Ceiling	2.5		1	4	4	
Section B2.3						
Lights						
Day light	4.1		3	5	1	
Night light	3.8		1	5	2	
Section B2.4						
Services						
Electricity	3.7		2	5	4	
Cold Water	2.8		1	4	5	
Warm Water	3.8		2	5	3	
Sullage	2.5		1	4	6	
Fire Alarm	4.1		3	5	1	
Smoke Alarm	3.9		2	5	2	

Client Point of View:

Section B1	Average	Std Div	Min	Max	Average Ranking
Value for Money					
Building Externals					
Access to Building	4.5		3	5	1
External Finishing Quality	3.5		1	4	3
Green Field planning	1.5		1	3	6
Building View (Fashion)	3.1		2	4	5
Harmony with Environment.	3.8		2	5	4
Parking Area	4.2		3	5	2
Building Internals					
Super structure	2.3		1	4	8
Internal Access (stairs, elevators, ….)	4.3		3	5	1
Internal Finishing (Please fill section B1.1 for details)	4.1		2	5	2
Lights (Please fill section B1.2 for details)	3.8		2	5	4
Air Conditioning	2.8		1	5	7
Internal Temperature (Please fill section B1.3 for details)	2.9		2	5	6
Services (Please fill section B1.4 for details)	4.2		3	5	3
Internal View	2.9		1	5	5
Fit for Purpose					
Area	4.8		4	5	1
Functionality	3.9		2	5	2

Section B1.1					
Internal Finishing					
Painting	3.8		2	4	3
Carpeting	3.7		2	4	2
Tiling	3.5		2	4	4
Ceiling	3.4		2	4	5
Services (Toilets, Bathrooms, ….)	4.1		3	5	1

Section B1.2					
Lights					
Lights in Night	4.1		3	5	1
Lights in Day	2.9		2	5	2

Section B1.3					
Internal Temperator					
In warm days	4.5		3	5	2
In cold days	4.7		4	5	1

Section B1.4					
Services					
Cold water	3.9		2	5	3
Warm water	4		3	5	2
Electricity	4.1		3	5	1

Third Party Point of View:

Section B3	Average	Std Div	min	Max	Average Ranking
Fit for purpose					
Area standards (Size, Services, Lighting System…)	3.9		2	5	3
Functionality standards	2.7		1	4	5
Access standards	4.1		4	5	2
Security standards	3.7		1	5	4
Safety standards	4.5		4	5	1
Superstructure standards	2.5		1	4	6
Material quality					
Standardized material using ISO and BS reports	4.1		3	5	1
Nonstandardized material compairing with standard equivalent.	2.5		1	4	2

Despite many areas of commonality, each type of construction project has distinct characteristics. Therefore, project quality measurement should be undertaken for each individual project type. To this end, the CI/SfB building types, given by BCIS, can be used. Having identified the type of building, the attributes of quality should be identified and classified. This should be undertaken for the above three perspectives.

Attributes of Quality

It has been noted that quality can be defined in terms of its constituent attributes. This breakdown of quality into attributes will allow separation of the measurable components from the subjective components and facilitates measurement of all attributes.

Through an extensive literature review a list of attributes were identified. This list was then validated and refined through the analysis of the data collected through a questionnaire. The sub-scale attributes, as identified by the respondents, were removed from the list. Also, the respondents were asked to add to the list where appropriate.

The refined list of attributes, which was used for the next stage of analysis is given in Table 1. The list is divided into three groups representing the point of views from the key players. Also, each point of view is sub-divide into sections encompassing the relevant attributes. However, the statistical average of a few respondents appears on the list and has been addressed in the next part.

Table 2: Summary ranking for the 3 perspectives

Client Point of View:	Average Ranking
Value for Money	
Building Externals	2
Building Internals	1
Fit for Purpose	
Area	4
Functionality	3

Constructor Point of View:	
Client Satisfaction	
External Factors	3
Internal Factors	1
Fashion	
External View	4
Internal View	2

Third Party Point of View:	
Fit for Purpose	1
Material Quality	2

Table 3: Average claim over quality by the 3 parties

Average Client's Claim on Quality	39%
Average Constructor's Claim on Quality	35%
Average 3rd Party Claims on Quality	26%

Quantification of the attributes

Having established the attributes of quality from three points of view, a method is adopted to measure the importance level of each attribute individually and in relation to other attributes. A five-scales system (1=least to 5=most) was used in order to determine the importance level of each attribute. Table 1. also contains the statistics relating to individual attributes. These are summarised into a higher level and shown in Table 2.

It is envisaged that each party has its distinct views and claim over quality. Further, each party has views about the claims other parties have on quality. Therefore, the sources of data are asked to respond to all questions relating to all parties. This triangulation facilitates better understanding about quality and the identification of clusters of important areas. In Table 3, the claims over quality for each party is identified by all three parties. The figures are averaged and normalised. The above statistics are the product of the initial round of inquiry. Further elaboration is expected in the next phase of the work.

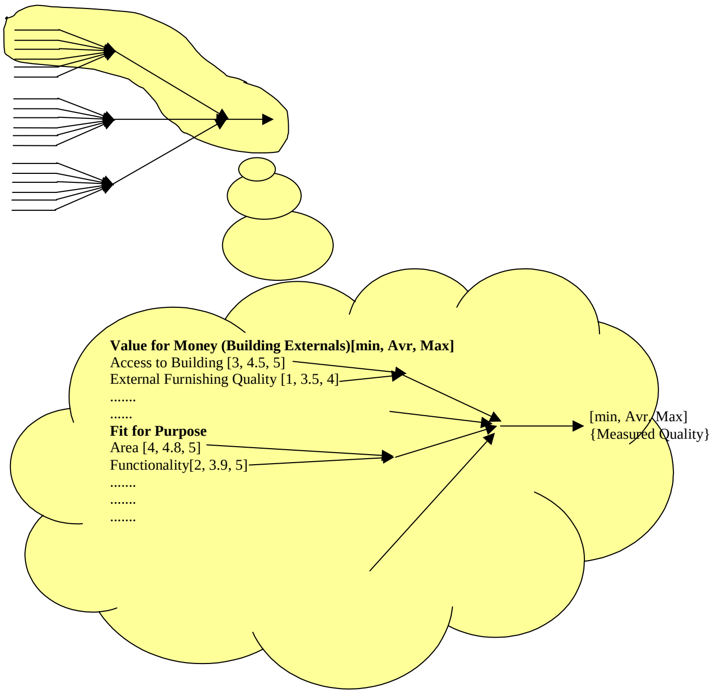

Figure 1: Quality measurement tree

As shown in Figure 1, a weighted tree is constructed through normalisation of the average of all attributes. For a given project, the quality measurement is carried out through forward-feeding of project data into the weighted tree.

At present, assuming the statistical minimum of 0% and statistical maximum of 100%, the averages become normal in a 100% scale. For the evaluation of the quality level of the particular project (product), the relevant data is applied to the weighted tree. At each level, prior to transfer to a higher level, data are normalised to 100% (based on the current statistics - minimum, maximum and average).

Once the quality level is determined for each individual party, the overall level of product quality is calculated by applying the respective weights relating to each claim over quality.

So far, the data were generalised for all project types. A more accurate measurement can be obtained by using the data relevant for each type of building.

CONCLUSION

Having reiterated the importance of quality, the paper highlights the need and complications associated with measurement and quantification of quality. To this end, the paper contemplates that an objective measurement of quality should be based on the encapsulation of views of the three 'claims' on quality. Therefore, the paper examines quality and its constituent attributes from three perspectives: clients, constructor and third party.

Trough a bi-directional ranking system of the importance level of quality attributes, the views of the three parties are identified. The results from the initial round of inquiry are highly satisfactory: while the views from the three perspectives vary on individual attributes, their overall average claim on quality are rather close, hinting at a consensus amongst three parties. This is further validated through triangulation of the views of each party about the claims of other parties on product quality.

In the next phase of the work, a more elaborate measurement will be produced by applying additional data to individual project type.

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