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**PROCUREMENT, GOOD DESIGN AND QUALITY INTEGRATION: SOME RESEARCH ISSUES**

*Keywords*: Construction, Design, Design Quality Index, Procurement, Quality,

**Abstract**

According to Lupton (2013) any decision that affects the final form or composition of the building is a design decision. Design covers a wide spectrum, from strategic space planning to the smallest level of detail. Conceptual design involves identifying needs or requirements, analysing possible solutions to a properly thought out decision as to which design will be most promising. The next is the detailed design phase which has the mission to reduce the concept in the conceptual phase to a practical scheme design that will show whether a useful end product is likely to emerge. As a result of the detailed design a set of detailed drawings, specifications and other documents have to be produced so that manufacturing and quality targets, together with satisfactory service in the field, can be achieved (Design Council Committee, 1976). The designer’s task is not finished until it has been shown that the product can be manufactured, tested and maintained to cost targets, and that it performs properly at all points in the specified performance. An exact definition of “design” and “designer” has to be done in contract documents meaning the same thing to all the contractual parties. There will not be any room for confusion between parties. Design in this paper mean, “to design is to decide. This will avoid the confusion from “workmanship”, which is taken to be the “manner” in which the work is carried out. Quality in design and construction has to be treated as one. Quality means right first tie, delivery on time and to budget, innovating for the benefit of the client and minimising waste. Design quality is critical for the success of any construction project. There is a significant role for clients in promoting good design. Good design promote value for money (VFM) in terms of total cost, sustainability and environmental concerns. The primary concern of procurement is to determine how the asset (building or civil engineering project) will be obtained. Procurement involves the
conversion of an idea or possible requirement for construction by the Client into an expression of demand; the conversion of the expression into a decision and the conversion of the decision into a fully designed and completed project ready for use. Design issues and contractual responsibility for the parties varies in in different procurement routes. This paper aims to give an overview and find out the relation between procurement routes, design and quality parameters in construction projects.

1. Procurement

Mohsini and Davidson (1989) defined procurement as “the acquisition of new buildings, or space within buildings, either by directly buying, renting or leasing from the open market or by designing and building the facility to meet a specific need”. Approximately ten years later Lenard and Mohsini (1998) modified the procurement definition as “a strategy to satisfy client’s development and/or operational needs with respect to the provision of constructed facilities for a discrete life-cycle”. McDermott (1999) referred to a definition, which was developed by CIB W92 at its meeting in 1991, of procurement as “the framework within which construction is brought about, acquired or obtained”. This and the other definitions sought to emphasize that the procurement strategy must cover all of the aspects of the processes in which the client has an interest, within the whole lifespan of a constructed asset.

The form of procurement is critical as it determines the overall framework embracing the structure of responsibilities and authorities for participants within the process. Therefore, it is a key factor contributing to project success (Cheung, et al, 2001). Developing a model for procurement selection is of strategic importance and many research works have been carried out and reported (Masterman and Gameson, 1994; Skitmore and Marsden, 1988; Love et al, 1998). The overall purpose of a procurement strategy is to select an arrangement that fits for purpose and satisfies the client needs in meeting the main procurement parameters namely, time, cost, quality and certainty.
1.1. Quality Dimensions of Procurement Parameters

Fig. 1. Quality Dimension of Procurement Parameters (Akbiyikli, 2005)

1.2. Procurement Routes and Design Relation

Below in a brief outline in Table 1 is given in order to highlight where in the process the design activity will occur.
Table 1. Procurement Routes and Design Relations (Adapted from: RICS, 2016; Lupton, 2013 and Ndekugri & Corbett, 2004)

<table>
<thead>
<tr>
<th>PROCUREMENT ROUTE</th>
<th>DESIGN</th>
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<tbody>
<tr>
<td>1. Traditional Procurement Route</td>
<td>Contractor: Has no obligation to design (in some cases very limited responsibility). Design: Is done by the Client’s directly engaged consultants.</td>
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<tr>
<td>2. Traditional plus design</td>
<td>Contractor: Contractor’s design obligation is limited to an identifiable part or aspect of a project. (Design done by others). Design: Is done by the Client’s directly engaged consultants.</td>
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<tr>
<td>3. Design-Build Procurement Route</td>
<td>Contractor: Buildability expertise in design (work + design). Responsibility of entire or part of the design.</td>
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<tr>
<td>4. Management Contracts</td>
<td>Design: Client’s directly appointed consultants (same way as traditional). Separate trade contractors carry no design responsibility.</td>
</tr>
<tr>
<td>5. Turnkey Contracting</td>
<td>Contractor: Designs and builds the project usually for a fixed price. The project is commissioned and handed over ready to operate. A variant of turnkey contracting is BOT or BOOT. The UK’s (PPP) PFI model is a particularly significant variant of this procurement system.</td>
</tr>
<tr>
<td>6. Partnering</td>
<td>More integrated and collaborative approach. Efficient and fostering non-adversarial culture. Parties work together in an open and trusting relationship based on mutual objectives. In design terms, involve all parties will often involve all parties contributing their expertise to the design process. The pain/gain mechanism may be limited to a quality objective such as “minimal defect” or “building’s performance in use”. Partnering is used extensively in UK’s PFI projects. (Latham, 1994 &amp; CIB, 1996).</td>
</tr>
<tr>
<td>7. Prime Contracting</td>
<td>Often use with partnering. Prime Contractor is responsible for the management and delivery of project using a system of incentivisation and collaborative working to integrate the activities of the supply chain members to achieve a project that is on time, within budget and is in accordance with the specified outputs and it is fit for purpose.</td>
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</table>
2. What is Quality?

There are numerous definitions of quality in manufacturing and in the construction industry. Juran’s definition pointed to quality as “fitness for use” in terms of design, conformance, availability, safety and field use (Omachonu and Ross, 1994). Besides this definition there are other definitions covering different aspects of quality. Crosby (1979) defined quality as “conformance to requirements”. According to Burati et al. (1991) quality is defined as “customer satisfaction”. In construction, defining quality as “conformance to established requirements” (Construction Industry Institute, 1989) renders its achievement or lack thereof detectable, and its measurement and assessment quantifiable. This definition implies that based on a quality level scale, the conformance of the asset/service to the design requirements and the conformance of these requirements to the client needs/expectations, in the design stage respectively. According to Battikha (2003) quality is “a product of the system, thus the system must be designed to guarantee that requirements will be met”.

In PFI (Private Finance Initiative) projects the quality is focused essentially on performance related features. This aim in these projects is “to reflect the best understanding of what determines quality and to create a contractual framework that maximises cost effectiveness” (Chamberlain, 1995). Performance-related specifications aim to “give better” levels of the long-term performance of the completed asset. Performance-related specifications also reflect the payment mechanism depending on the performance of the completed asset.

The required quality and standards will naturally have an effect on the procurement route chosen. For example, if the client wishes to have complete control over the design during the construction phase, you are unlikely to select a 'design and build' option.

The choice of procurement options range from where the client retains responsibility for and control of the design team and the design quality throughout the process (for example by following the 'traditional' procurement route) to where the client may have a lack of control over design decisions with the result that the project may not be perfectly suited to his/her needs when completed (for example by following a 'turnkey' approach). Other issues that may arise relate to matters such as:

- how 'buildable' the design may be;
- the potential for over-design and/or over-engineering;
- the opportunity to use the expertise of the contractor in the design process;
- the lack of flexibility available to the client to make changes during the build process; and the checks on quality that the client wishes to be able to make.

All of these issues need to be taken into account when deciding upon the procurement route to follow.
In understanding the importance and relationship to the other aspects of buildability of a building project RICS (2012) listed certain questions about quality parameter to be answered. Typical questions to ask are likely to be:

- Is the project for a completely new detached building, an extension to an existing building, the refurbishment of an existing building, the restoration of a historic structure or a repair and maintenance programme?
- Should the design be wholly in the hands of the client's consultants or can some detail design be placed as a contractor's responsibility?
- Does an innovative design demand sophisticated construction methods?
- Should there be provision for design by specialist subcontractors?
- What measure of control will the client wish to exert over materials and workmanship?
- How much reliance can be placed on performance specified requirements?

2.1. Relation between good design and quality of the Project output

Good design is essential for achieving value for money in construction and provides the arguments, evidences that make places work better. But this is not just about buildings being completed on time and within budget; it is also concerned with ensuring that the costs of operating buildings over their whole life are optimized and that those who use and work in buildings gain real value from them. (Farooqui & Ahmed, 2009).

Considering the design, in order to understand why time is such a crucial factor, it is important to first understand the nature of design as a process. In this regard, design is used in the broadest sense to suggest a value-adding activity that is integral to good planning, urban design and architecture or engineering. In this conception, design is seen as a cyclical, iterative and ‘universal’ process in which solutions are gradually refined through a series of creative leaps. When, a problem is identified and an image of a likely solution is generated.

Every project situation is different and presents a different set of requirements and limitations, unique set of cultural, environmental, technological, and aesthetic contexts to be considered creating its own set of challenges and opportunities.

It is hard to quantify design quality as it consists of both objective and subjective components. Whilst some indicators of design can be measured objectively, others result in intangible assets, depending in part on the subjective views, experiences and preferences of the people asked. The most important measure in any evaluation of a building’s design quality is whether it satisfies user requirements and what users think and feel about it.

The DQI as a product quality measuring tool has been developed to work with the existing performance measures from Constructing Excellence, in particular
the Key performance Indicators- KPIs which assess the process – the delivery of the building. It also complements sustainability tools. The DQI is a tool which assists a building’s procurement team to define and check the evolution of design quality at key stages in the development process. The development of DQI has been led by the Construction Industry Council- CIC with sponsorship from the DTI, the Commission for Architecture and built Environment- CABE, Constructing Excellence and the Strategic Forum for Construction and with support from Office of Government Commerce- OGC.

2.2. **DOQ (Design Quality Index) - What is it for?**

It has been developed to help all built environment stakeholders gain more value from the design of buildings, and to assist in improving the quality of buildings. The Design Quality Indicator (DQI) is based on a research project to provide a toolkit for improving the design of buildings. It seeks to complement methods for measuring performance in construction by providing feedback and capturing perceptions of design quality embodied in buildings. (Gann Et al. 2003) The comparative lack of emphasis on design quality in the early stages of performance measurement following Rethinking Construction led to disquiet among leading members of the UK building design community. (Gann Et al. 2003) The Design Quality Indicator (DQI) was developed as an extension of the Rethinking Construction agenda for targeting, mapping, measuring and managing performance improvement in construction. It was developed explicitly to measure quality of design embodied in the product – buildings themselves. (Gann Et al. 2003) The report Accelerating Change (Egan, 2002), which updates the Rethinking Construction agenda, makes explicit reference to the DQIs and calls for their adoption across the construction sector. It also highlights the role of clients in promoting value through design in new buildings and refurbishment projects. Sir John Egan’s Rethinking Construction (Egan, 1998) and Strategic Forum for Construction Report “Accelerating Change” (Egan, 2002) highlighted the key importance of “design quality”. The DQI is the pioneering process to evaluate the design quality of buildings. All clients should aim for good design in their projects. Clients need to consider the cost and impact of design over the whole life of their projects. It is at the design stage that most can be done to optimize the value of a facility to its end users. Good design takes full account of sustainability and environmental concerns. Badly designed facilities will fail to meet the needs of end users, cause operational problems, have high maintenance or running costs and can be inefficient, costly and dangerous to build (OGC, 2007).

Design quality is a combination of functionality (how useful the facility is in achieving its purpose), impact (how well the facility creates a sense of place), and build quality (performance of the completed facility). (OGC, 2007).

The three parts of DQI is shown in Table 2.
Table 2. Parameters of Design Quality Index (DQI) (Adapted from OGC, 2007 Procurement Guide No.9)

<table>
<thead>
<tr>
<th>PARTS OF DESIGN QUALITY INDEX (DQI)</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
<td>Functionality</td>
<td>Is concerned with the way in which the building is designed to be useful and is split into <strong>use, access and space.</strong></td>
</tr>
<tr>
<td>Build Quality</td>
<td>Is concerned with the way in which the building is designed to be useful and is split into <strong>performance, engineering and construction.</strong></td>
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</table>
| Impact                              | Refers to the building’s ability to create a sense of place and to have positive effect on the community and environment. Impact is split into:  
  - Character and innovation  
  - Form and materials  
  - Internal Environment  
  - Social Integration  
  All projects exist within a context of finance, time and environmental resources. Good design quality enables the better deployment of these resources. |

3. Engineering Design

A formal definition of engineering design is found in the curriculum guidelines of the Accreditation Board for Engineering and Technology (ABET). The ABET definition states that engineering design “is the process of devising a system, component, or process to meet desired needs. It is a decision-making process (often iterative), in which the basic sciences, mathematics, and engineering sciences are applied to optimally convert resources to meet a stated objective. Among the fundamental elements of the design process is the establishment of objectives and criteria, synthesis, analysis, construction, testing, and evaluation”. From the definition, it is evident that design is both a scientific and a creative process. (Walton, 1991)

Walton lists the reason for failures in most engineering designs:
- Incorrect or overextended assumptions
- Poor understanding of the problem to be solved
- Incorrect design specifications
- Faulty manufacturing and assembly
- Error in design calculations
- Incomplete experimentation and inadequate data collection
- Errors in drawings
- Faulty reasoning from good assumptions
As can be seen, all of the disaster related deficiencies and the reasons for catastrophic failures can be summarized and categorized within one or more of the items Walton lists. However, even if a design is a technical success and no faults occur, many designs still fail to achieve their desired goals, and many achieve them but are not adopted by the users. So why do many people fail at design? One of the answers is that design is inherently difficult and a major challenge. Designers not only have to have the creative and technical skills to develop an idea to become a reality, but they also need to predict the future in some ways. (Ross, 1984)

Design is widely regarded as one of the most important steps in the development of a product. Design has been driven to meet an existing requirement, to reduce a hazard or an inconvenience, or to develop a new approach (Haik and Shahin, 2011).

To design is to create a new product that turns into profit and benefits society in some way. The design process is a sequence of events and a set of guidelines that helps define a clear starting point that takes the designer from visualizing a product in his/her imagination to realizing it in real life in a systematic manner—without hindering their creative process. (Haik & Shahin, 2011)

4. Design Process:

The design process involves the sequential steps shown in the Fig. 2. Design Process (Adapted from: OGC, 2007)
The client’s primary role in design process is to demonstrate clear leadership by developing a clear brief with help from independent client advisors and the integrated supply team, which is absolutely essential to achieve good design. It is at the briefing stage that most can be done to optimise value. Design must always be managed to obtain value for money. This depend on the selected procurement route. Managing the design process to ensure:

a) The use of appropriate advice,
b) The benchmarking of design standards,
c) The evaluation of design quality, and
d) The endorsement and approval process.

In order to achieve value from outline and detailed design we have to answer the following questions: (OGC, 2007)

**Outline design:**
- Have we optimised the design as far as possible?
- Are we satisfied about buildability?
- Will the proposed design achieve the benefits we want?
- Are we using DQIs?
- Have risks been reduced through good design?

**Detailed design:**
- Does the design take full account of maintenance etc.?
- Does the design eliminate accidents on construction site?

These and other relevant questions and checklist for each project will help to test how well a design meets the criteria that form the definition of good design.

4.1. **Who are designers?**

4.1.1. **Architects**

Architects are recognized as the profession with the key role in the design of buildings. They have influence and significance within the construction industry. Architecture in the UK is the only profession that has a protected title. However, there is no protection of function. There is no requirement under the law to engage an architect (or other professional for any stage of the building design or construction process in the UK. In the UK only those who are registered with the Architects Registration Board (ARB) may use the title “Architect” (Lupton, 2013). This is not the case in other countries, where function not title may be protected.

4.1.2 **Engineers**

In the UK neither the *title* nor the *function* are protected by law. In the UK the Engineering Council holds a national register of Chartered Engineers (CEng),
Incorporated Engineers (IEng) and Engineering Technicians (EngTech). This is a voluntary organization (not statutory). To join, members must already be members of another engineering institution, such as the Institute of Civil Engineers. The Association for Consultancy and Engineering (ACE) exists to promote the advancement of the profession of those engineers who practice as consulting engineers (Lupton, 2013).

5. Conclusions

Design quality incorporates the key requirements of the stakeholders and business, functionality, whole life value in relation to maintenance, management and flexibility, health and safety, sustainability and environmental impact. Design quality is not merely subjective, it can be defined and measured. Design Quality Indicators (DQIs) is a means of measuring and evaluating design quality.

Quality means:

- Right first time,
- Delivery on time and to budget,
- Innovating for the benefit of the client,
- Stripping out waste (whether it is in design, materials or construction – on or off-site).

It is essential to pursue of design quality in the overall procurement process, bringing together client leadership, integration of project team and continuous improvement. 

Quality is about “meeting the needs and expectations of end-users”.

Key aspects of quality are:

- Good design,
- Good functionality,
- Reliable (acceptable level of break-downs or failure),
- Consistency,
- Durable (lasts as long as it should), and
- Value for Money (end-user must be satisfied that the price fairly reflects the quality).

Construction is defined as, “the mobilization and utilisations of capital and specialized personnel, materials, and equipment to assemble materials and equipment on a specific site in accordance with drawings, specifications, and contract documents prepared to serve the purpose of the client” (Merritt et al. 1996).
Quality in design and construction has to be treated one. The main question in this respect is: Why design quality is important?

- It is critical for success of any construction project.
- Good design will provide VFM in terms of total cost and cost-in-use.
- Good design will address issues of sustainability and environmental concerns.
- Good design “add value” and “reduce whole life costs”.
- Create built environment that is safe to construct and safe to use.
- Contribute to construction that is quick, safe and efficient.

Design quality can be defined precisely in terms of quality elements for a specific facility:

a) Efficient, clear space for maximum flexibility of layout,
b) Place making,
c) Maximum access to views and outlook,
d) Good environmental qualities (light, heat, air, etc.),
e) Design for energy efficiency, and
f) Design for security and safety.

Critical Success Factors (CSFs) for achieving design quality:

a) Clear brief and sound business case,
b) Expert advice (where necessary) from independent client advisers,
c) Designers in the integrated project team with appropriate skills and experience,
d) Early involvement of the integrated project team,
e) A good site,
f) An efficient client who champions design,
g) Well managed designed and procurement process, and
h) An adequate budget and time scales.

REFERENCES


