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# Quality Assessment System Of Affordable Housing In India Using QFD As A Benchmarking Tool

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**ABSTRACT:** This paper identifies quality indicators of affordable housing in India and recognizes benchmarking as a tool for quality assessment. The current lack of quality in existing housing and the enormous need of new housing highlights the need of stringent quality management controls in the housing sector. Improvement in quality standards can only take placeif there is a set benchmark, and in order to know if the changes have made a difference, measurement is essential. Hence, the present study aims to evaluate and assess the comprehensive quality of affordable housing and develop a benchmarking framework for its implementation for quality management of Affordable housing construction in India. Quality Function Deployment (QFD) has been used as tool for benchmarking. The paper identifies quality indicators and its sub components by understanding their theoretical applicability to the construction industry. The outcomes of the study are the development of a benchmarking framework with the help of HOQ tool and further validating it with existing case studies of affordable housing.

## INTRODUCTION

India is a rapidly urbanizing country facing development challenges associated with rapid growth.One of the key challenges for a developing country like India is urban migration, which is further exacerbated by limited resources to meet increasing housing demands, pressure on basic amenities like shelter, water and sanitation (Deloitte, 2016). According to National Housing Bank (2013), the housing shortage in India as estimated was 18.78 million units in 2012, based on the census record and various other individual studies (Madala, et al., 2019).
The housing sector in India suffers certain setbacks (National Housing Bank, 2013) like non availability of land, encroachments, lack of funds, clumsy titles of land, unclear demand and supply, financial constraints due to pressure on land and operational constraints on infrastructure (Madala, et al., 2019). However, currently the real estate market provides affordable houses which are often characterized by insecure tenure, small size, unhygienic environment and non-existent infrastructure.

Due to lack of proper civic amenities and basic social infrastructure, areas providing affordable housing often perpetuate unemployment, lack of education, crime and unsanitary living conditions.This current lack of quality in existing housing and the enormous need of new housing highlightsthe need of stringent quality management controls in the housing sector (Seth, 2016). The"Housing for All by 2022" mission also recognizes the need of faster and quality construction of housing using modern and innovative technologies and techniques.

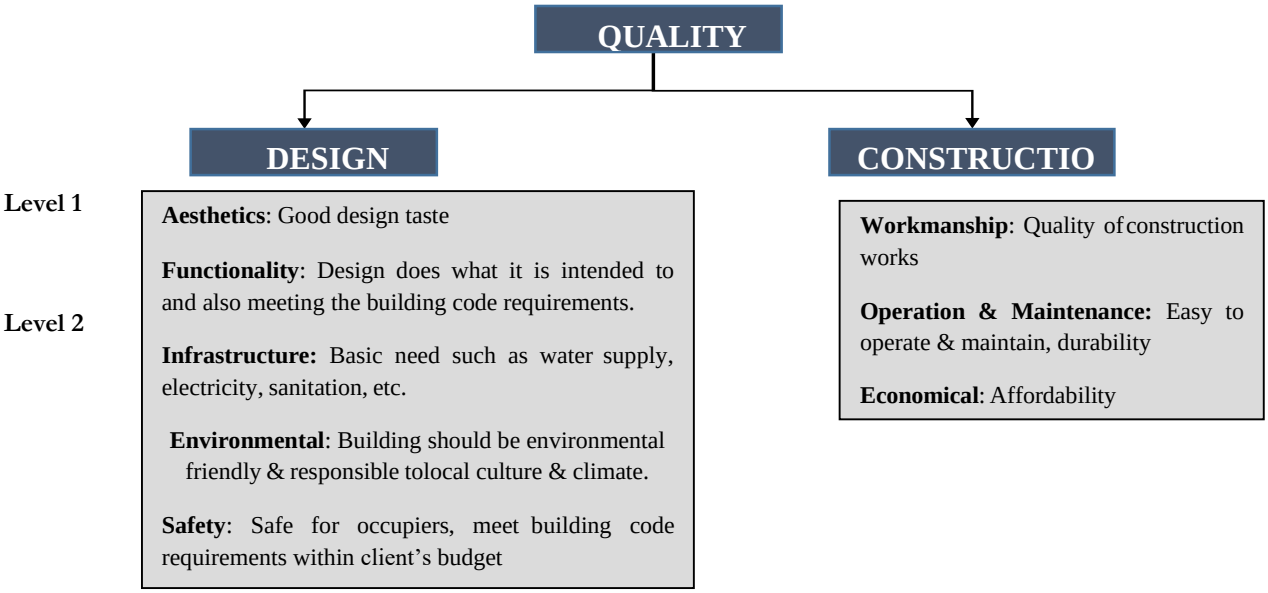
Implementing quality in the vast endeavor of providing "Housing for All" requires an integrated organizational effort to improve quality at every level and strive to attain excellence in total quality management. Often poor quality calls for higher costs due to costs resulting from failures. There always appear two sides of a coin in the development of housing projects: "quality" and "price" (Le, et al., 2016). Both of the two elements are important, however cost reduction seems to be of utmost importance to affordable housing projects rather than quality factor. In fact, the role of construction quality is sometimes considered redundant, which leads to long-term effects for users, and this addresses the reason why people gradually lose faith in affordable housing provisions (Le,et al., 2016).

So as to provide the people of low income with access to housing, it is crucial to think a way to reduce housing cost. However, so as to obtain the goal, there should be a system of criteria for assessing the quality of construction solutions (Le, et al., 2016). Different quality assessment systems are being used in the world for the construction industry to increase satisfaction of residents and quality (Celiknalca, 2006).

Improvement in quality standards can only take place if there is a set benchmark, and in order to know if the changes have made a difference, measurementis essential (McCabe, 2001).
Quality Function Deployment (QFD) is one such tool suggested for functional improvement of building systems, which can be explored to meet the need for developing a benchmarking approach for affordable housing as well. This paper explores QFD as a tool that can be used for benchmarking of quality parameters for housing based on suitability and performance driven parameters.

## QUALITY INDICATORS OF HOUSING

Quality of housing divided in two groups namely design and construction which are essential elements. A comprehensive quality management framework requires defining quality parameters that incorporates inputs from larger housing policy agenda, functional requirements and user's perspective. From Quality management philosophy, it is imperative that all quality parameters to be defined place focus on customer satisfaction and customer satisfaction is the key driver of the quality management system. On the basis of different perspectives, functional and user's requirements, the comprehensive demanded qualities for affordable housing can be listed as:




## BENCHMARKING FRAMEWORK USING QFD

QFD uses the House of Quality (HOQ) approach to document desired qualities in a technical andconnecting these to their means of accomplishment. QFD starts with an input list of objectives or root consumer needs for the target market or segment for which the Indicator is being developed.The HOQ then translates these inputs into engineering characteristics and targets. In subsequent HOQs engineering targets are translated into design requirements and design requirements are translated into desired parts characteristics (Ettlie and Johnson, 1994). Figure 1 is the QFD processused for housing quality benchmarking.

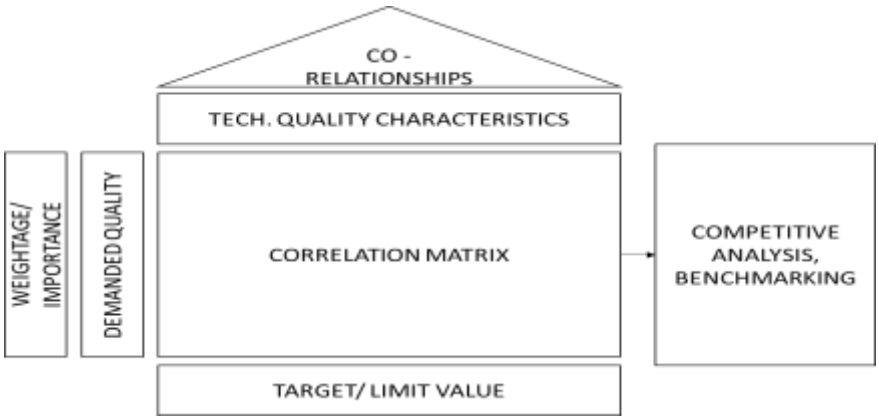



***Figure 1: QFD Process for Housing quality Benchmarking***

The following steps discuss the methodology and benchmarking inputs used in HOQ matrix to determine the priority parameters for quality improvement in affordable housing:

### 1. IDENTIFICATION AND DEFINITION OF PRODUCT

The concept of QFD is used for Affordable housing construction. These projects apply QFD in the quality and design improvement of affordable housing. The demanded qualities are selected on thebasis of literature studies. Data is collected on

the basis of different perspectives, functional and user's requirements.

## 2. DETERMINE THE DEMANDED QUALITIES

For the purpose of gathering data, house users and potential users are targeted. The demanded qualities are identified from various literature studies and research papers. The input parameters for benchmarking on HOQ matrix have been narrowed down to eight demanded qualities (Table 1).

***Table 1: Demanded qualities (Whats)***

| S.NO. | DEMANDED QUALITY |
|---|---|
| | |
| 1 | Aesthetics |
| 2 | Functionality |
| 3 | Infrastructure |
| 4 | Safety |
| 5 | Environmental |
| 6 | Workmanship |
| 7 | Operation and Maintenance |
| 8 | Economical |

## 3. DETERMINE THE IMPORTANCE RATING

In the Table 2, the importance rating is done on each and every demanded qualities, by the users. The information from the user and non-user are achieved through survey, which requires the user to identify the importance of each of the requirements. Based on given Likert scale from 1 to 5, as1= Not important; 2 = Quite important; 3 = Important; 4 = Very Important; 5 = Most Important.

***Table 2: Importance rating of Demanded qualities***

| S.NO. | DEMANDED QUALITY | IMPORTANCE RATING |
|---|---|---|
| 1 | Aesthetics | 3 |
| 2 | Functionality | 5 |
| 3 | Infrastructure | 5 |
| 4 | Safety | 5 |
| 5 | Environmental | 4 |
| 6 | Workmanship | 4 |
| 7 | Operation and Maintenance | 4 |
| 8 | Economical | 5 |

## 4. DEVELOPING TECHNICAL REQUIREMENTS

*This is all process of translating the user requirements into design parameters in a way to force the team to define, using measurable and actionable statements. These are collected through the inputs from experts on the subject. Various Research papers are referred on affordable housing construction and twenty-eight attributes are considered for QFD matrix and are listed under*

***Table 3: Technical Requirements (Hows) – HOQ***

| S.NO. | QUALITY CHARACTERISTICS (TECHNICAL REQUIREMENTS) |
|---|---|
| 1 | Response to local culture |
| 2 | Location |
| 3 | Accessibility |
| 4 | Efficiency of Space |
| 5 | Incrementalism, Adaptability and Flexibility |
| 6 | Daylight |
| 7 | Natural Ventilation |
| 8 | Green and Social spaces |
| 9 | Access to Infrastructure |
| 10 | Water supply |
| 11 | Sewerage and Sanitation |
| 12 | Electrical Services |
| 13 | Refuse disposal |
| 14 | Use of Conventional Material |
| 15 | Response to local climate |
| 16 | Site Planning |
| 17 | Embodied energy |
| 18 | Fire resistance |
| 19 | Structural detailing design against disasters |
| 20 | Specification of architectural finishes |
| 21 | Specification of M&E fixtures |
| 22 | Operational and Maintenance cost over life |
| 23 | Durability |
| 24 | Detailing of joints |
| 25 | Ease of fixing and maintaining services |
| 26 | Ease of modification and Replacement of parts |
| 27 | Affordability |
| 28 | Employment opportunities |

## 5. CORRELATING THE TECHNICAL REQUIREMENTS

The top of the house referred to as roof of the house is the correlation matrix. It is designed to show the correlation between one design parameter with the others and indicates the synergic impact changes in the technical attributes. These relationships are shown with the help of symbolslike:

O – Positive relationship,

- – Negative relationship,

⓪ - Strong Positive,

-- - Strong negative

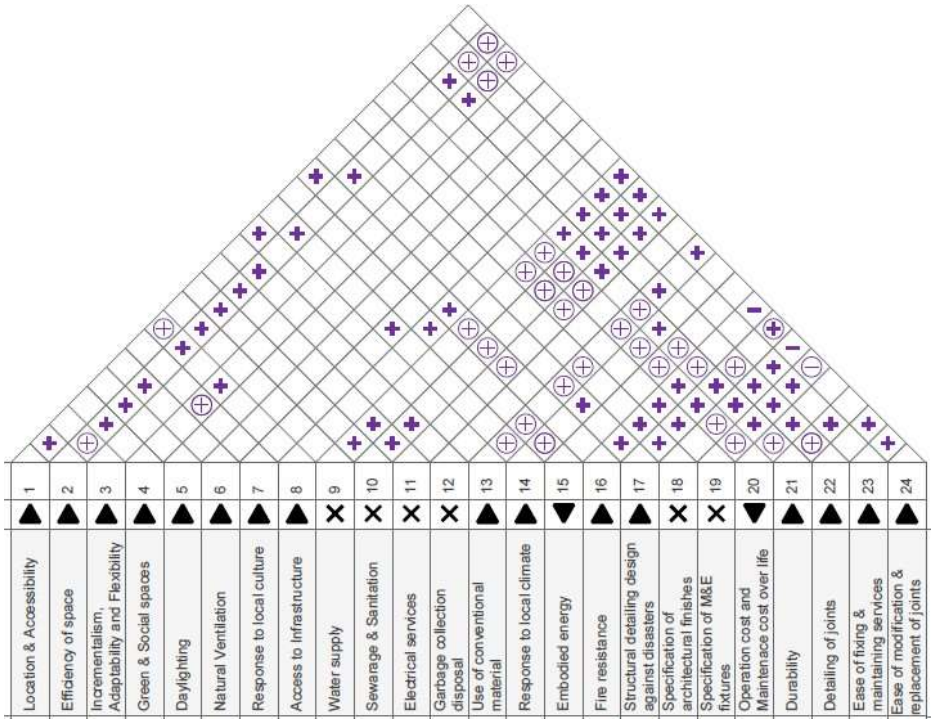



***Figure 2: Correlation matrix of Technical requirements***

## 6. DEVELOPING THE CORRELATION MATRIX BETWEEN THE USER NEEDS AND DESIGN REQUIREMENTS

The central body of the house knows as Relationship matrix provides a mechanism for analysis how each quality parameters will help achieving each of the requirements. These are achieved through discussions and deliberations with the concerned technical personnel. The relationship scale used is: 9– Strong, 3 – Average, 1- Weak, Blank – No Relationship.

Those relationships are depicted by the symbols like;Θ – Strong relationship

O - Moderate relationshipΔ – Weak relationship.

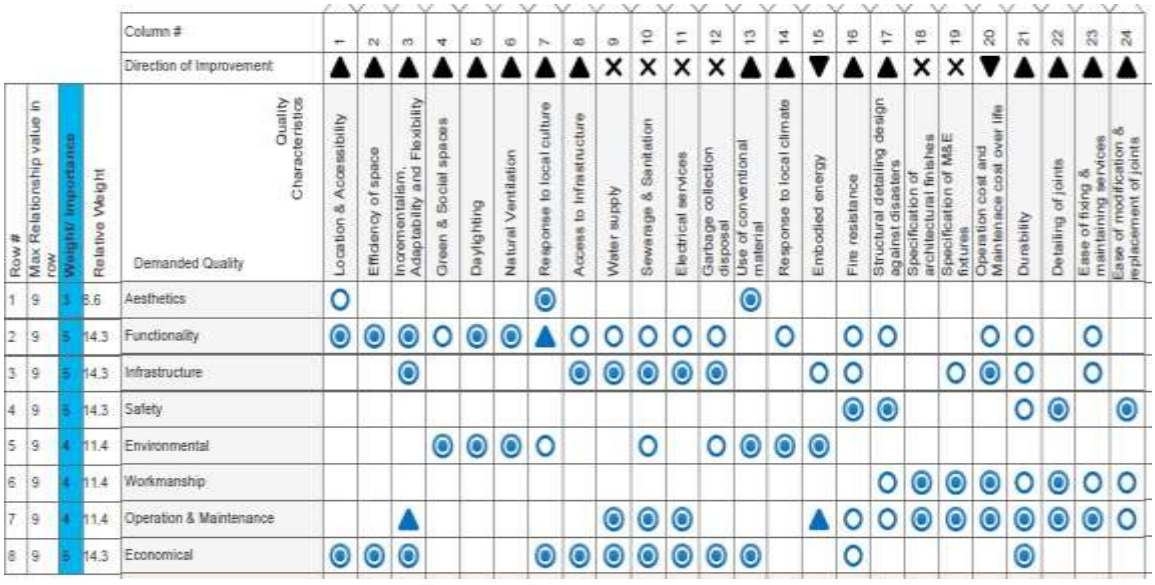



***Figure 3: Relationship matrix***

## 7. DEVELOPING TARGET FOR QUALITY PARAMETERS

Directly below the priorities, a row has been added to address the targets. The targets pertain to the technical attributes mentioned in each column. These targets add the necessary details to bringthe technical definition from the abstraction of words to the concrete reality of design.

Each quality characteristic is measured against well-established performance standards and targetvalues are assigned based on application of performance standards in their particular context.

The target values are assigned on the basis of NBC requirements and IS codes of different qualitycharacteristics.

## 8. QFD CORRELATION MATRIX

Based on the above steps, the QFD matrix (Figure 4) is developed and the importance weight and relative weight of Technical requirements is identified to prioritize/ benchmark the most importantrequirements and needs for the new design of affordable housing and helps to improve the qualityof design and construction of affordable housing.

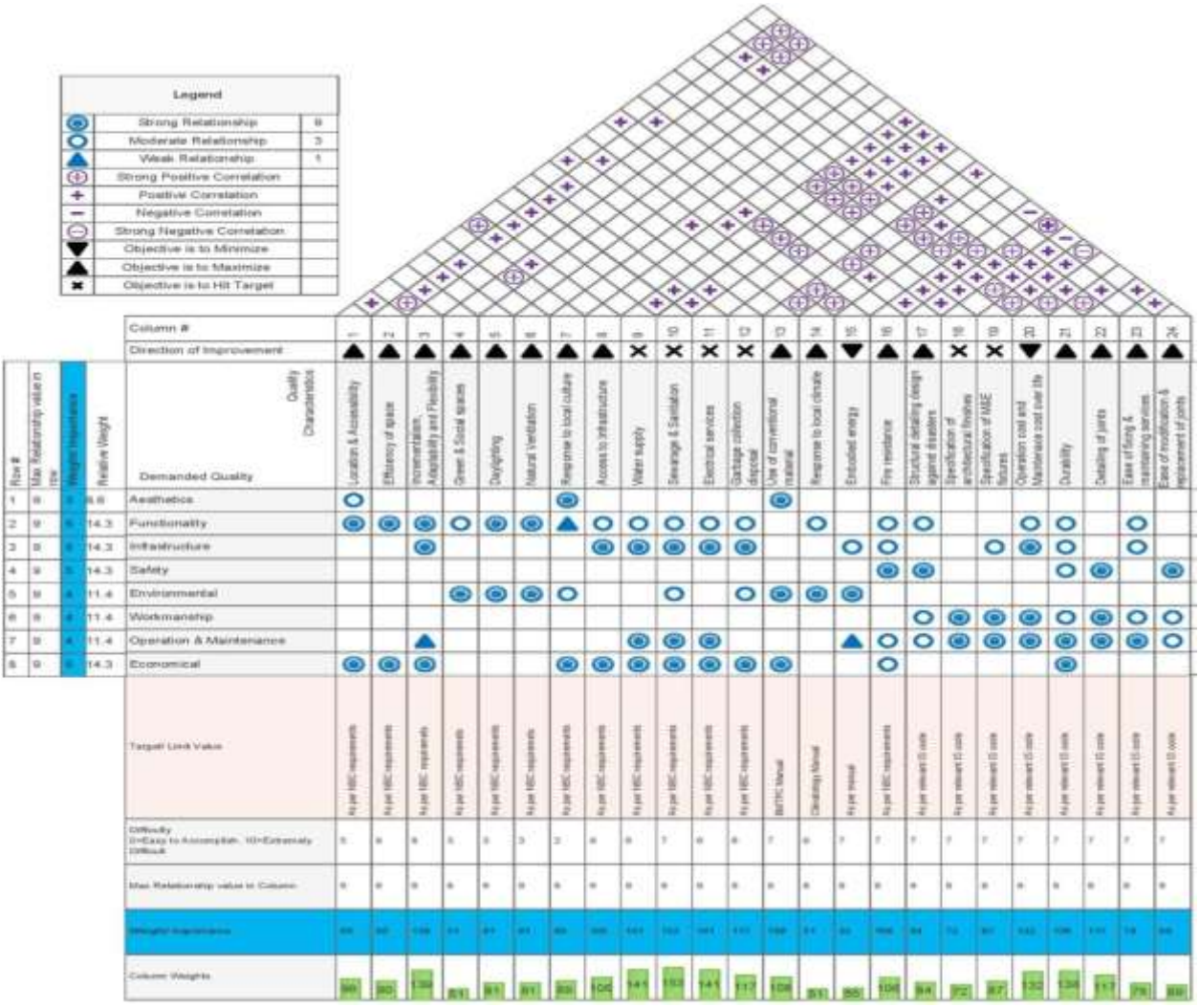



***Figure 4: QFD Matrix***

## 9. CASE STUDIES FOR COMPETITIVE ANALYSIS

To demonstrate the validation of Benchmarking quality framework developed three case studies are chosen, one surveying project and two competitor project to make the comparison matrix and analyze the priority ratings of quality parameters. The surveying project taken up for study which is a proposal for EWS housing in Sector G8, Narela, New Delhi and the competitor projects includean affordable housing pocket of in Sector 23B, Dwarka in New Delhi which consists of 2300 EWS houses and Kathputli Slum redevelopment Project, Shadipur, New Delhi.

After surveying the case study projects, rankings are done with performance matrix analysis by comparing the indicators with performance standards. Then the rankings are filled in the framework as shown in Figure 5

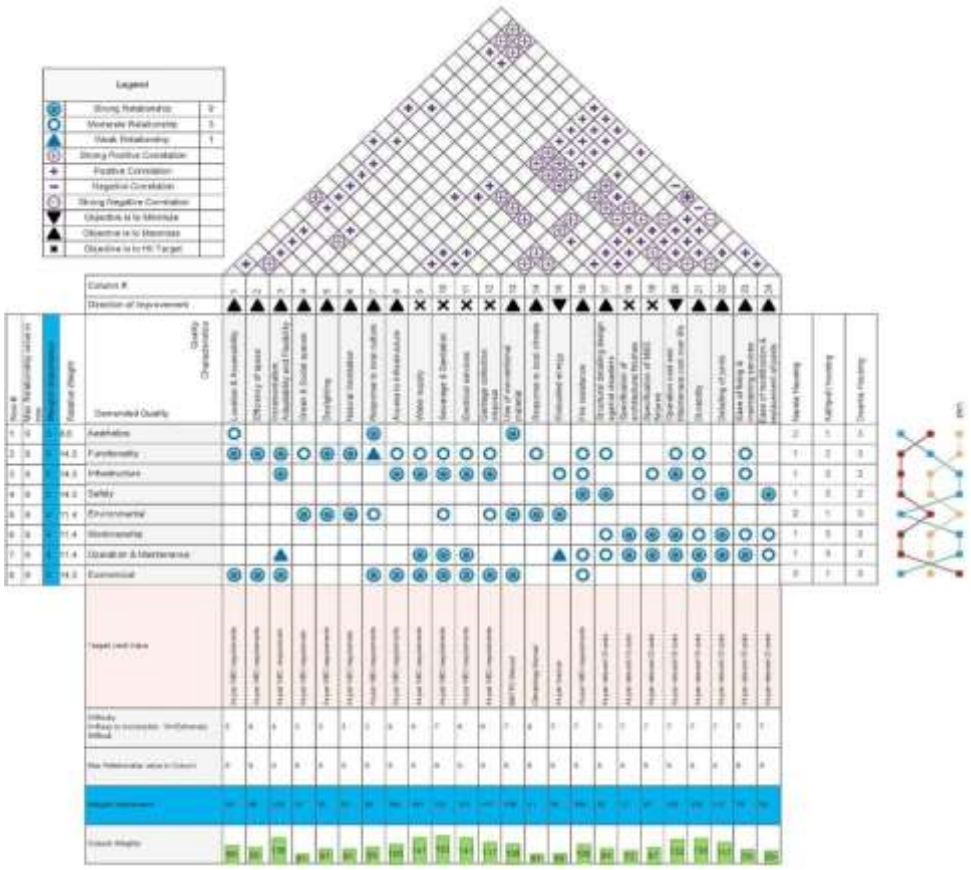


***Figure 5: HOQ Matrix with Validation of case studies***

**FINDINGS FROM THE QFD PROCESS**

In the quality chart developed for affordable housing Figure 4, the quality requirements have beenprioritized in relation to the assigned rate of importance. Quality indicator have been correlated to these requirements which gives the absolute degree of importance and relative degree of importance to every quality characteristic.

The weightage/ importance can help an organisation evaluate the quality of affordable housing according to the prioritization obtained from HOQ matrix. In the identified demanded qualities with various quality characteristics and their corresponding absolute weight and relative weight which are obtained in the process of benchmarking shown in Table 4.

***Table 4: Absolute weight and Relative weight***

| S.NO. | QUALITY CHARACTERISTICS | WEIGHTAGE/ IMPORTANCE | RELATIVE WEIGHT |
|---|---|---|---|
| 1 | Location & Accessibility | 99 | 4.15 |
| 2 | Efficiency of space | 90 | 3.78 |
| 3 | Incrementalism, Adaptibility & Flexibility | 139 | 5.83 |
| 4 | Green & Social spaces | 51 | 2.14 |
| 5 | Daylighting | 81 | 3.40 |
| 6 | Natural ventilation | 81 | 3.40 |
| 7 | Response to local culture | 89 | 3.73 |
| 8 | Access to infrastructure | 105 | 4.40 |
| 9 | Water supply | 141 | 5.91 |
| 10 | Sewarage & Sanitation | 153 | 6.42 |
| 11 | Electrical services | 141 | 5.91 |
| 12 | Garbage collection disposal | 117 | 4.91 |
| 13 | Use of conventional material | 108 | 4.53 |
| 14 | Response to local climate | 51 | 2.14 |
| 15 | Embodied energy | 55 | 2.31 |
| 16 | Fire resistance | 106 | 4.45 |
| 17 | Structural detailing design against disaster | 84 | 3.52 |
| 18 | Specification of architectural finishes | 72 | 3.02 |
| 19 | Specification of M & E fixtures | 87 | 3.65 |
| 20 | Operation cost & Maintenace cost overlife | 132 | 5.54 |
| 21 | Durability | 138 | 5.79 |
| 22 | Detailing of joints | 117 | 4.91 |
| 23 | Ease of fixing & maintaining services | 78 | 3.27 |
| 24 | Ease of modification & replacement of joints | 69 | 2.89 |

**Prioritization level**

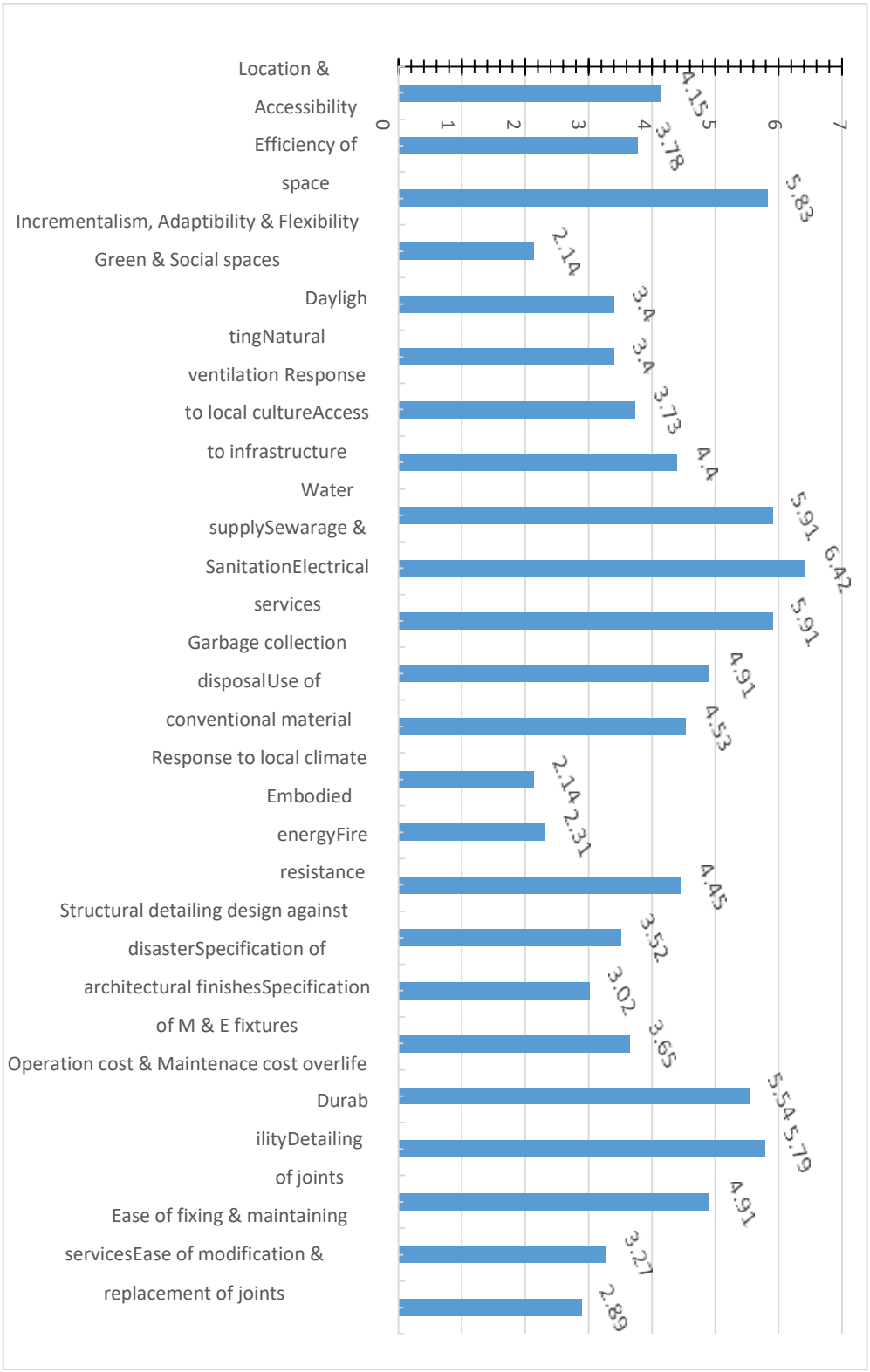



***Figure 6: Prioritization Level of Quality elements of affordable housing***

**The prioritization of quality elements of affordable housing is represented with the help of columnchart (Figure 6).**

## CONCLUSION

Affordable housing provision is marred with a series of problems that are linked both to the quantity and to the quality of the public affordable housing stock delivery. The current lack of quality in existing housing and the enormous need of new housing highlights the need of stringent quality management controls in the housing sector. In this study, the quality indicators which are identified through the process of study are as follows 1) Aesthetic 2) Functionality 3) Infrastructure 4) Safety 5) Environmental 6) Workmanship 7) Operation and Maintenance 8) Economical. Underwhich 28 subcomponent quality attributes are identified through various literatures which affect the design and construction quality of affordable housing. Each of the performance standard of quality attributes may vary by its specification to suit to different geographic, climatic and other exposure conditions.

In this study, an attempt has been made for the adaptation of QFD methodology as a benchmarking tool to improve the affordable housing sector. An implementation has been made in macro level to question the applicability of the methodology and to constitute a precedent for the mass house producer which might eventually like to use QFD as a benchmarking tool. It is important to understand that the developed matrix within the case study presents a system approach and a decision making/ planning tool which helps in value addition to the future affordable housing project by maintaining quality assurance of prioritized quality indicators. That is the reason why the producers need to concentrate on the methodology of the study instead of the content of this macro level house of quality matrix.

It is concluded that the construction of best and quality low cost housing system within a specifiedtime constraint starts with improvement of prioritized quality parameters obtained through benchmarking, selected by an objective driven methodology. This prioritization will be used as a guide to focus on what the consumer wants throughout the design process.

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