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# INDICATORS TO MEASURE DESIGN QUALITY OF BUILDINGS

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## ABSTRACT

Design quality is an important component in measuring satisfaction towards total product quality (TPQ) of buildings, the product of construction projects. Design Quality Indicator (DQI), developed by the Construction Industry Council (CIC) in the UK looking at three quality fields, i.e. functionality, build quality, and impact of building in measuring the quality of design embodied in the buildings through feedback and perceptions of all stakeholders involved in the production and use of buildings. Design quality is always a major concern in the Malaysian construction industry. With inspiration from this DQI, this study was carried out to identify indicators for measuring the satisfaction towards design quality of buildings and to evaluate the suitability of the indicators for application in the context of Malaysian construction industry. Through literature survey, 34 indicators of design quality were identified and grouped into the three design quality fields. A questionnaire survey was carried out among Malaysian construction professionals (architects, engineers, quantity surveyors, contractors and developers) to assess the identified design quality indicators in terms of their significance or relevance in the context of construction industry in Malaysia. The survey reveals that access, natural lighting, structure elements, landscape and location are among the design quality indicators that were perceived as the most important to be looked at. In overall, all the indicators are relevance for adoption in the Malaysian construction industry to measure the satisfaction towards design quality of buildings.

*Keywords: Design quality indicators, Satisfaction measurement, Stakeholders' perception, Malaysian construction industry,*

## INTRODUCTION

Quality is one of the triple constraints or forces for every construction project besides the other two parameters i.e. time and cost. Adopting the definitions by Webster, Oxford and Cambridge dictionaries, quality can be defined as any character or characteristics that determine whether an object good or bad after measuring the character or characteristics against a standard. The standard refers to specification of the object to be designed [1]. Buildings are design object, the product of the design. The actual result related to the design quality of the building will be only known after several years of building is occupied [2]. During the occupancy stage, measurement and feedback such post-occupancy evaluation (POE) can be carried out to acquire the relevant data to determine the level of design quality in satisfying the needs and requirements of building client/customer/occupants. This approach also can be categorized under satisfaction measurement (SM) which is used to measure the level of project performance [3]. Satisfaction is a measure of the difference between actual and expected performance of a product or service to meet the needs and requirements of users and current perspective [4]. Satisfaction is a sense of excitement or disappointment after comparing the effects or results received with the expected [5]. Design quality will determine the suitability of buildings and the quality of compliance that shows how the building in accordance with the specifications required by the design [6]. The quality of the design can produce more efficient intermediation services and will improve the work environment for all those who use it [7].

Over the past decades, measuring and valuing the quality of design draws the attention clients, designers, and other construction practitioners as well as many researchers [8] and [9]. Design quality is always a major concern in the Malaysian construction industry. Construction Industry Development Board (CIDB) Malaysia, a government agency and an important player in Malaysian construction industry emphasizes the issues of quality in Construction Industry Master Plan (CIMP) 2006-2015 under Strategic Thrust 3; strive for the highest standard of quality, occupational safety and health, and environmental practices [10] Despite this emphasize from the CIDB, the Malaysian construction industry still suffers with many quality-related problems [11], such as quality below expectation [12], low quality finishes on buildings [13], and there is no benchmark to measure the standard of quality of houses constructed by developers [14]. It is apparent that

appropriate mechanism should take place in Malaysian construction industry to resolve quality-related issues especially on design quality.

Design Quality Indicator (DQI), developed by the Construction Industry Council (CIC) in the UK has successfully used in the UK's construction industry since it was launched in 2002. 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) [15]. The indicators and evaluation approach can be adopted in Malaysian construction industry with some modification. Therefore, with inspiration from this DQI, the objectives of this paper are to identify indicators to measure satisfaction towards design quality of buildings and to assess the suitability of the indicators in the context of the construction industry in Malaysia.

## INDICATORS OF DESIGN QUALITY

### Design Quality Indicators (DQI) of UK

The DQI was developed to measure the quality of design embodied in the product, the buildings themselves through feedback and perceptions of individuals who have interest or connection with the product [16]. It is applicable for new or refurbished buildings. It is in the form of a questionnaire which contains a set of statements that collect the views or perceptions of all stakeholders by looking at three quality indicators, i.e. Functionality, build quality, and impact of buildings [17].

The functionality of buildings is emphasized on the arrangement, quality and inter-relationship of spaces, and how the building is designed to be useful. It looks into three following aspects:

a. Use - how well the building caters for the functions it may accommodate originally and in the future.
b. Size - the size and interrelationship of the building's, rooms or component spaces.
c. Access - how easy it is for all people to get to, and around the building.

The built quality of buildings is evaluated on how well the building is constructed: its structure, fabric, finishes and fittings, its engineering systems, and the coordination of all these and how well they perform. The evaluation is on the following aspects:

a. Performance - the building's mechanical, environmental and safety systems.
b. Engineering - the quality of the building's components.
c. Construction - how well the building is put together.

The impact of buildings highlights building's ability to delight, to intrigue, to create a sense of place, and uplift the local community and environment, and also the design's contribution to the arts and science of building and architecture. The evaluation includes the following items:

a. Character and innovation - what people think of the overall building?
b. Form and materials - the building's physical composition, scale and configuration within its boundaries.
c. Internal environment - the quality inside the building's envelope.
d. Urban and social integration - the relationship, of the building with its surroundings.

### Indicators of Design Quality from Previous Studies

Thirty-four (34) indicators that relevant for measuring design quality from previous studies (from year 1996 to 2014) were identified and tabulated in Table 1. The thirty-four indicators are regrouped into the three quality fields as listed and explained in Table 2, 3 and 4.

## METHODOLOGY

### Questionnaire Development and Sampling Frame

Quantitative approach using questionnaire surveys has been used to collect data. The purpose of the questionnaire survey was intended for feedback on the suitability or significance of the design quality indicators which are grouped under three categories i.e. functionality, build quality and impact in the context of Malaysian construction industry. A pilot test was conducted before distributing the questionnaire to respondents for actual survey. Questionnaires were distributed to 70 established construction companies in Malaysia to elicit feedback from 300 samples. This phase involves postal surveys via ordinary mail.

### Data Analysis

A five-point Likert-scale with options ranging from "1 = Not Significant" to "5 = Very Significant" has been adopted to elicit feedback on the indicators. In order to determine the level of significance of the indicators, average index (AI) analysis was carried out. The interpretation of the AI value (adopted and modified based on [18] is shown in Table 5.

## RESULT AND DISCUSSION

### Background of Respondents

Eighty-eight (88) respondents completed and returned the questionnaires; make up the valid response rate at 29%. This is close to the 25-30% normal response rate for construction research that

was suggested by [19]. Most of the respondents are engineers (33%), contractors (23%) and developer (17%). The remaining respondents are quantity surveyors (11%), architect (3%) and other construction project personnel such as project manager and landscape architect (13%). The majority (64%) of the respondents have bachelor degree. 23% of respondents have diploma degree. Respondents with higher degree level (master and PhD) accounted for 11%, and the remaining 2 % have qualification below diploma level. For their working experience, most of the respondents (52%) have worked in the construction industry less than 6 years.

Table 1 Indicators for measuring design quality of buildings

| Items | [20] | [21] | [22] | [16] | [23] | [24] | [25] | [7] | [26] | [27] | [28] | [29] | [30] | [31] | [32] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Layout | √ | √ | | | | √ | | | | | | | | | |
| Design | √ | √ | √ | √ | √ | | √ | | √ | √ | | √ | √ | √ | √ |
| Access | | | √ | √ | √ | √ | √ | | | √ | √ | √ | | √ | |
| Space | | | √ | √ | √ | | √ | | | √ | √ | √ | | √ | √ |
| Lighting | | | | | | √ | | | √ | √ | √ | √ | | | |
| Open space | | | | | | √ | | | | | | | | | |
| Service | | | | | | √ | | | | | | | | | |
| Natural Lighting | | | | | | | | | √ | | | | | | |
| Natural ventilation | | | | | | | | | √ | | | | | | |
| Use | | | √ | √ | √ | | √ | | | | | | | √ | |
| Engineering system | | | √ | √ | √ | √ | √ | | | | | | | √ | |
| Landscape | | | | | | √ | | | √ | | | | √ | | |
| Security system | | | | | | | | | | √ | | √ | | | |
| Energy | | | | | | √ | | | | | | | | | |
| Green energy and sustainability | | | | | | √ | | | | | | | | | |
| Finishes | | | | | | | | | √ | √ | √ | √ | | | √ |
| Structure element | | √ | | | | | | | | | | | √ | | |
| Road width | | | | | | | | | | | | | √ | | |
| Infrastructure | | | | | | | | | | | | | √ | | |
| Building stability | | √ | | | | | | | | | | | | | |
| Pedestrian walkway | | | | | | | | | | | | | √ | | |
| Building maintenance | √ | √ | | | | | | | | | √ | | | √ | |
| Colour | | | | | | | | | √ | √ | √ | √ | | | |
| Building stability | | √ | | | | | | | | | | | | | |
| Pedestrian walkway | | | | | | | | | | | | | √ | | |
| Building maintenance | √ | √ | | | | | | | | | √ | | | | |
| Colour | | | | | | | | | √ | √ | √ | √ | | | |
| Form and materials | √ | √ | √ | √ | √ | | √ | | √ | √ | | √ | √ | | |
| Comfort | | | | | | | | | √ | √ | √ | | | | |
| Internal environment | | √ | √ | √ | √ | | √ | | √ | | √ | | | | |
| External environment | | | | | | | | | | | | | | | √ |
| Character and innovation | | | √ | √ | √ | | √ | | | | | | | | |
| Urban and social integration | | | √ | √ | √ | | √ | | | | | | | | |
| Location | | √ | | | | √ | | | | | | | | | |
| Visual Effect | | | | | | √ | | | | | √ | | | | |
| Security | | √ | | | | | | | √ | | | | | | |
| Natural disaster | | | | | | | | | √ | | | | | | |
| Noise | | | | | | | | | | | | √ | | | |

Table 2 Functionality aspect and quality indicators

| Indicators | Descriptions |
|---|---|
| Layout | The building layout is easily understood by its users to find their way round the building |
| Design | The design of building is attractive |
| Access | The building provides good and safe access for everyone (users and visitors including those with disabilities) |
| Space | The spaces in building are the right size for their functions |
| Lighting | The lighting is efficient and allows for different user requirements |
| Service | The building provides essential services to the user |
| Natural lighting | Position of windows and doors are suitable for natural lighting |
| Natural ventilation | Position of windows and doors are suitable for natural ventilation |

Table 3 Build quality aspect and quality indicators

| Indicators | Descriptions |
|---|---|
| Use | The building easily accommodates the users' needs |
| Engineering system | Mechanical and electrical systems in building functioning properly |
| Landscape | Building landscape is attractive |
| Security system | Security system of the building is function properly |
| Energy | The building is efficient in its use of energy |
| Green energy & sustainability | Building using green energy sources and sustainability system |
| Finishing | Finishes of the building is attractive |
| Structure element | The building's structure is efficient |
| Road width | The road width of the building is suitable |
| Infrastructure | Building infrastructure is sufficient |
| Stability | Building is stable from natural elements e.g. wind, rain and earthquake |
| Pedestrian walkway | Building walkway is suitable and pedestrian- friendly |
| Building maintenance | Building is maintained properly |

The involvements of these respondents were reasonably balanced by those who have worked for more than 6 years up to 20 years or more (48%). This provides a substantially reliable data for this study as their feedbacks represent the perspective of the key construction players in Malaysian construction industry.

Table 4 Impact aspect and quality indicators

| Indicators | Descriptions |
|---|---|
| Colour | Building colour is suitable for the building |
| Form & Material | The building has the shape and materials in accordance with the functions |
| Comfort | Buildings provide comfort to the user |
| Internal environment | Atmosphere in building, relation between light and space and working climate at workplaces provide comfort |
| External environment | External surrounding is good quality for users |
| Character & innovation | The impact of buildings on the character, thinking and human appearance |
| Urban & integration social | Interaction with private and public areas and the impact of buildings on the city and community |
| Location | Positioning of the building in good location |
| Visual effect | The scene of the building is attractive |
| Security | The building provides a sense of security |
| Natural disaster | Location of buildings survived from natural disaster like floods or others |
| Noise | Surrounding noise of the building is not intrusive and affect human health |

Table 5 Average index (AI) range value and interpretation

| AI range value | Interpretation |
|---|---|
| $4.50 \leq$ AI < 5.00 | Very Significant |
| $3.50 \leq$ AI < 4.50 | Significant |
| $2.50 \leq$ AI < 3.50 | Moderately Significant |
| $1.50 \leq$ AI < 2.50 | Less Significant |
| $1.00 \leq$ AI < 1.50 | Not Significant |

**Perception on Indicators of Design Quality**

As shown in Fig. 1, 2 and 3, the AI value of all the indicators under functionality, build quality and impact aspects are within the range of $3.50 <$ AI $< 4.50$, suggesting that all the indicators are significant to be considered in evaluating the design quality of buildings in Malaysia. Under functionality aspect, natural lighting and access scored the highest AI values. This finding indicates that buildings in Malaysia should be designed to efficiently utilise the

natural lighting to light up the indoor considering Malaysia is a tropical country with abundance of natural-light. A building with good access to its users especially users with disabilities is perceived as a significant indicator to measure design quality. In Malaysia, there is a growing awareness, efforts and commitment of key building stakeholders to improve the accessibility of buildings especially for users with disabilities.

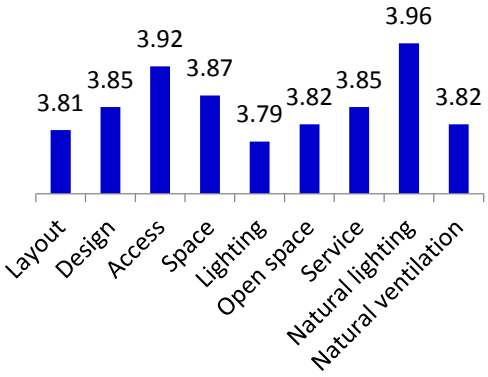


Fig. 1 Average index of indicators - functionality

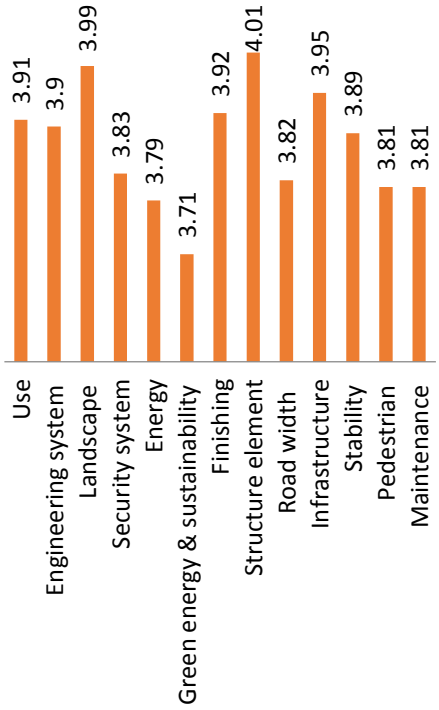


Fig. 2 Average index of indicators - build quality

Structure element of buildings such as beams, columns and floors which are efficient is considered as significant build quality indicators with the highest AI value (4.01). The efficiency of the structure elements can accommodate challenging and creative architectural designs and will lead to buildings that are of high build quality. Landscape scored the second highest AI value. Building landscape should be designed not only to be attractive but at the same time it can strengthen the identity and character of the building.

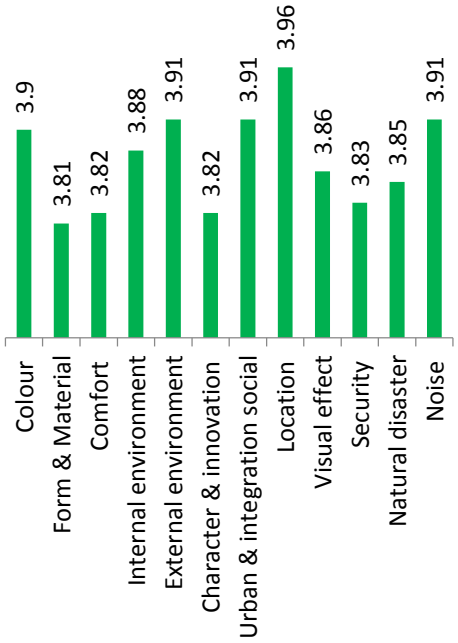


Fig. 3 Average index of indicators – impact

Among the impact indicators, location scored the highest AI value. Positioning of building in appropriate location or local environment will help the building to create a sense of place. The other three impact indicators i.e. external environment, urban and social integration and noise scored same 3.91 AI value.

## CONCLUSION

Indicators to measure design quality that has been adopted in the DQI of the UK can be adopted in Malaysian construction industry with some modification. This study was carried out to identify indicators to measure satisfaction towards design quality of buildings and to assess the suitability of the indicators in the context of the construction industry in Malaysia. The survey revealed that all the indicators are significant in measuring the design quality of buildings in the context of construction industry in Malaysia. The identified design quality indicators are likely to be useful to all building stakeholders especially owner, user, contractor and designer who have direct participation in producing or utilising the building. The work is also expected to support the existing green building assessment system particularly on eliciting stakeholders' perception on the actual design quality of buildings.

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