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EXPLORING QUALITY DIMENSIONS FROM A CONSTRUCTION PERSPECTIVE: A LITERATURE REVIEW

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Graphical abstract

Abstract

The quality of products and services is fundamental to organizational performance and reputation. A construction project entails meeting the specification criteria and standards of quality, finishing the task on time, and within the specified budget. Construction projects have different quality dimensions, and each can be measured from a different perspective. An exploratory research approach was used to explore the eight quality dimensions within the construction industry's perspective by exploring the quality issues within the Malaysian construction industry. The findings indicate that a related quality dimension is conformance or the degree to which a product's design and operating characteristics meet established standards. Thus, the study's significant contribution is the exploration of the eight quality dimensions from the construction industry's perspective. Thus, it is essential to ensure that the project meets the users' needs, and the best way to do this is to involve the users in the quality planning process. This will help ensure the project is designed and built to meet their needs and expectations. In conclusion, considering all the quality dimensions when planning and executing a construction project is essential, and by prioritizing these quality dimensions, we can ensure that the buildings are built with quality.

Keywords: Construction, Quality, Dimensions, Perspective, Quality Issues

Abstrak

Kualiti produk dan perkhidmatan adalah asas kepada prestasi dan reputasi organisasi. Projek pembinaan memerlukan memenuhi kriteria spesifikasi dan standard kualiti, menyelesaikan tugas tepat pada masanya, dan dalam anggaran yang ditetapkan. Terdapat banyak dimensi kualiti yang berbeza dalam projek pembinaan, dan setiap satu boleh diukur dalam perspektif yang berbeza. Pendekatan penyelidikan penerokaan digunakan untuk meneroka lapan dimensi kualiti dalam perspektif industri pembinaan dengan meneroka isu kualiti dalam industri pembinaan Malaysia. Penemuan menunjukkan bahawa dimensi kualiti yang berkaitan ialah pematuhan atau tahap di mana reka bentuk dan ciri operasi produk memenuhi piawaian yang ditetapkan. Justeru, sumbangan penting kajian ialah penerokaan lapan dimensi kualiti dari perspektif industri pembinaan. Adalah penting untuk memastikan projek itu memenuhi keperluan pengguna. Cara terbaik untuk melakukan ini adalah dengan melibatkan pengguna dalam proses perancangan kualiti. Ini akan membantu untuk memastikan bahawa projek itu direka bentuk dan dibina untuk memenuhi keperluan dan jangkaan mereka. Kesimpulannya, pertimbangan semua dimensi kualiti semasa merancang dan melaksanakan projek pembinaan adalah penting dan dengan mengutamakan dimensi kualiti ini, kami dapat memastikan

bangunan dibina dengan kualiti.

Kata kunci: Pembinaan, Kualiti, Dimensi, Perspektif, Isu Kualiti

1.0 INTRODUCTION

The quality of construction projects has been debated for many years. Some argue that quality should be measured by the final product, while others believe quality should be measured throughout the project lifecycle. There is no right or wrong answer, but many factors must be considered when measuring quality in construction projects.

One of the major problems in the construction industry is poor quality. The construction industry globally generally contributes about 10% to the gross domestic product (GDP) and employs more than 10% of the workforce in many economies [1]. In Malaysia, the construction industry is one of the most vital and contributing sectors to the nation's economy [2]. However, Malaysia's economy has witnessed an accelerated growth of 4.7% in the fourth quarter of 2018, with the construction industry being one of the main contributors [3]. But unfortunately, the construction industry currently accounts for 2.6% of contributions to the GDP [3], compared to 4.7% in 2007 [4].

A country must have a vibrant construction industry to experience long-term growth and considerable development. However, quality in the industry remains elusive due to the late completion of projects, cost overruns, and poor quality [5], [6]. In particular, the quality of workmanship in buildings is poor compared to other industries. As a result, errors in building sites are common and can be costly for contractors and clients [7]. Likewise, most defects in building projects are attributable to human error; in other words, we can say that human errors are attributable to a lack of skills, mainly at the construction stage[8].

According to the Building Research Establishment (BRE) research, 90% of building failures are due to problems arising in the design and construction stages [8]. However, the nature of these problems varies greatly. For example, 20-40% of all building problems are caused by construction mistakes [7], while 54% are caused by human factors such as unskilled labourers or poor construction supervision. Likewise, material and quality management failures account for 12% of building problems [7].

A variety of factors can cause poor workmanship in new buildings. The reasons have been characterized variably, with the majority concerning design and construction concerns [9–11]. Many research discovered that design-related variables were the primary contributors to poor quality. Nevertheless, given that the construction stage accounts for more than 90% of project costs and time, building projects' actions may significantly influence building quality [1].

The quality of products and services is fundamental to organizational performance. Therefore, the company should emphasize the importance of quality in all its management and operational activities [12]. The fundamental unifying aspect of any quality plan is the focus on continuous improvement through constructive enhancements that match the client's expectation of quality [13]. A company's desire to satisfy clients' perceived quality of products and services is increasingly challenging. However, products and resources can be efficiently and effectively managed through quality improvement, resulting in quicker, cheaper, and more quality workmanship [14].

Quality challenges vary from company to company, and companies tend to resolve their quality problems differently. Construction quality and success entails finishing the task on time, according to the quality specifications, and staying within the specified budget [15]. Quality standards, management commitment, coordination, planning, design, and relationships among building stakeholders are critical factors that play a vital role in addressing quality concerns [12]. Therefore, there is a need to assess each quality concern based on the eight dimensions of quality to ascertain the peculiar nature of the problems.

2.0 METHODOLOGY

An exploratory research method was adopted based on existing literature using inductive reasoning associated with the interpretivism philosophy. Exploratory research includes techniques, such as secondary research - such as reviewing available literature and data. Exploratory research gathers preliminary information to help define problems and suggest hypotheses. Exploratory research allows researchers to search for new insights, raise questions, and test phenomena in a new light, such as this, by expressing their interpretation of a problem from a different perspective [16]. The critical characteristic

of an exploratory study is the use of theories, which are selected and then strained through analysis and interpretation.

Furthermore, it is considered the most suitable approach for this research because it addresses quality issues from the construction industry's perspective. The eight quality dimensions were then explored from the construction industry's perspective based on quality issues within the Malaysian construction industry. The dimensions were further analyzed using narrative description and interpretation of the quality dimensions in the construction industry's context. There was no existing research exploring the quality dimensions within the construction industry's perspective at the time of this study. As a result, this study will act as a context study [16] that will benefit all construction industry stakeholders, from the production manager to the construction engineer. The research topic explores the current quality dimension from the construction perspective, focusing on Malaysia.

3.0 RESULTS AND DISCUSSION

Definition of Quality

Quality is a broad term that is difficult to describe. There is no one definition of quality that is universal. Quality is the degree to which a product or service meets or exceeds the customer's expectations. For example, in the construction industry, quality can be defined as the degree to which a building or infrastructure meets its design and performance requirements. The quality of construction is essential for ensuring safety, durability, and efficiency. The three most influential quality management gurus define quality in the following ways; Juran defined it as "fitness to use"[17, 18], while Deming defined it as "the predictable degree of uniformity and reliability at low cost and appropriate for use [19]" and Crosby defined it as "Compliance with requirements [20]." Other quality experts' defined it based on their distinct views as the "fitness for use, doing it right the first time, clients need to adhere to specified standards, recognize the value for money, doing it right at the right time, and so on [21–23]." Garvin [24] categorizes quality definitions into five categories to solve the range of quality definitions: transcendental, product-based, user-based, manufacturing-based, and value-based.

More broadly, quality is defined as the greatness of a product or service in meeting or exceeding customers' expectations [25]. These expectations are primarily determined by the product's or service's intended usage and price. A product or service is considered high quality when it meets or exceeds expectations. As a result, the concept is primarily intangible and perception-based.

Yap [26] expresses the quality equation as:

$$Q = P/E \quad (1)$$

Where Q = quality
P = Price
E = Expectations

"If Q is greater than 1.0, then the customer feels good about the product or service quality. However, of course, P and E are based on perception, with the organization determining the price and the customer determining the expectations [26]."

Eight Dimensions of Quality

Understanding the critical factors or dimensions of quality from the construction perspective is essential for improving construction quality. This study's primary objective is to explore quality dimensions from the construction perspective. Therefore, it is necessary to ascertain the perception dimension of quality in a construction context. Additionally, Garvin established eight quality dimensions for products and services. The eight quality dimensions are listed in Table 1 and their associated definitions and explanations [27].

Since these dimensions are partly independent, a product can be good in one dimension and medium or bad in another. Very few items can be said to satisfy all the eight dimensions. For instance, in the 1970s, the Japanese were recognized for their high-quality automobiles only based on their reliability, conformance, and aesthetics. As a result, some quality dimensions could be used to judge whether or not a product or service is of high quality. Hence, it is necessary to determine the relative value of each quality dimension in construction work. The identified dimensions can then be used to define the requirements for improving the quality of construction projects. The summary and definitions of the eight quality dimensions proposed by Garvin are given in Table 1 below.

Table 1 Eight Dimensions of Quality

No.	*Dimensions*	*Definitions*
1.	Performance	A product's primary operational characteristics.
2.	Features	Additional features of a product.
3.	Reliability	The probability that a product will fail within a specific period.
4.	Conformance	The extent to which a product's design adheres to set standards, i.e., workmanship.
5.	Durability	Product's useful life.
6.	Serviceability	After-sale service for the product, like the ease of repair.
7.	Aesthetics	The product's appearance and characteristics, such as exterior finishing.
8.	Perceived Quality	Indirect assessment of product quality.

A. Performance

This dimension primarily concerns the question, "Does the construction work satisfy the client-specified performance standards; does it meet the aesthetic quality specified in the 3D model?" Performance is frequently cited as a concern between workers and clients, especially when project quality is not explicitly and expressly stated within the quality standards [25]. Even though this quality dimension contains quantitative features, companies typically rate performance objectively and based on specific performance elements [24, 28].

B. Features

This aspect pertains to the characteristics that make a building function as designed. Garvin [24] asserts that "features are the bells and whistles of high-quality service, the qualities that augment their fundamental functionality." As a result, companies must describe the performance characteristics and features explicitly and the intended processes to achieve high quality in implementing their projects [25]. Furthermore, for many clients, better quality is less about the availability of specific features and more about the overall aesthetic appearance of the building [25, 29].

C. Reliability

Reliability is inextricably linked to performance and is a significant driver of a company's image and organizational reputation. The underlying question remains, "Will companies continue to meet standard quality specifications? "This dimension represents the likelihood of a product or service failure or degradation of the technology over a specific period. The mean time to the first failure, the time between failures, and the failure rate per unit time are among the most frequently used dependability metrics [24]." Additionally, clients want reliability more as mechanical problems and management costs increase.

D. Conformance

Garvin [24] defines quality conformance as the degree to which a product's design and operating characteristics meet established standards." The central question under this dimension is, "Does the construction work conform to the design specifications in the 3D model?" When the workmanship quality meets the specified performance specifications, it is said to have conformed with the quality standards set in the design model [25].

E. Durability

Garvin [24] defined durability as "the lifespan of a product," which has economic and technological implications. Durability is a technical word that measures the duration of use that a thing may withstand before deteriorating. Clients often evaluate the anticipated operating and maintenance costs against the initial investment cost in economic terms and personal discomfort [24]. Thus, this dimension covers the critical question of how long the building can withstand the adverse effect of weather and other environmental hazards. As a result, it is intertwined with the principle of contractual terms. More significantly, clients frequently incorporate quality durability criteria in procurement contracts. Garvin [24] states that "the durability dimension has two direct implications. Firstly, it implies that "durability and reliability" are inextricably related. Second, it implies that details relating to durability must be evaluated critically through new technological tools like BIM. The quality of workmanship can be improved by using more quality materials. Hence, new technologies capable of improving quality need to be adopted throughout the construction process [30].

F. Serviceability

This dimension is concerned with the serviceability and maintainability of the building. According to Garvin [24] and Kenyon [28], "Clients are worried not just about the issues of rework, defects, but also about the quality of workmanship, the regularity of future maintenance work and other quality issues. The quality of construction projects significantly impacts the economy, the environment, and the public's safety.

G. Aesthetics

This dimension, which refers to the final appearance of the building, is centered on the viewer's opinion of whether the building is precisely the same as in the 3D model and pertains to the structure's construction precision [30]. Additionally, it is concerned with the aesthetic qualities of the building and its relationship to the company's overall corporate image and quality adherence reputation. Thus, this is one of the primary focuses of this research. Clients here are more concerned with the extent to which the physical aesthetics conforms to the 3D model and the overall appearance of the building.

Garvin [24] asserts that the "aesthetic appearance of a building is subjective, but with the advent of new technologies, it is possible to easily measure or identify the quality problems. Additionally, Pereira [30] mentioned that "quality issues that impair the aesthetic characteristics of a building do not necessarily mean altering the quality dimensions or lack of conformance to a quality specification, but the aesthetic appearance that significantly affects the building design, which leads to rejection [27].

H. Perceived Quality

Perceived service quality evaluation is done at the end of the project to rate the client's satisfaction. The

perceived quality is obtained from customer satisfaction feedback based on the quality inspector's evaluation after completing the project [31]. Garvin [24] succinctly summarizes the link between reputation and perceived quality when he states, "Reputation is the primary stuff of perceived quality." More precisely, reputation relates to how the quality of service is perceived. Its strength stems from an implicit "analogy: that the quality of products today was similar to yesterday's products, or the quality of goods in a new product line is similar to the quality of a company's established products [27]. " Thus, the basic premise remains that perception is reality. Using high-quality materials in construction work is not just the element that impacts the overall quality reputation of the construction project. Because a project may be labelled low-quality due to poor workmanship or poor construction service even though the materials used are qualitative. If the building is not correctly constructed and fails to meet the aesthetic appearance, the failure is frequently attributed to service quality rather than material quality [32].

Therefore, quality should be embedded in the construction process, decision-making, design, maintenance, and operation [33]. Construction experts should prioritize quality as their topmost priority in the project's execution to maintain their competitive edge over other industries. Jong *et al*. [34] suggest that construction work's quality should be the suppliers' and consultants' primary attitude and focus. However, the good's standard is negatively affected if the stakeholders are not committed to quality standards. Then, quality culture becomes more challenging to execute [35]. It is essential to have strong collaborative team players to meet the project's desired goal. Continuous improvement in all aspects of the project can lead to a high-quality culture.

The construction sector can compete with other industries worldwide where quality is still in high demand [36]. Additionally, applying the quality culture concept on site is a significant problem in the construction industry because construction projects are unique regarding the project location, design, workers, materials, cost, and time. Project quality is influenced by quality standards, materials, quality of workmanship, and future maintenance costs [37]. The structure's safety depends on the construction quality and stakeholders' satisfaction. The quality establishment is the target of every construction company to maintain its fame and recognition among its competitors. The truth is that most companies are still left behind in understanding the true potential of adhering to quality standards. Quality is critical for organizational efficiency, performance improvement, client satisfaction, and business success [38].

In Malaysia, the quality challenge is mainly on on-site and off-site workers. However, it also includes; the whole construction process, management process, team players, suppliers, training and education, and policies [39]. The primary challenge in developing a quality model include contractors' roles in the construction process, resource optimization to achieve the intended outcome, meeting design standards, and fully implementing a structured quality framework [40, 41]. Additionally, other factors to consider in ascertaining the perceived quality of goods and services are; Clarity and applicability of design, compliance with quality specifications, construction environment, energy efficiency, and ease of operation and maintenance. Other quality activities in the construction environment include; management commitment, suppliers' relationships, information analysis, and human resource management [42]. The quality of construction work is affected by three key factors: lack of management commitment and adherence to standard specifications and training policies [43].

Nevertheless, several benefits have been identified by attributing quality issues to a specific dimension in the construction industry. They are; continuous quality improvement, client satisfaction, the company's image and reputation, enhancement of its growth and efficiency, and documentation establishment [44]. Many tools and techniques can be used to measure quality in construction projects. Some standard tools include quality audits, inspections, and surveys. Quality audits are conducted by independent third parties to assess the quality of the project. The project team conducts inspections to identify potential problems. Finally, surveys are conducted for the project users to assess their satisfaction. Garvin proposes eight critical dimensions or categories of quality that can serve as a framework for strategic analysis, as illustrated in Figure 1 below.

Figure 1 8 Dimensions of Quality

Problems of Quality in the Malaysian Construction Industry

The construction industry is responsible for building and shaping our world. The industry significantly impacts our daily lives, from towering skyscrapers to intricate bridges. However, with such an enormous responsibility comes the need for quality construction. The dimension of quality is an aspect that is not often explored in the construction industry. Therefore, this article will explore the quality dimension from a construction perspective. Quality has recently been a significant concern and has gained much attention. The importance of quality in construction has equal importance as in other industries [45].

On the other hand, the construction industry faces discontinuous, uncoordinated, complicated, and different construction operations compared to other sectors [45]. The project's quality level represents the technology used in its execution and is key to its success [46, 47]. The above gave us some insight into some of the quality issues being faced by the construction industry. In another effort to address quality in construction work, the Malaysian government also mandated using a Quality Management System (QMS) [48]. QMS, as defined by the International Organization for Standardization (ISO), "is the management system used to direct and control an organization regarding quality [49]" QMS models are being used effectively by different industries, in particular the manufacturing industry, because of the wide range of models it contains, such as Total Quality Management (TQM), Malcolm Baldrige National Quality Award, Six Sigma, Lean, and the ISO 9000 quality standards which are among the most recognized quality models in the world [50].

In addition, Kiew *et al*. [50] stated that many companies strive for quality certification for different reasons, and other potential benefits are gained in return. Therefore, it is envisaged that implementing QMS will resolve quality issues and satisfy the client's demands [51]. However, it is worth mentioning that the successful adoption of QMS in the manufacturing industry prompted the integration of QMS into the construction industry more than 20 years ago [52]. According to research done by McIntyre and Kirschenman [53], the utmost and most apparent benefit of QMS is that it reduces rework if adequately implemented. Furthermore, other factors should be considered in developing a new quality approach, such as conformance to quality and design specifications, constructability and design analysis, life cycle cost analysis, and sustainability issues to enhance construction output and develop a good quality reputation in the construction industry [41].

The Malaysian construction industry continues to face fundamental setbacks in terms of economic uncertainties, poor quality of work, reworks and delays, poor attitude by workers, lack of skilled workers, bad reputation, poor construction output, and insufficient data and communication [54]. So, if these effects are not curtailed, it can jeopardize the structure's safety. Furthermore, all the factors mentioned above are capable of adding additional costs as a result of poor quality of work, poor budgeting and planning, cost of rework, correction of mistakes, the cost of responding to customer complaints, and failure to meet up with the targeted completion date [55]. Thus, the Malaysian construction industry remains inferior to other developing nations [55]. Furthermore, a successful and effective construction project is defined by the project's completion time, within the specified budget, and acceptable stipulated quality [57]. Therefore, to meet the high demand for construction works, a new approach to the traditional practice was developed and named Industrialized Building Systems (IBS) [58, 59, 60, 61]. IBS was introduced mainly to provide a strategic position and give a new direction to the AEC industry through innovation, sustainability, professionality, profitability, and to be a globally competitive industry [60].

Leveraging IT in the construction industry's vision is key to quality [62]. Thus, the CIDB developed the IBS plan, consisting of 7 strategic thrusts, 21 strategic recommendations, 82 action plans, and 453 activities [62]. First, the IBS approach was based on three cardinal points: restoring quality in construction works, reducing time and cost overrun, and reducing labour reliance on foreign workers [63]. Implementing Quality Assessment Systems in construction (QLASSIC) has led to the efficiency of the building approval process and improvement in the design process through high IT adoption by construction companies [64]. Nevertheless, still, there is a lack of awareness by the general public on sustainable building practices [65]. The Minister of Works, Datuk Fadillah Yusof, May 2016, said that the implementation percentage of IBS by the private sector is about 14% which is relatively low compared to the public sector (government projects), which is around 69%, as stated by CIDB's survey in 2014 [67, 68]. Consequently, the Minister also said, "Ministry of Work intends to make IBS usage compulsory in 2018, with the assistance of local authorities, so that any proposed plans will use IBS in its construction [4] ".

It is also important to note that the construction industry is diverse, complicated, and has different construction stages affecting the final construction output [69]. Moreover, Malaysian construction is divided into the general construction industry and unique trades [70]. From the above insights, it will be seen that by exploring these quality dimensions, effective quality management implementation and good quality construction work can be achieved by prioritizing quality as the primary driver for enhancing quality in construction works [71]. It is important to note that no single quality dimension is more important than the others. Therefore, it is essential to consider all of the quality dimensions when planning and executing a construction project. Quality should be measured throughout the project lifecycle, from planning to execution to completion. At the same time, a recent study conducted by [1] on the poor

quality of buildings in Malaysia found that more than 80% of the completed building projects have quality problems, and 40% are attributable to poor quality. Poor quality can perhaps increase the cost of a building by more than 50% and delay a project by up to 50% [1]. Furthermore, the estimated cost of non-conformance to quality standards in Malaysian construction sites is around 5-6% of the project cost [1, 70, 71]. Poor quality management, poor planning, a lack of communication, design modifications, and poor subcontractor management were the major causes of poor quality [72].

There are many tools and techniques that can be used to measure quality in construction projects. The best way to do this is to involve the users in the quality planning process. This will help ensure the project is designed and built to meet their needs and expectations. The quality of construction projects significantly impacts the economy, the environment, and the public's safety. Therefore, it is crucial to ensure that quality is considered throughout the project lifecycle.

4.0 CONCLUSION

In Malaysia, the quality challenges can be attributed to the dimensions mentioned above. No single quality dimension is more important than the others. Quality should be measured throughout the project lifecycle, from planning to execution to completion. However, some of the quality issues identified are mainly in the construction and management processes. Thus, knowing the right quality dimension could ease quality assessment in the construction process, decision-making, design, maintenance, and operation. The explored quality dimensions could also be used to categorize quality issues into a specific quality dimensions. Furthermore, it can attribute each quality issue to a dimension for a more straightforward assessment. The attributed dimension can then be used to define the requirements for improving the quality of construction work. Construction quality entails finishing the task on time, meeting the specification criteria, and completing the project within the budget. For instance, time is usually measured by the project's completion date. The budget can be measured by the project's total cost or the cost per square foot. Aesthetics quality can be measured by the project's overall appearance or user satisfaction.

A related quality dimension is a conformance or the degree to which a product's design and operating characteristics adhere to established standards. For many clients, better quality is less about the availability of specific features and more about the overall aesthetic appearance of the building. Hence, the aesthetic quality of a building is a subjective matter. As Aristotle said, " Quality is not just a habit, but an act." Therefore, construction experts should make quality a habit and prioritize it in executing construction projects. Finally, considering all the quality dimensions when planning and executing a construction project is essential. Furthermore, through these dimensions, every construction stakeholder will know the quality dimension he/she must address in his project. Following best practices and standards and implementing regular inspections and quality control measures can help ensure construction quality. By prioritizing these quality dimensions, we can ensure that the buildings and infrastructure we construct are built with quality and can meet the needs of the present and future generations.

Conflicts of Interest

The author(s) declare(s) that there is no conflict of interest regarding the publication of this paper.

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