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Factors Affecting Quality in Construction Project Life Cycle (CPLC)

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Abstract: Quality is among the critical element in managing a construction project. Unfortunately, according to several established documents, issues related to quality in the Malaysian construction project are still rampant. Therefore, to delve deeper into the predicament, understanding the factors affecting construction quality was deemed essential. This even more vital given the minimal number of manuscripts looking into the matter accordingly with the generic construction project life cycle (CPLC). Thus, to operationalise the initial research, a mixed methodology endeavour was selected. This by carrying out a Multi-layered Thematic Analysis (MLTA) to determine factors affecting the quality in the CPLC and questionnaire survey to validate each factor's agreement. Through the MLTA, the results show several similarities in factors, especially in the off-site phases. Whereby in the on-site phases, factors related to 4 M's (money, material, manpower, and machinery) were found to be common. Then, through the questionnaire survey, each factor's mean and median values indicate that the majority of respondents were agreed (scale of 4 to 5) with the dedicated phase of each factor. To sum up, there is evidence that different CPLC has different factors affecting construction quality. In the current form, the findings are valuable as a basis for subsequent research undertaking, e.g. focusing on the micro perspective of quality within each phase and parties involved in the construction project.

Keywords: Quality, construction project life cycle, construction project

1. Introduction

The construction industry is indeed known as one industry that contributed to the growth of any nation. However, the development of the construction industry certainly faces with issues and challenges. Challenge in the Malaysian construction industry is including the quality of the construction project. The current initiative focused on the end product, which emphasised workmanship and material. Instead, the quality of the construction project is not only depending on the construction works. The construction project produces a deliverable such as private facilities (house,

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office or shops building), public facilities (highway, bridges, dams, etc.), service facilities (medical centre, educational campuses or rail station), high-rise towers and infrastructure. The deliverables of a construction project result from the process involved and resources used in the construction project development [1], [2]. Thus, quality of construction shall include the process starting from the client's initiation of project needs and physical development by contractors until the project is handing over the project back to the client. During each process in the CPLC, various resources are involved includes the responsibility of each personnel over different things that affect quality.

The paper aims to classify the factors affecting construction quality in CPLC. The paper focused on the traditional procurement method. In line with the aim, the objectives are to identify the factors affecting quality in CPLC and to validate each factor's agreement in the dedicated phase of CPLC. Therefore, the following sections encompass the overall views of the research, methodology, and finally, the paper's results. Inline, part of the research is used to develop the model on learning construction quality for building works.

1.1 Overview of the Malaysian Construction Industry

Generally, the construction industry involves various activities and resources in a project life cycle for producing buildings or any structures in the built environment [3]. Referring to the Department of Statistics Malaysia's (DOSM) classification, the construction industry is described as either new work, repair work, addition or alteration for building construction works, civil engineering works, or specialised construction works [4]. Meanwhile, the Construction Industry Development Board (CIDB) Malaysia stated the construction industry as any construction tasks, including design, manufacturing, technology, material, and quality of construction works [5]. Thus, the construction industry seems to relate with the economic activity from producing a construction material and building component, providing a professional service such as design, project management and building investigation. Other than that, the construction industry equipped with trading and renting of construction equipment and machinery and executing the physical work on site. With various activities involved in the construction industry, the construction industry's impact in a country's economy is undeniable. Although the contribution of the construction industry in Gross Domestic Product (GDP) averagely around 3% to 5%, the impact through forward and backward linkage to other industry support the economy improvement [6]–[8].

Considering the construction industry is important for the nation development, fulfilling client (public or private entity) satisfaction in term of time, cost, quality, scope, resources, and safety is crucial[6], [9]–[11]. Thus, the Construction Industry Development Board (CIDB) introduce Construction Industry Master Plan 2006-2015 (CIMP) followed by Construction Industry Transformation Programme 2016-2020 (CITP) [12]. CIDB sets a plan to strengthen the construction industry's image through several initiatives laid in CIMP and CITP. The initiative related to the quality of construction in CIMP and CITP includes a publication of national standard named Construction Industry Standard (CIS) 7: 2014 (Quality Assessment System for Building Construction Works-QLASSIC), the development of Malaysia Standards for manufacturing of building materials, and raising a quality culture in construction industry.

Unfortunately, the initiative appears ineffective as recurring quality issues in Malaysian construction project [13]–[16]. Consecutive Malaysia's Auditor-General Report 2015 to 2018 reported repetitive issues in the quality of construction project. The issues reported are poor workmanship, defects in facilities, work does not meet specifications, facilities unable to function accordingly, and low-quality material used in the construction [17]–[19]. The issues have caused a recurring bad reputation of the construction industry and parties involved in it.

1.2 Quality in Construction Project

Quality in a construction project has started during the Mesopotamia era where the builder should be responsible for their construction. The builders will face the death penalty if their building collapsed or cause death to the occupants. Starting from that, in 1000 B.C, the Greeks start quality control to construct their temples. Further, the Romans expanding quality by standardised the process for any of their development [20]. The early history then continued with the artisan involvement (the guilds) starting from the 5th century. The artisan (the guilds) take their responsibility extensively on quality control by carried out the inspections and audits [20], [21]. This era was a starting point of quality inspection, followed by quality control, quality assurance, and total quality management (TQM). Concepts of TQM is widely used in the manufacturing industry and further used in construction.

There is no specific definition of quality in a construction project. Previous research always defines quality according to the concept by quality gurus. To name a few, quality is always related with Juran et al. [22] where he defines quality as "features of products which meet customer need thereby provide customer satisfaction and freedom from deficiencies". Other than that, Feigenbaum [21] described quality as "the total composite product and service characteristics of marketing, engineering, manufacturer, and maintenance through which the product and service in use will meet the expectations of the customer". Meanwhile, Crosby [23] defines quality as "conformance to requirements".

Additionally, the Chartered Institute of Building (CIOB) stated no standard definition of quality in construction. It is subjective and viewed from a different perspective of parties involved in construction [24]. It is supported by CIDB, which says quality is subjective and difficult to quantify. However, it is an important parameter in construction alongside time and cost [25]. However, quite a few research in construction generally defines quality as satisfying

customer satisfaction, fulfil the customer requirements, meeting the legal, aesthetic and functional needs of a project, conformance to specifications, and fitness for use [26]–[30]. Additionally, in the construction industry, quality can be defined as meeting the owner's requirements (client), design team, contractor, and regulatory agencies [31]. Each party involved has its requirement on quality depends on their roles in the construction project.

Hence, in this research, quality in a construction project can be concluded as achieving a degree of excellence, with complying to standards, specifications and requirement of construction project determined by customer, design team, related agencies and contractor to ensure the project is value for money, fitness for use and effective in achieving organisational goals.

1.3 Construction Project Life Cycle (CPLC)

In the Malaysian construction industry, the common procurement method is traditional and design and build (D&B). The traditional procurement method widely used since it allows the contractors to compete competitively and develop the economy [32]. There are three (3) parties involved in the traditional procurement method: client, consultant, and contractor. The traditional procurement method has a separate phase with an exact function in each phase. Table 1 shows the phase of a construction project according to several past researchers. Previous research shows there are several phases of the project life cycle for the traditional procurement method. However, four (4) phases (planning, design, tender and construction) with a higher frequency is used in the paper as a guide for the construction project life cycle (CPLC). In CPLC, the overall activities can be divided into off-site and on-site, as shown in Fig. 1.

Table 1: Summary of phase in construction project life cycle according to several researchers.

Phase	[33]	[34]	[35]	[35]	[36]	[37]	[14]	[11]
Initiation				x				
Inspection		x					x	
Planning	x		x	x	x	x		x
Design	x	x	x			x	x	x
Tender		x			x		x	x
Construction	x	x	x	x	x	x		x
Closing				x	x		x	
Operation and maintenance			x					

The construction project starts with the planning phase, where the client initially guides it. Generally, the planning phase is where project scope, purpose, objective, resources, deliverables, time, and cost estimation is determined [34], [35]. Besides that, during the planning stage, consultants are appointed. The team was brief on the project development, developed a work program, identified the alternatives available for the project, site investigation, preliminary drawing and cost estimation, project funding and selection of site [38].

In the design phase, consultants appointed will develop a schematic design as a preliminary design graphic presentation. Once the consultant and client approved the schematic design, the consultant will finalise the drawing and prepare for the tender document. The consultants are responsible for the detailed drawing and the written document containing legal requirements, material specifications, project conditions, technical specifications, and other documents related to selecting contractors [35], [38].

The tender stage is the process of selecting a contractor for the project. In the early stage, the client should decide the tendering method, contractor criteria, duration of tender, and the managing team for the tendering process. On the contractor side, they have to consider few factors, either to accept the tender invitation or not. Once the communities for selecting qualified contractor has their result, the client will notify a successful contractor by using Letter of Intent (LI) for their preparation to start the project [38], [39].

Then, the construction phase is where the physical activities of work performed by the contractor. During this stage, consultants are responsible for monitoring the project, and the client will usually pay the contractor on a monthly basis. The construction phase is the most critical phase where the management of resources, communication, and documentation is crucial [38]. The contractor needs to ensure the project meets the quality, time, and cost as declared in the document contract [11]. Finally, when the project completed, the contractor will hand over the project back to the client.

In conclusion, each phase in the construction project life cycle has activities to perform. Furthermore, it includes the involvement of different resources. To achieve overall quality in a construction project, each activity in every phase requires quality management. Thus, it was clear that each phase may present different factors in achieving quality.

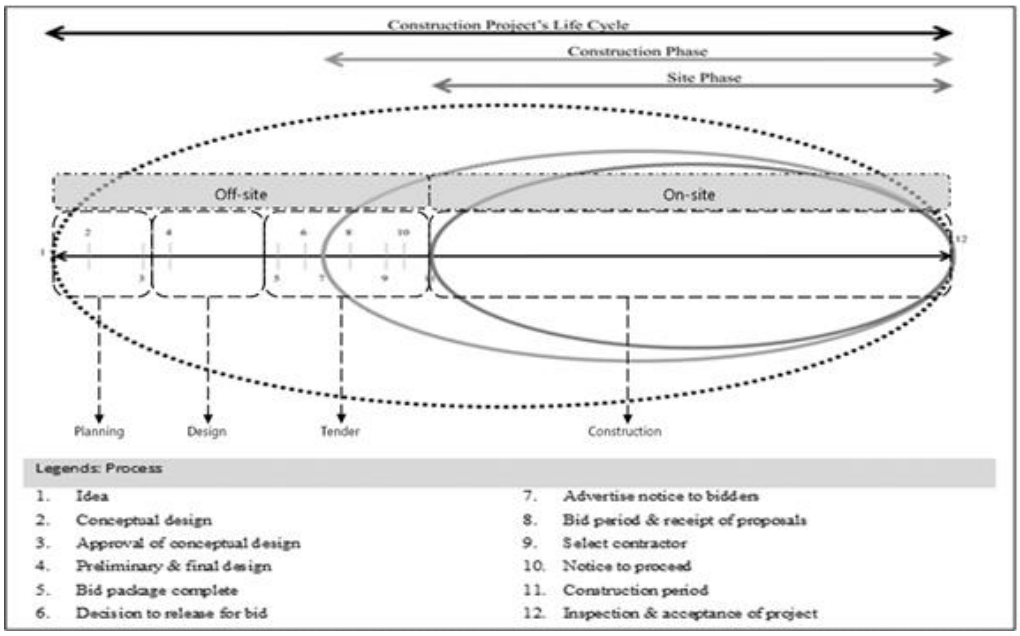

Fig. 1- The overall CPLC in traditional construction [11]

2. Methodology

The paper employed a mixed methodology comprising the document analysis and questionnaire survey, respectively. The methodology was guided mainly by [40] and other researchers, as cited throughout the paper.

2.1 Literature Analysis

Generally, the construction industry involves various activities and resources in a project life cycle for producing buildings. In identifying the factors affecting quality in the CPLC, the literature analysis is constructed by referring to [40]. Further, to ensure the reliability of document analysis, the paper uses a multi-layered thematic process (MLT), where three (3) layers were prepared to ensure the factors listed are within the scope of objectives (see Fig. 2) [41]–[44]. Layers in Figure 2 used to sieve the past researchers' document in identifying the factors affecting quality in CPLC. In short, Layer 1 used to ensure the analysis are focusing on quality in construction projects as a theme. Subsequently, Layer 2 identified that each document discussed factors affecting quality in the construction project. Within these former two layers, any document that did not fulfil the layers' requirement will be disqualified. Moving on to the final layer (i.e., Layer 3), this will become a layer to sentimentalised factors into predetermined clusters (as according to the CPLC). Thus, any factors beyond the phase in CPLC will be ignored.

The list of factors affecting quality in the phase of construction project life cycle was gathered from several past research [13], [14], [29], [45]–[47]. The authors used a matrix table to organise the factors. Further, the table of factors in each phase of the CPLC (

Table ***2*** to Table 5) was developed. The factors are categorised into its phase by referring to the previous publications and the activities involved in each phase in the construction project life cycle.

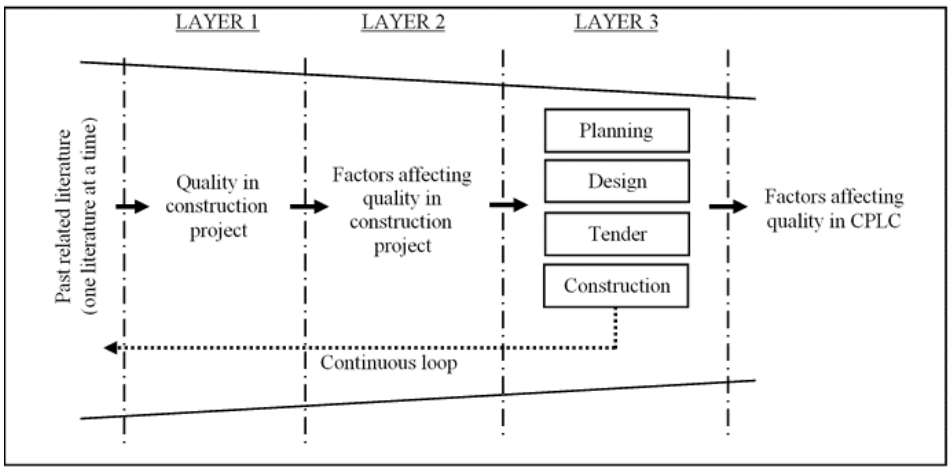

Fig. 2- Multi-layered thematic process

2.2 Questionnaire Survey

The purpose of the questionnaire survey is to validate the agreement on allocation of factors in each phase of the construction project life cycle from related construction practitioners by using five (5) Likert-scale, that is (1) Strongly Disagree, (2) Disagree, (3) Somewhat Agree, (4) Agree, and (5) Strongly Agree. Following the previous discussion in Sub Chapter - CPLC, the questionnaire was developed into two different sets. Set A dedicated to an off-site phase where the distribution of the questionnaire is to the main parties in the off-site phase, which are the client (public and private company), architects, and consultants [38], [48].

Meanwhile, Set B devoted to the contractor as its main character in physical activities at the construction site, whereas the role of client, architect and consultants is more towards supervising and inspecting the construction work [38], [48]. The questionnaire was distributed in Johor, Malaysia. Since the data collection is implemented during the 1st Movement Control Order (MCO) and Conditional Movement Control Order (CMCO) in Malaysia due to Covid-19, the questionnaires were distributed using e-mail and WhatsApp Message to the respondents in the form of online version (Google Form).

Then, SPSS software is used to facilitate the analyses and results of this study. Firstly, the reliability value is calculated using Cronbach's Coefficient Alpha (α), which commonly used to estimate the internal consistency of a set of items [49]. Meanwhile, median values used as it was appropriate to determine the more accurate scale towards respondents' agreement on factors affecting quality in the construction phase.

3. Result and Discussion

This chapter is devoted to highlighting the paper's collection of data, analysis, and results afterwards. Accordingly, the arrangement of the subchapter is made with close proximity to the previous chapter's layout.

3.1 First Objectives: Identify the Factors Affecting Quality in CPLC

Through multi-layered thematic analysis, related document from [13], [14], [53]–[57], [26], [29], [45]–[47], [50]–[52] was analysed, and a list of factors affecting quality in CPLC was documented as

Table ***2*** to Table 5. All items were grouped into each related phase in the construction project.

Table 2 - Factors affecting quality in planning phase

Num.	Factors Affecting Quality	[46]	[50]	[47]	[51]	[13]	[52]	[26]	[53]	[54]	[55]	[14]	[56]	[45]	[29]	[57]	Frequency
1	Attitude							x			x						**2**
2	Cash flow project		x														**1**
3	Client requirements												x				**1**
4	Conflict of interest													x			**1**
5	Decision-making process									x	x		x				**3**
6	Information		x														**1**
7	Owner decisions										x						**1**
8	Owner/ client competency			x													**1**
9	Planning									x	x	x		x			**4**
10	Price fluctuation									x							**1**
11	Project funding		x	x				x									**3**
12	Research and development				x												**1**
13	Short term objectives									x	x						**2**
14	Teamwork			x			x										**2**

Table 3 - Factors affecting quality in design phase.

Num.	Factors Affecting Quality	[46]	[50]	[47]	[51]	[13]	[52]	[26]	[53]	[54]	[55]	[14]	[56]	[45]	[29]	[57]	Frequency
1	Attitude							x			x						**2**
2	Authority approval							x				x					**2**
3	Cash flow project		x														**1**

4	Construction costs control								x								**1**
5	Design complexity		x			x											**2**
6	Design error										x		x				**2**
7	Drawing and specifications			x				x			x						**3**
8	Estimation in design													x			**1**
9	Quality/ design codes and standard						x										**1**
10	Rules and regulations							x									**1**
11	Stakeholder role																**1**
12	Teamwork			x			x										**2**

Table 4 - Factors affecting quality in tender phase

Num.	Factors Affecting Quality	[46]	[50]	[47]	[51]	[13]	[52]	[26]	[53]	[54]	[55]	[14]	[56]	[45]	[29]	[57]	Frequency
1	Attitude							x			x						**2**
2	Cash flow project		x														**1**
3	Communication							x		x	x						**3**
4	Contract document								x	x				x			**3**
5	Contract duration												x				**1**
6	Contract price										x	x	x				**3**
7	Contractor appointment											x					**1**
8	Corruption												x				**1**
9	Decision-making process									x	x		x				**3**
10	Owner decisions										x						**1**
11	Price fluctuation									x							**1**
12	Project information and specifications			x				x									**2**
13	Teamwork			x			x										**2**
14	Tendering procedure											x	x				**2**

Table 5 - Factors affecting quality in construction phase

Num.	Factors Affecting Quality	[46]	[50]	[47]	[51]	[13]	[52]	[26]	[53]	[54]	[55]	[14]	[56]	[45]	[29]	[57]	Frequency
1	Communication					x				x			x	x	x		**5**
2	Competency of contractor									x		x					**2**
3	Construction equipment and methods									x			x		x		**3**
4	Construction process					x				x				x	x		**4**
5	Contractor financial			x										x		x	**3**
6	Contractor's progress									x		x					**2**
7	Cost									x				x	x	x	**4**
8	Decision-making process									x		x		x			**3**
9	Design changes											x			x		**2**
10	Document contract specifications											x					**1**
11	Labour adequacy													x			**1**
12	Labour productivity			x								x	x	x			**4**
13	Labour skills											x		x			**3**
14	Labour competency			x								x		x			**3**
15	Machinery cost													x			**1**
16	Management commitment					x						x		x	x		**4**
17	Material delivery									x		x	x	x	x		**5**
18	Material quality			x		x				x		x	x				**5**

19	Materials and machinery			x	x	x	x	x		**5**
20	Nature of construction		x	x	x	x		x		**5**
21	Order changes				x					**1**
22	Overtime						x			**1**
23	Payment			x	x	x	x	x	x	**6**
24	Safety policies								x	**1**
25	Site management and supervision			x						**1**
26	Subcontractors			x			x			**2**
27	Time	x		x		x			x	**4**

During the planning stage, the owner's role is important in achieving the construction project's quality. The owner is responsible for making decisions, identifying the project's objectives, providing information, determining project requirements, and providing funding to determine quality in the construction project. In the design stage, where consultants have a bigger role, a factor related to document tender preparation is mostly affecting the quality. Besides late approval from authority, the complexity of the design, and misunderstanding of guidance (design codes and standard/ rules and regulation), late issuance of construction drawing also may lead to the factors affecting quality in a construction project. Additionally, the tendering process (duration, price, corruption, and procedure) is also identified as affecting quality.

On the other hand, for the on-site phase where the physical works commence, the factors identified are mainly from the resources (4M's; money, material, machinery, manpower) involved during this stage. Other than that, competency of contractors, communication among parties involved in construction, changes in design, the commitment of the management in implementing a quality programme, and delay in performing inspection and testing are also identified as factors affecting quality in the construction project.

3.2 Second Objective: Factor's Validation

3.2.1 Descriptive Analysis

Concerning the second phase of the research, a questionnaire survey was developed by using the factors in each phase. The purpose of this survey is to validate each factor by measuring the agreement level. A pilot test is carried out to evaluate the validity and reliability of the questions. The questions are given to several expert persons (i.e., academicians and senior practitioners) to evaluate the overall questions' structure. The improvement of questions is made after receiving responses from the expert. Apart, a summary of the actual survey for respondents' demographics was tabulated in Table 6.

Table 6 - Summary of collected data

Data/ Test			**Results**	
			Set A (off-site phase)	**Set B (on-site phase)**
Reliability (α)			0.917	0.935
Response rate (%)			42%	44%
Category of respondents	Developer/ Client (Public and private)		12%	-
	Architect		14%	-
	Civil and structural consultants		57%	-
	Quantity surveyor		17%	-
	Contractor	Grade 7 (G7)	-	48%
		Grade 6 (G6)	-	3%
		Grade 5 (G5)	-	22%
		Grade 4 (G4)	-	15%
		Grade 3 (G3)	-	0%
		Grade 2 (G2)	-	7%
		Grade 1 (G1)	-	5%
Years of experience	1 – 5 years		58%	75%
	6-10 years		18%	10%
	11 years and above		24%	15%

Table 6 shows the average response rate of 43% is achieved through 88 completed questionnaires collected from the clients, architects, civil and structural consultants, quantity surveyors, and contractors. The majority of the respondents from Set A is from Civil and Structural Consultants, and Contractor Grade 7 (G7) for Set B. Meanwhile,

most of the respondents have 1 to 5 years' experiences. Afterwards, the data's reliability has been checked using Cronbach's Coefficient Alpha (α). The value shows internal reliability is maintained for the intended purpose.

Descriptive analysis for all items is carried out separately for each phase and shown in Table 7 to Table 10. In general, the median for all factors was within the range of 4.00 (agree) to 5.00 (strongly agree). Meanwhile, the mean value for factors in all phases recorded a value between 3.00 (somewhat agree) and 5.00 (strongly agree).

Table 7 - Mean and median for factors in planning phase

Factor	Mean	Median	Rank
Teamwork	4.38	4.50	1
Cash flow project	4.20	4.00	2
Planning	4.04	4.00	3
Decision-making process	4.02	4.00	4
Client requirements	3.96	4.00	5
Project funding	3.92	4.00	6
Owner decisions	3.92	4.00	7
Owner/ client competency	3.92	4.00	8
Price fluctuation	3.90	4.00	9
Information	3.82	4.00	10
Attitude	3.78	4.00	11
Research and development	3.76	4.00	12
Conflict of interest	3.74	4.00	13
Short term objective	3.56	4.00	14

In the planning, design and tender stage, the respondents consist of client and consultants (architect, engineer and quantity surveyor). Each party have different responsibilities in the construction project. In the planning stage, teamwork was ranked first by the respondent. It was followed by a cash flow project, planning and decision making, which has a mean value between 4.00 (agree) to 5.00 (strongly agree). The planning stage is crucial in construction project management as all matter related to a construction project is determined during the planning stage such as scope determination, team selection, cost determination, and duration of the project. Thus, it makes teamwork, cash flow project, planning, and decision-making higher ranking (mean value between 4.00 to 5.00) for factor affecting quality in the planning stage.

Table 8 - Mean and median for factors in design phase

Factor	Mean	Median	Rank
Cash flow project	4.66	4.00	1
Teamwork	4.32	4.00	2
Authority approval	4.28	4.00	3
Design error	4.22	4.00	4
Construction costs control	4.18	4.00	5
Drawing and specifications	4.16	4.00	6
Design complexity	4.08	4.00	7
Estimation in design	4.08	4.00	8
Rules and regulations	4.04	4.00	9
Quality/design codes and standard	3.96	4.00	10
Stakeholder role	3.92	4.00	11
Attitude	3.60	4.00	12

During the design stage, the role of consultants is more significant compared to the client. In the design stage, the final design is prepared for document tender preparation. Therefore, respondents agreed that cash flow project, teamwork, authority approval, design error, construction cost control, drawing and specifications, design complexity, estimation in design, rules, and regulation are the leading factors (mean value 4.00 to 5.00) in the design stage. While factors with a mean value of 3.00 (somewhat agree) to 4.00 (agree) are quality/ design and codes standard, stakeholder role and attitude.

Meanwhile, in the tender stage, eleven (11) factors are classified into the range of mean 4.00 (agree) to 5.00 (strongly agree). The factors are corruption, contract price, contract duration, tendering procedure, cash flow project, teamwork, communication, contractor appointment, project information and specifications and owner decision. The respondent agrees corruption is the leading factors affecting quality in the construction project. It is related to the activities involved in the tender stage, such as completing the tender document, call for tender, tender evaluation and

especially during contractor's selection. Corruption during the tender stage will lead to the selection of incompetent contractor which causes poor quality during the construction.

Table 9 - Mean and median for factors in tender phase

Factor	Mean	Median	Rank
Corruption	4.32	4.00	1
Contract price	4.18	4.00	2
Contract duration	4.12	4.00	3
Tendering procedures	4.12	4.00	4
Cash flow project	4.10	4.00	5
Teamwork	4.08	4.00	6
Communication	4.08	4.00	7
Contractor appointment	4.08	4.00	8
Contract document	4.06	4.00	9
Project information and specifications	4.02	4.00	10
Owners decisions	4.00	4.00	11
Price fluctuation	3.98	4.00	12
Decision-making process	3.94	4.00	13
Attitude	3.68	4.00	14

Table 10 - Mean and median of factors in construction phase

Factor	Mean	Median	Rank
Labour productivity	4.15	4.00	1
Contractor's progress	4.13	4.00	2
Payment	4.13	4.00	3
Site management and supervision	4.10	4.00	4
Labour skills	4.03	4.00	5
Communication	4.00	4.00	6
Construction equipment and methods	4.00	4.00	7
Construction process	4.00	4.00	8
Competency of contractor	3.98	4.00	9
Labour competency	3.98	4.00	10
Design changes	3.95	4.00	11
Document contract specifications	3.95	4.00	12
Labour adequacy	3.95	4.00	13
Contractor financial	3.93	4.00	14
Subcontractors	3.93	4.00	15
Management commitment	3.90	4.00	16
Order changes	3.90	4.00	17
Materials and machinery	3.87	4.00	18
Time	3.87	4.00	19
Material delivery	3.85	4.00	20
Cost	3.83	4.00	21
Material quality	3.80	4.00	22
Overtime	3.73	4.00	23
Machinery cost	3.68	4.00	24
Nature of construction	3.68	4.00	25
Decision-making process	3.63	4.00	26
Safety policies	3.58	4.00	27

Factor affecting quality in the construction phase was validated by contractors. Eight (8) factors are in a range of 4.00 (agree) to 5.00 (strongly agree). The factors are labour productivity, contractor's progress, payment, site management and supervision, labour skills, communication, construction equipment and methods, and construction process. Meanwhile, the other nineteen (19) factors are in the range of 3.00 (somewhat agree) to 4.00 (agree).

As listed in Table 10, factors affecting quality in the construction phase are mostly related to resources at the site. Labour productivity, labour skills, labour competency, and labour adequacy are among the factors with high mean score since construction project is a labour-intensive industry. Payment and contractor's progress are interconnected as the contractor's progress depends on the client's payment. Both factors will also influence subcontractors' progress, material delivery, labour adequacy, and contractors finances. Additionally, the client and consultant's role by providing

complete document contract specifications and diminish the design change during construction will also affect the quality of construction.

Other than that, the respondents were open to suggest any other factors affecting quality other than listed. The suggestions are analysed separately for the off-site phase and on-site phase, as summarised in the following table (Table 11). Based on the suggestion, in the off-site phase, the respondent emphasised on roles of client and consultants. A design change is a common issue in the construction project. It affected the contractor during the construction phase and affected the consultants in the off-site phase. Other than that, a commitment of top management in implementing quality management plan in construction is crucial. It is proven that any successful programme starts with the commitment of top management. However, the political and economic situation is an external factor from CPLC that affecting quality in construction. For the on-site phase, it seems that knowledge and skills achieved from training and education are important factors in affecting quality. Besides, strict supervision requires to ensure quality, especially for sub-contractors work.

Table 11 - Summary of respondent suggestions

Off-site phase	On-site phase
Last-minute changing of drawing by architect/ client	Labours ethics
Designer (lack of experience, incompetence, lack of knowledge)	Training and education
Commitment of management	Strict supervisions
The political and economic situation	Site management skills and knowledge
Significance of project	

With the value factors listed in Table 7 to Table 10 are in a range of 3.00 (somewhat agree) to 5.00 (strongly agree) for mean and 4.00 (agree) to 5.00 (strongly agree) for the median, the author summarised that all factors gather during the document analysis in Phase 1 are deemed appropriate in their phase. From the suggestions, related knowledge and skills are observed as important factors for both phases. Next, to generalise the data from different categories of the respondent, the Kruskal-Wallis H test is applied in this paper.

3.2.2 Kruskal-Wallis H

Since for both sets of the questionnaire has different categories of the respondent (Set A: developer/ client, architect, civil and structural consultant, and quantity surveyor) and (Set B: G7 to G1 contractor), a nonparametric test (Kruskal-Wallis H) is used to identify any difference between an independent variable and dependent variable [58]. In the paper, Kruskal-Wallis H is used to find any difference in the factors affecting quality towards the different category of respondent.

Through Kruskal-Wallis H, the difference between the control variable (i.e., category of respondent) and independent variable (factors of affecting quality) can be identified. To proceed with Kruskal-Wallis H test, the data need to comply with four (4) assumptions [58]:

a) Assumption 1: Dependent variable evaluate as the ordinal or continuous level.
b) Assumption 2: Independent variable consist of two or more categories.
c) Assumption 3: Independence of observations (no relationship between the observations in each group or between the group).
d) Assumption 4: Distributions of independent variables have the same shape (same variability).

Assumption 1 to Assumption 3, can be implemented by reviewing the data. However, for Assumption 4, the data can be checked using SPSS. The purpose of Assumption 4 is to interpret the results of Kruskal-Wallis H correctly either by using median or mean ranks. However, Assumption 4 also be developed after conducting the Kruskal-Wallis H test, precisely for the "reject the null hypothesis" item [59]. Therefore, the summary of hypotheses for Kruskal-Wallis H Test for this paper is shown in Table 12.

Table 12 - Hypotheses used for Kruskal-Wallis H test

Set A (off-site phase)	Set B (on-site phase)
Significance value, $\alpha = 0.05$	
H_0: there is no difference of agreement for factor affecting quality in the off-site phase towards the different category of respondent	H_0: there is no difference of agreement for factor affecting quality in the on-site phase towards the different grade of contractor
H_1: there is a difference of agreement on factor affecting quality in the off-site phase towards the different category of respondent	H_1: there is a difference of agreement on factor affecting quality in the on-site phase towards the different grade of contractor

Table 13 - Result of Kruskal-Wallis H test (shows the rejected item only)

Phase	Null Hypothesis	Sig.	Decision
Planning	The distribution of **planning** is the same across categories of the respondent.	0.048	Reject the null hypothesis.
	The distribution of **conflict of interest** is the same across categories of the respondent.	0.047	Reject the null hypothesis.
	The distribution of **teamwork** is the same across categories of the respondent.	0.038	Reject the null hypothesis.
Design	The distribution of **quality/ design codes and standard** is the same across categories of the respondent.	0.041	Reject the null hypothesis.
Tender	The distribution of **price fluctuation** is the same across categories of the respondent.	0.031	Reject the null hypothesis.
	The distribution of the **cash flow project** is the same across categories of the respondent.	0.026	Reject the null hypothesis.
	The distribution of **project information and specifications** is the same across categories of the respondent.	0.021	Reject the null hypothesis.

The Kruskal-Wallis H test for Set B (on-site factor) does not show any rejected item. It concludes that there is no difference in agreement for factor affecting quality in the on-site phase across different contractors' grades. However, for factor affecting quality in off-site phase as reported in Table 13, seven (7) out of 40 factors has significant values of less than 0.05. There are three (3) factors from the planning phase, one (1) factor in the design phase, and three (3) factors in the tender phase. Therefore, a proposed null hypothesis of there is no difference in terms of factor's agreement within the off-site phase across multiple respondent categories was rejected. In short, it was evident that significant variability of responses was recorded. The reason for this phenomena may be due to different perspectives on quality in construction, which comparable to the findings from D. Arditi and H. M. Gunaydin [31]. Nevertheless, these items were currently being maintained in the paper for subsequent exploration through other means of validation initiative.

4. Conclusion

Generally, Objective 1 (to identify factors affecting quality in CPLC) and Objective 2 (to validate the factors affecting quality in CPLC) are successfully achieved through the literature analysis and questionnaire survey. As the factors affecting quality in CPLC is essential in the paper, the perspective of construction project characteristics and boundary of phases in CPLC for the screening processes are deemed paramount. Given the previous research are generally identified the generic factors, the understanding of the activities of each phase is crucial for clustering the factors into its suitable phase. Therefore, Table 2 to Table 5 listed the factors affecting quality in CPLC from the literature analysis by employing the MLT techniques. Although CPLC is divided into the off-site phase (planning, design, and tender) and on-site phase, the factors generated in the off-site phase are basically interrelated. It is seen to focus on the people and processes involved, where several factors reappeared, such as attitude, project's cash flow, stakeholder's role, and teamwork.

Correspondingly, Table 7 to Table 10 shows the result from the validation process derived from the result of the questionnaire survey. The factors obtained from the first phase were validated to be suitable in each specified phase. In the Kruskal-Wallis H test, seven (7) factors are identified to have a different agreement within the different categories of the respondent. Thus, further analysis is required, using median test and box plot, to allocate the location of differences among group of respondent [58].

To sum up, the paper's findings have fulfilled the gap by publishing the list of factors affecting quality in CPLC. With the results obtained, the findings are valuable as a basis for subsequent research undertaking, e.g. focusing on the micro perspective of quality within each phase and parties involved in the construction project. Towards the end, each party involved in the construction project could evaluate the needs and role of providing a better service to achieve high quality in the construction project.

Mainly, a construction project successful is the responsibility of each party involved. In addition, the need of creating a quality culture among all party involved in construction is crucial. As a client, the scope must be clearly defined, and funding for the project must determine before the project even started. Consultants should improve team working and communication to ensure the document preparation went smoothly. Building Information Modelling (BIM) possibly improves the documentation process, delivers results more efficiently, and indirectly improves quality

in construction. Lastly, the contractor as a responsible party in implementing the construction project should improve the basic knowledge in the construction process by providing training and education. It is important to the labour and management people in the construction project, especially the site engineer and construction manager, responsible for managing the work in the construction site. Quality is not the responsibility of one person but all personnel involved in the construction project.

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