History of the construction quality assessment system construction essay

The short form of the Construction Quality Assessment System is CONQUAS, it was introduced by Building and Construction Authority (BCA). The objective of introduction of CONQUAS is for the public and private construction industry sector to measure the standard quality of works done of construction project. (The National House Buyers Association (HBA), 2009).

The Building and Construction Authority (BCA) is developed by the Singapore government, this agency is classified under Singapore's Ministry of National Development. The BCA have good results in the construction industry in Singapore which it is awarded as the champion for the excellent built environment in Singapore development. All of the infrastructures, structures and buildings in our surroundings that provide the setting for the community's activities are considered as the " Built environment" (Building and Construction Authority, 2006)

Since 1989, the CONQUAS have been launched and it is only implemented by the Singapore local construction field at the beginning (Building and Construction Authority, 2006).

Nowadays, Malaysia, Singapore, Hong Kong, China, Australia, Hong Kong, South Africa, India and United Kingdom construction field have started to implement the CONQUAS assessment system in their construction project. The CONQUAS system is widely adopted in the international construction industry due to the CONQUAS system is widely recognized and accepted as the benchmarking tool for quality internationally. Now, CONQUAS is regoznized as registered trademark (Building and Construction Authority, 2006).

The main objective of CONQUAS is assessing the quality of construction works to ensure the quality of the project fulfill the quality standard. Besides, it also enable the assessment of quality can be carried out within reasonable cost and time systematically. Furthermore, the constructed works will assessed by the CONQUAS regarding the workmanship standards quality and specifications (Building and Construction Industry, 2005).

Moreover, CONQUAS is considered as an independent assessment. All of the CONQUAS assessment can be only assessed by the BCA Singapore officer, means only the officer of BCA Singapore can become the assessor. The CONQUAS are using the sampling system as their assessment system. Sampling system mean that only few samples will be randomly chosen by the assessor for inspection to represent the quality of whole project, not every unit will be assessed (The National House Buyers Association (HBA), 2009).

There are exceeding 2, 238 private and public construction projects have been inspected by BCA after the CONQUAS have been introduced since 1989. The analysis stated that cost of more than 81. 9billion Singapore dollar is the total cumulative contract value of the assessed projects (Building and Construction Authority, 2006).

In this recent years, construction filed in Malaysia start to adopt CONQUAS 21 assessment system into the construction projects.

Problem Statement

According to building product, quality is a important issue that always concerned by house buyers, investors, contractor and developer. All of the

qualities of building products are depend on how the contractors or developers construct it and how they control the quality management. Every house purchaser hope the building that they purchase achieved the standard quality. There is always a question from most of the house buyers, how can they ensure the quality of the building product is tally with the amount money they have paid? Is there anything can justify it?

The contractor can implement the Construction Quality Assessment (CONQUAS 21) into the building project to ensure the quality of the constructed work and to deliver a good quality product to the house purchaser. How do the CONQUAS assessment systems function to maintain the standard quality of constructed work? This is also the answer that the house purchasers wish to know to have more confident on the CONQUAS assessment system. Besides, what is the advantage brought to contractor, developer and house buyer by applying CONQUAS 21 assessment system. Instead, what is the problem will be occurred while applying it? So, the researcher will investigate the answer for above question by doing research on application of CONQUAS 21 assessment system in the construction industry.

Aims & Objectives

Aims

To investigate Quality Assessment System (CONQUAS 21) in construction industry.

Objectives

To study the principle and concept of CONQUAS 21

To find out problems occur when applying the CONQUAS 21

To find out the advantages of using CONQUAS 21

Scope of study

The journal papers, conference papers, books and browsing through websites is the secondary source that the information and details to be obtained from for the researcher to provide the information regarding the CONQUAS 21 procedure system and the standard of CONQUAS 21.

Besides that, the objective researcher is investigate the factor encourage most of the local developers and contractor to use the CONQUAS 21 as the assessment system for their project in the construction field. Furthermore, the researcher also will figure out the advantage and the disadvantages of CONQUAS 21. There are more details will be investigate regarding to adopting of CONQUAS 21.

Research Methodologies

Literature Research

Cover journals, relevant textbook, and internet research and conference paper is the sources that I obtain my information and doing for my literature research.

Interview

Site agent, supervisor and the site manager will be interviewed by the researched to get more details about the CONQUAS 21. The researcher will go to Swiss Garden Residences site to conduct the interview.

Case Study

Case study will be carried by site visit to the Swiss Garden Residence to find out the advantage of CONQUAS 21. Furthermore, another aim of site visit is to find out the problems occur when applying the CONQUAS 21.

Chapter Outline

Chapter 1: Introduction

The background of CONQUAS will be introduced by the researcher. Moreover, the researcher indicates more details about the objectives and aim of this research to be carried out.

Chapter 2: Literature Review

The concept and principle of CONQUAS 21 will be reviewed in more details by the researcher. The researcher searches the secondary source such as books, articles, journals and web site to get more details about the CONQUAS 21. Besides, the researcher indicates the advantages and disadvantages of implementing of CONQUAS 21.

Chapter 3: Designing the case study and research methodology

An interview will be conducted by the researcher at Swiss Garden Residences for the more details about CONQUAS 21. The project manager, site manager and site agent will be interviewed for obtaining the relevant information.

Chapter 4: Analysis of the secondary data

The researcher is going to do analysis on the information collected and give some opinion based on the information obtained regarding the CONQUAS 21.

Chapter 5: Conclusion and further studies

In chapter 5, the further studies for quality assessment will be stated out by the researcher and conclusion will be indicated by the researcher.

Chapter 2

Literature Review

2. 1 Quality Philosophy

Definition of Quality

Different party defines the quality in different way. Some people will define it as to meet contract requirements, instead some people define it as the satisfaction of customer and others also define as it reaches the required standards. ‘ The sum of the characteristics of an entity, its ability to meet the needs of the express or implied commitment to’ is the definition that The National Organization for Standardization (ISO) defines quality (Chung, 1999). The aims or requirements have been fulfilled or reached by any party; mean the quality standard has been achieved.

Furthermore, quality also can be defined based on own opinion such as ‘ providing customers with products and services that consistently meet their needs and expectations’ (S. L. Tang, 2005), ‘ performance to the standard expected by the customer’ (S. L. Tang, 2005) and ‘ fitness for purpose’ (Chung, 1999).

However, the definiton of quality is based on how a party to define, it can be defined is several way.

Basic Concept of Quality

Quality is the most important factor to be concerned in every field including construction field. In order to achieved the quality, the industries have come out with there are assessment system and guidelines to be carried out to ensure the works done in the construction industry can achieve the quality. ISO 9001: 2000, Quality Assessment System in Construction (QLASSIC) and Construction Quality Assessment (CONQUAS) is the assessment system that always used by constrction industry to ensure the works done reach the quality standard requirement. Case study of CONQUAS will be carried out in more details later.

Quality can be quantified as follows:-

Q= P/E

Where,

Q = quality

P = performance

E = expectation

If Q is greater than 1. 0, then the customer has a good feeling about the products or services (Besterfield, 1998).

Furthermore, There are nine dimensions in the quality. All dimensions are independent, which means that an end product can be excellent in one dimension but poor in others (Besterfield, 1998). These nine dimensions details and their terms is the following:-

Table 1: Nine dimensions of quality and their terms

Dimension	Terms
Performances	Primary products/service characteristic such as time, cost and workmanship aspect.
Features	Secondary characteristic, added consideration such as creativity in design and attractivenes.
Conformance	Meeting specification or industry standards, workmanship and client’s requirement in contract.
Reliability	Consistency of performance over time, average time for the unit to fail.
Durability	Useful life period with less maintenance or repair.
Service	Resolution of problems and complaints, ease of repair.
Response	

Human to human interface such as efficiency during meeting, fast decision making, effective human resources management.

Aesthetics

Sensory characteristics in design such as exterior finishes.

Reputaion

Past performance such as being ranked first in the tendering process.

Adapted from Garvin, 1988, Managing Quality: The strategic and Competitive Edge, New York: Free Press.

(Garvin, 1988)

Furthermore, there are always the relationship between quality with cost, value, cycle time and productivity. The details of the relationship is shown as following:-

Quality and Productivity

Productivity increase will influence the quality by improvement

Productivity = Salcable output / Resources used

Quality and Costs

Cost will increase if the quality of conformance increase

Cost will increase if the quality of design increase

Quality and Cycle Time

The cycle time will be reduce if there is improvement of quality effort

The cycle time to complete the activities is the key parameter

Quality and Value

Organizations must evalute the value they provide, relative to the competition

Value = Quality / Price

(S. L. Tang, 2005)

2. 1. 3 Quality Management

Quality management will influence the quality directly. The principles of quality management are applicable to every industry, within all organisations and at every level (McCabe, 1988). The basic goal of quality management is the elimination of failure: both in the concept and reality of products, services and processes (Juran, 1989).

The quality management is defined as " all activities of the overall management function that determine the quality policy, objectives and responsibilities, and implement them by means such as quality planning, quality control, quality assurance, and quality improvement within the quality system" (McCabe, 1988)

The quality management have four stages in evolution, known as: Quality Inspection, Quality Control (QC), Quality Assurance (QA) and Total Quality Management (TQM) (UTM, 2003). Inspection and Quality Control are

retrospective; their aim is find out the occurred problem by detection mode. Instead, the aim of Quality Assurance and Total Quality Management is reduce and to avoid problems occuring (McCabe, 1988). The characteristic of the different stages in Quality Management as shown following:-

Figure 1: The four stages of quality management

TQM

QA

QC

Inspection

Adapted from Dale, Boaden and Lescelles 1994: Levels of total quality management adoption

(Dale, Boaden and Lescelles, 1994)

Figure 2: The four stages of quality management

Quality Assurance

Quality systems development

Advanced quality planning

Comprehensive quality manuals

Use of quality costs

Involvement of non-production operations

Failure mode

Total Quality Management

Policy deployment

Involve suppliers and customers

Involve all operations

Process management

Performance management

Teamwork

Employee involvement

Quality Control

Develop quality manual

Process performance data

Self-inspection

Product testing

Basic quality planning

Use of basic statistics

Paperwork controls

Inspection

Salvage

Sorting, grading, relending

Corrective actions

Identify sources of non-conformance

Adapted from Steven McCabe 1988: Quality Improvement Techniques in Construction

(Steven McCabe, 1988)

Stage 1 : Inspection

The first stage of quality management is inspection. The inspection is defined as " Whether the activities implemented by each feature, such as metering, measurement, testing and inspection, the characteristics of one or more entities, and compare these results with the prescribed requirements in order to establish" (McCabe, 1988).

Inspection is used by most of the construction industry to ensure the conformance. The site supervisor will carried out the inspection of the construction project. The supervisor will make the comparison the architectural works and structural based on the specification and drawing. If there is any defective works found by the customers, the contractor need to rectify the defective works until fulfill the customer's requirement.

Stage 2 : Quality Control (QC)

Quality control will be carried out after the inspection done. Quality control is considered as a system of routine technical activities, to measure and control the quality of the inventory as it is being developed (Mangino, 1996).

The procedure of Quality control is very complicated. QC mostly is based on the statistical analysis. Collection of data is required in QC to maintain the quality by statistical techniques.

Stage 3 : Quality Assurance

Quality assurance is defined as “ implemented all planned activities within the quality system, and proof of the need to provide adequate confidence that an entity will meet the quality requirements” (McCabe, 1988).

The objective of Quality Assurance (QA) is to provide adequate confidence that a service or product will fulfill customers’ requirement by performing system audit, Failure Mode and Effect Analysis, design of experiment and similar initiatives (UTM, 2003). In other words, QA is more specified on planning. The prevention of poor quality and defects is based on detection activities.

Stage 4 : Total Quality Management

The final stage of quality management is Total Quality Management. The implementation and understanding of quality management principles and concepts in every aspect of business activities are involved in this stage. The best service or product will be provided to the customer at the lower cost by using these activities.

However, TQM is less formal; having either procedures or system, and it is hard to be described due to it is less in formality (McCabe, 1988). Normally, only guidance will be provided by TQM and it consider as a philosophy.

Concept and Principles of CONQUAS 21

2. 2. 1 Introduction

Recently, the requirement of customers towards the building that they purchase is quality. They wish to get the best quality of the purchase building as possible. In this condition, the developers have to play an important role to ensure the quality of the building project. The developers overcome the problem by using Quality Assurance (QA) and Quality Control (QC) into the construction project to maintain the standard of quality as the requirement. CONQUAS 21, ISO 9001: 2000, QLASSIC will become the choice for the developers for their assessment system. Case study about CONQUAS 21 will be carried out by the researcher in more details.

2. 2. 2 Objectives of CONQUAS 21

There are three objectives in the CONQUAS 21 system:

Act as a standard quality assessment system in construction projects.

Inspecting quality assessment by:

Measuring the specification and standard of the workmanship in the works done

Randomly selecting the sample as represent the whole project

To enable quality assessment systematically take place within reasonable cost and time

(Building and Construction Authority (BCA), 2006)

Scope of CONQUAS 21

In CONQUAS 21 system, all the works done will be given points based on the quality standard. All of the given points will be added together to get the total quality score which also known as CONQUAS score for the construction project (Building and Construction Authority (BCA), 2006). The quality workmanship is better, the higher of CONQUAS score will be obtained. 100% is the maximum CONQUAS score in construction project, but our human being is unable to construct a work with zero-defects.

The general building works is covered by CONQUAS 21 system. There are 3 components in the assessment:

Structural Works

Architectural Works and

Mechanical & Electrical (M&E) Works

There are different item to be assessed in the different component stated above (Building and Construction Authority , 2005).

CONQUAS 21 is considered as ‘ first time right’ inspection approach (Building and Construction Authority , 2005) means that the rectification works will not take into consideration in CONQUAS 21 score for the assessment. Furthermore, sampling system is the assessment system used in the CONQUAS. The assessor will choose the unit according to the average, 1-in-4 apartment units in a residential development for the assessment (Building and Construction Authority , 2005). Thus, which unit will be chosen is

unknown so the contractors have to ensure all of the constructed works are in good quality condition. If there is any defective found, the works will be considered as failed.

Besides, the heavily equipment-base such as heavy foundation, sub-structure works and piling is not available for assessment and the work separate contracts or sub-contracts are not included in the assessment (Building and Construction Authority (BCA), 2006).

The inspection is different with the inspection done by the site supervisor. Normally, the contractors have to purposely do an arrangement for the inspection which form a specific team for the inspection. There is a guideline have to be followed for the assessment.

Components to be assessed

Structural Works, Architectural Works and M&E Works are the components under CONQUAS 21 assessment.

Structural Works

Structural Works can be considered as ‘ body’ for a building, the stability of the building will be affected if there is failure or defect in structural works. Thus, maintain its quality is necessary due to the cost of rectification is very expensive. Below show the details of the assessment of Structural Works:-

Inspection of finished concrete, formwork and steel reinforcement have to be carried out on site during the construction site. If any component constitutes exceed 20% of the total structural cost, the pre-stressed concrete and

structural steel are included in the assessment. If found the precast concrete volume more than 20% of structural concrete volume, the precast elements have to be assessed.

Tensile strength of steel reinforcement and testing of compressive strength of concrete will be carried out on laboratory testing.

Non-destructive testing of the uniformity and the cover of hardened concrete.

(Building and Construction Authority (BCA), 2006)

Appendix 1 shows the quality standards of Structural Works.

Architectural Works

The components and finishes are classified in Architectural Works. The workmanship and quality can be easily seen and found. Below are the details of assessment of Architectural Works:-

After the building have complete, the assessments have to be carried out on roofs, external works, external walls and internal finishes. All the assessments have to be carried out on site. Internal walls, doors, components, windows and floors are classified under the internal finishes.

Functional and material tests such as on adhesion of internal wall tiles, water-tightness of window and external walls

(Building and Construction Authority (BCA), 2006)

Appendix 2 shows Architectural Works quality standard.

Mechanical & Electrical (M&E) Works

The progress of whole building will be influenced by M&E Works. Air conditioning & Mechanical Ventilation Works (ACMV), Electrical works, the basis M&E fittings and Fire Protection Works are classified under the progress of the building. Below are the stages of assessment:-

Concealed pipes, ACMV ductworks and electrical conduits are classified as installed works, the inspection on the item have to be carried out before embedded on site.

The cooling tower, fire alarm control panel and Air-Handling Unit (AHU) are the final installed works which the assessments have to be carried out on site.

Dry Riser Test, Earthing Test and Water Pressure Test are considered as selected works. The performance tests are carried out on them.

(Building and Construction Authority (BCA), 2006)

Appendix 3 show the quality standard of M&E Works.

The Weightages

CAT A (Commercial, Industrial, Institution and Others), CAT B (Condominium, Institution and Others), CAT C (Public housing), and CAT D (Landed properties) are the four categories of building that distribute the weightages

for M&E Works, Architectural Works and Structural Works in CONQUAS 21 system.

The objective of weightage system is making the quality of a building is based on the CONQUAS scores. In general, M&E works consist 10% for four categories of building in average, 35% is consisted by the Structural works and the highest percentage is consisted by Architectural works which 50% in average for the four categories of buildings. The quality of Architect works is the most important with the highest percentage, second is represented by the Structural works and M&E works is the lowest.

Table 2: The Weightages in CONQUAS 21

Components
CAT A Commercial, Industrial, Institution & Others
CAT B Commercial, Industrial, Institution & Others
CAT C Public Housing
CAT D Landed Properties

Structural Works

30%

35%

45%

40%

Architectural Works

50%

55%

50%

55%

M&E Works

20%

10%

5%

5%

CONQUAS Score

100%

100%

100%

100%

Adapted from Building and Construction Authority (BCA): CONQUAS 21 manual book

(Building and Construction Authority, 2006)

CONQUAS Assessor

In CONQUAS 21 system, only the Building and Construction Authority (BCA) officer can be the assessor to inspect the works done of the project. BCA will conduct a calibration program and training for assessors to attend to ensure competency and consistency in the assessment (Building and Construction Authority, 2006).

Furthermore, CONQUAS 21 system is consider as independent assessment. Therefore, the architects and engineers are not allowed to use CONQUAS to make any decision unless the building contract specify it (Building and Construction Authority (BCA), 2006).

Sampling

Sampling system is introduced in the CONQUAS 21 system for the assessment. It is impossible for us to inspect every unit of the works done. Thus, the sampling system is used for the assessment, it helps the accessor a lot by saving the time and make the assessment easier due to the samples will be randomly chosen by the assessor for inspection to represent the quality of whole project, not every unit will be assessed.

Furthermore, the sampling system want to make sure the inspection is sufficient to represent the whole building by referring to the gross floor area of the building.

The assessment of CONQUAS 21

Assessment approach

Sampling system is used by the CONQUAS 21 as the assessment system, the sample will be randomly selected for the quality assessment according to the location plan and drawing plan and it will be distributed based on the construction stages (Building and Construction Authority (BCA), 2006).

Furthermore, “ doing things right the first time” is the principle of the CONQUAS 21 system which want to make sure all the contractor do the works well and maintain the quality in first time. Thus, the scoring will not take into account for the rectification works, only the first time works done will be inspected and scored in the CONQUAS 21 system (Building and Construction Authority (BCA), 2006).

In filling the assessment form, “ X” mean the work done do not fulfill the CONQUAS quality standard after inspection on it. Instead, “” consider the inspected work have reached the quality standard stated in the CONQUAS system. Besides, not applicable item will be noted as “-” in the assessment form. The number of “” over the total number of item assessed is the final score of CONQUAS for the whole project.

Structural works assessment

After the whole projects have been completed, the inspection on structural works only can be done. Wall, slab, beam and column can be classified as the Structural works. Below show the details of the assessment of a reinforced concrete structure:-

Table 3: The assessment of a reinforced concrete structure

Reinforced Concrete Structure	Weightage %
Formwork	15
Rebar	20
Finished Concrete	25
Concrete Quality	5
Steel Reinforcement Quality	5
NDT – UPV test for concrete uniformity	15
NDT – Electro-Cover meter test for concrete cover	15

Total

100

*If total precast concrete volume exceeds 20% of total structural concrete volume, assessment will be carried out for precast concrete construction. The points will be distributed proportionately between formwork/rebar assessment and precast concrete assessment based on the respective concrete volume percentage.

Adapted from Building and Construction Authority: CONQUAS 21 manual book

(Building and Construction Authority, 2006)

The structural works assessment is carried out by using sampling system which mean only part of the samples have been chosen to represent whole project for the assessment, not every unit is inspected. Thus, there are some guidelines for the assessment of structural works. The guidelines are shown as below:-

Table 4: Guidelines for Structural works assessment

Items

GFA per Sample

Min Sample

Max Sample

Remarks

1

Structural Elements

500 m2

30

150

For Non-Housing Project

1a

Strctural Elements

1500 m2

30

50

For Housing Project

2

Concrete Compressive Strength

—

100%

—

Declaration by Qualified Person

3

Steel reinforcement Tensile Strength

—

100%

—

Declaration by Qualified Person

4

NDT – UPV test for concrete uniformity

5, 000 m2

2 sets

20 sets

5 structure members per set

5

NDT – Electro-Cover meter test for concrete cover

5, 000 m2

2 sets

20 sets

5 structure members per set

Adapted from Building and Construction Authority: CONQUAS 21 manual book

(Building and Construction Authority, 2006)

The inspection is only site inspection, the inspection cannot be done at precast yard due to all the structure works to be inspected is cast in-situ concrete works, not the precast component. The inspection of the structural works is according to compliance to the standards (see in the Appendix 1, 1a, 1b & 1c).

The further assessment will be required if the structural steelwork in the structural works exceed 20% of the structural cost and the points will be distributed proportionately. The Pre-stressing Works is similar with the structural steelwork (Building and Construction Authority (BCA), 2006).

Below table show how the points of pre-stressed concrete and structural steelwork are distributed:-

Table 5: Structural Steelwork

Structural Steelwork	Weightage %
Main member/Partially Assembled Component	40
Metal Decking	20
Erection Tolerances	10
Corrosion & Fire Protection	

10

Welding Test Reports

20

Total

100

Note: Assessment for structural steel roof truss is compulsory irregardless of the 20% costing criteria.

Adapted from Building and Construction Authority: CONQUAS 21 manual book

(Building and Construction Authority, 2006)

Table 6: Pre-stressed Concrete

Pre-stressed Concrete

Weightage %

Tendon & Anchorage

25

Sheathing

25

Stressing & Grouting

25

Debonding

25

Total

100

Adapted from Building and Construction Authority: CONQUAS 21 manual book

(Building and Construction Authority, 2006)

Table 7: Selection of Samples for Structural Steelwork

Items

Steel tonnage per sample

Min Sample

Structural Elements