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Comparison of Construction Quality Management Systems in Japan, Hong Kong and Singapore

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Abstract
Infrastructure construction has always been attached to economic development and the management of quality problems associated with construction is expected to evolve continuously. This paper presents a literature review of the recent construction quality systems in Japan, Hong Kong and Singapore. All these three Asian countries have already developed high standard of construction management. The quality management concept had caught the attention of the Japanese construction industry since the 1970s. By applying the quality management tools, many Japanese contractors are practicing total quality management. In order to compete internationally, they also commenced their ISO 9000 certification programmes in mid 1990s. The awareness on construction quality in Hong Kong emerged in late 1980s. The Performance Assessment Scoring System (PASS) was introduced in 1990 for measuring building contractor performance. In 1993, the authorities commenced ISO 9000 registration requirements for contractors and consultants in Hong Kong. In Singapore, the Construction Quality Assessment System (CONQUAS) was set up in 1989 to assess the quality of construction work. In 1999, the Singapore government announced the ISO 9000 certificates requirement for contractors and consultants. The Building Design Appraisal System was also set up by the government in 2001 to assess the quality of buildability in design.

Keywords
Construction, Quality, Quality Management, Quality System, Asia, Japan, Hong Kong, Singapore

1. Introduction

Japan represents the most prosperous economy, not only in Asia, but in the world while Hong Kong and Singapore represent the two most developed Newly Industrialized places in the Asian Pacific region (Walker & Flanagan, 1991).

The quality management of construction works has become a popular topic world wide as a result of intensified competition and more stringent client expectations (Kam and Tang, 1997, Tam et al., 2000). Construction industry in Japan has been greatly influenced by the success of total quality management in the manufacturing sector. Both Hong Kong and Singapore have been implementing a comprehensive quality benchmarking system for public housing construction for more than a decade. Governments in all these three places have also been imposing the international ISO 9000 quality management standard certification requirement on tendering public construction works. In the following sections, the quality management systems in Japan, Hong Kong (Hong Kong SAR, China) and Singapore will be discussed and compared based on a literature review carried out by the authors.

2. Construction Quality Systems in Japan

2.1 Total Quality Management in Japanese Contractors

In early 1970s, there was a strong complaint from the owners and the public alike that construction quality in Japan was abysmal (Adbul-Aziz, 2002). Most contractors followed the lead of their manufacturing counterpart and began incorporating Total Quality Management (TQM) philosophies into their organizational culture.

Nearly all Japanese contractors are adopting TQM as their company quality policy (Xiao and Proverbs, 2002; Levy, 1993). They build up long-term relationships with customers and subcontractors. They invest in their own future by providing well-designed, on-the-job training both for their own and for their subcontractors' staff (Bennett, 1993; Levy, 1993). The concept of Kaizen (continual improvement), customer satisfaction and company wide responsibility are the major principles for establishing the system (Bennett, 1993).

Most contractors in Japan have incorporated design teams in their corporations whose quality systems usually contain an upstream section for design and a downstream section for conformance. The main features of total Quality Management in construction in Japan are summarized as follows:

2.1.1 Design and planning

Design of works is complete in every detail before construction begins. The detail design is based on standardized details which are familiar to the subcontractors. The overall effect is that buildability, based on well practiced methods and skills, is thoroughly considered at the design stage (Bennett, 1993; Maeda and Maeda, 1997). Construction works are planned in exceptional detail on every project, with remarkable consistency. The starting point of the consistency is that construction projects are completed exactly on time by main contractors with no exceptions (Levy, 1993; Bennett, 1993; Paulson and Aki, 1980).

2.1.2 Work routine

Commitment to quality by the contractors results in meticulous attention to detail. Once work commences, all tasks including material purchasing, payments, labour engagement and design work are carried out on site. Every activity undergoes the same plan, check, double-check and record regime. Moreover, almost every level of site management is by consensus, with plans and policies being agreed by all the parties including client, designers, engineers, supervisors and subcontractors (Paulson and Aki, 1980; Levy, 1990). The project managers are expected to prepare reports on matters as diverse as the weather, labour, machinery and raw materials. All such meticulous documentation is connected to TQM's requirements for decisions to be based on data and facts.

2.1.3 Cost Control

In Japan, contracts are normally awarded on a lump sump basis (Hasegawa, 1988). Cost control has to be as tight as it can be. For a typical design and build contract, cost control starts at preliminary planning and continues all the way through to final delivery. The contractors operate on the general assumption that if the quality and time criteria are fulfilled, costs will then look after themselves (Bennett *et al.*, 1987) Adjustment to contract sums due to variations is issued through gentlemen negotiations based on reasonableness and relative bargaining strengths (Abdul-Aziz, 2002).

2.1.4 Time control

In Japan, because of client expectation, meeting delivery deadlines becomes almost sacrosanct (Levy, 1990). Hence a lot of effort is spent on programming using bar charts and network technique for various time-frames ranging from total, monthly, and ten-day breakdown (Hasegawa, 1988). Detailed time control is achieved through consistent daily meetings with subcontractors who in turn hold their tool-box

meetings with the workers (Abdul-Aziz, 2002). Later in the day, the site management team conducts its own internal meeting to discuss whatever short term progress issues may have arisen. It is a common practice in Japanese projects that sufficient slack is built into the short-term schedules to ensure that all the key project dates are met (Bennett *et al.*, 1987).

2.1.5 Kaizen (continual improvement)

The Japanese contractors consider that the most important factor in steadily improving the remarkable consistency in performance is Kaizen, the continual incremental improvements (Bennett, 1993).Kaizen matters may be raised at daily meetings as an integral part of the normal work. Improvement ideas are taken seriously by the site management. The best ideas each year are selected to go forward to branch and then to the company presentation meetings. These presentations and publication are intended to emphasize the importance of looking for improvements by both staff and subcontractors.

2.2 Adoption of international quality management standards

It is considered by the Japanese construction industry that its quality management system needs to have a global as well as a corporate focus (Hirao, 1997). The Ministry of Land, Infrastructure and Transport (MLIT) started some pilots projects in 2000 in which ISO 9000 certification was included into the competitive bidding pre-qualification criteria. In 2001, MLIT expanded the trial for ISO 9000 series requirement to 155 construction projects and 21 service projects (RICE, 2002).

Many of the Japanese international main contractors take the lead in acquiring the international quality management standard to maintain their eligibility for tendering contracts internationally. These contractors started getting the ISO 9000 certification back in 1995. In 2003, it was reported that 12,950 companies had registered with the Japan Accreditation Board (JAB) for ISO 9000 certification in the construction sector (RICE, 2003).

3. Construction Quality Systems in Hong Kong

3.1 Development of Quality Systems in the Construction Industry

In the early 1980s, the Hong Kong Housing Authority (HKHA) decided to knock down and re-develope 26 public housing blocks which had been built during 1963 to 1975 and were having serious structural problems. Seventy thousand people were consequently required to be re-accommodated (Kam and Tang, 1997). Other quality related expensive maintenance problems associated with thousands of public residential buildings, including water leakages, de-bonded tiles and spalling of concrete also surfaced during 1980s and 1990s (Chiang *et al*., 2004). The continual increase in maintenance costs for the huge public and private establishment pressed the Hong Kong construction industry to promote quality assurance and management for its perceived potential saving in maintenance in the long run (Chiang *et al*., 2004; Kam and Tang, 1997).

In March 1990, the Hong Kong Government launched a “quality awareness campaign” and the Hong Kong Housing Authority (HKHA) took the initiative by striving for an improvement in the quality in the construction of all public housing works (Kam and Tang, 1997; Tang *et. al*, 2005). The key events in the Hong Kong Government’s drive for quality in construction are summarized as follows:

1. In 1991, HKHA implemented the Performance Assessment Scoring Scheme (PASS) and the Maintenance Assessment Scoring Scheme (MASS).
2. In 1993, HKHA required all building contractors to achieve registration under ISO 9000 series quality assurance standards.

3. In 1996, Works Branch required all design consultants and major main contactors under the public works listing to be certified to ISO 9000 series quality assurance standards.
4. In 1999, HKHA introduced Preferential Tender Award System for building contractors.

3.2 Performance Assessment Scoring System - (PASS) and (MASS)

The system was first introduced by the HKHA in 1990, aimed at building (Building Works PASS) and maintenance contractors (Building Works MASS) to ensure effective monitoring. It has been refined over the years and extended to building services sub-contractors (Building Services PASS and Building Services MASS) in 1997 (Tang *et. al*, 2005), and to piling contractors (Piling PASS) in 2005 (Hong Kong SAR Government, 2006). A separate set of quality indicator for laboratories after the name Laboratory Assessment Scoring System (LASS) was also introduced by HKHA in 1997.

Output assessment contributing to 70% of the total PASS score is conducted under the system for structural and building elements. Structural elements include reinforcement bars, formwork, finished concrete and construction quality. Building elements cover floor, internal and external wall finishes, ceiling, windows, plumbing and drainage, precast components, waterproofing, shop front and cladding.

With regards to input assessment which contributes 30% of the score, covering organization, resources, co-ordination and document, programming and progress achievement, safety and health and environment is evaluated (Tang et. al, 2005).

3.3 Quality performance considerations in tendering for public works

In managing the building contractor list, HKHA has taken the view that contractors who perform better in quality standard should be given more tendering opportunities than those less performing contractors. The PASS and MASS scores of the contractors are complied to a six-month composite score for their projects. The contractors are then separated into three groups by the composite target quality score at the upper 75% position and the composite lower score threshold at the lower 25% position. HKHA quarterly assigns the number of contract tenders to each band of contractors (Kam and Tang, 1997).

Similarly, the Hong Kong Works Branch also implemented the Contractors' Performance Index System in 2000 to provide a ready indication of contractors' performance standard for tender valuation. A quarterly measured weighted average of the project performance scores in the immediate past three years is taken as the contractor's current performance rating. The highest contract sum category and the most recent project report receive the heaviest weighting (Hong Kong SAR Government, 2000).

Quality performance assessment by the government bodies is also extended to architectural and engineering consultancy firms for public works projects. The works branch assesses quality aspects of the consultants in establishing the branch performance index system which has been used as a criterion for selection of consultants since July 2003 (Hong Kong SAR Government, 2003). Likewise, the assessment on the quality aspects of consulting firms in public housing projects has also been included in the consultancy selection process since 1998 through a price and quality competition mechanism in which the technical and quality submission carries a maximum weighting of 80% (Hong Kong Housing Authority, 2001).

4. Construction Quality Systems in Singapore

4.1 Development of Quality Systems in the Construction Industry

Quality in the Singapore construction industry first began to gain attention in the late 1970s (Low, 1993). The Construction Industry Development Board (CIDB) was formed in 1984 with a main task to oversee,

train and develop the construction sector (Kam and Tang, 1997). In 1999, it then merged with another government department to form the Building and Construction Authority (BCA) which now administers both the development and regulatory functions pertaining to the construction industry. CIDB set up the construction quality assessment system (CONQUAS) for public building construction in 1989 (Kam and Tang, 1997).

Quality in consultancy services is also managed by BCA. In conjunction with the launching of the central panel system in 2004, the Quality – Fee selection method was implemented for procuring consultancy services in architectural, civil, structural, M & E, quantity surveying and project management. The quality to fee weighing varies from 60/40 to 80/20 depending on the nature of the services to be procured (Quality–Fee Method, 2004). The Buildability Design Appraisal System (BDAS) was also implemented in January 2001 to enhance buildability, productivity and quality in the industry (BCA, 2005).

To further recognize the importance of construction quality, BCA imposed mandatory quality management system standard requirement in July 1999, when ISO 9000 certificate became a prerequisite for contractors and for consultancy firms undertaking public sector projects with values above S$10 million and $30 million respectively (BCA ISO 9000 Certification Scheme, 1991).

4.2 Quality Assurance Certification Scheme

The requirements for ISO 9000 certification for contractors and consulting firms who undertake government projects took effect from 1 July 1999. These requirements apply to:

1. Contractors with a registration grade of A1, A2, B1 and B2 (with tendering limits unlimited, S$ 65 million, S$30 million and S$10 million respectively) in BCA's Contractors Registry undertaking general building, civil engineering and piling works.
2. Consulting firms engaged in architectural, engineering and quantity surveying services who undertake public construction projects valued at more than S$30 million.

4.3 Construction Quality Assessment System (CONQUAS)

CONQUAS was initially implemented in 1989 for public building construction. The scoring is done on the works that are inspected for the first time. The objective of this practice is to encourage "*doing things right the first time*" (CONQUAS 21, 1998). After refinements and with modifications, it was then extended to cover also private building and civil engineering construction. The fifth edition of this assessment scheme was launched as CONQUAS 21 by the Building and Construction Authority (BCA) in 1998, together with the Bonus Scheme for Construction Quality (BSCQ) (Chiang *et al*., 2004).

4.4 Public construction tender quality bonus and discount

In attachment to the CONQUAS quality scheme, the Singapore government has set up a bonus and discount mechanism for tendering of public works. In 1990, one year after the launching of the CONQUAS scheme, the associated premium scheme was also introduced to provide tendering advantages of up to 5% or S$5 million who consistently achieve good-quality work as reflected by high CONQUAS scores (Kam and Tang, 1997). Upon the launching of CONQUAS 21, the maximum tendering advantages reduces to 3% or S$2 million. A maximum disadvantage loading of S$2 million will however be imposed on contractors having scores below the average CONQUAS score (CONQUAS 21, 1998).

4.5 Buildability Design Appraisal System - Buildability score

The legislation of buildable design took effect from January 2001, after which the Code of Practice on Buildable Design then applied to building work developments. Minimum Buildability Scores are required

to be met prior to development approval. In 2005, the minimum Buildability Score for new building varies from 57 for residential (landed) of GFA less than 5000 m^2 and to 77 for industrial of GFA more than 25,000 m^2 (BCA, 2005).

5. Comparison of the Construction Quality Management Systems

5.1 Systems in Japan

With the success in total quality management (TQM) in the manufacturing industry, Japan has adopted the TQM principles in the construction industry as early as 1967. Like their counter part in manufacturing, a lot of contractors consider the achieving the top quality awards such as the Deming Prize and the Japan Quality Control Medal Award as part of the company policy.

Design and construct contract is the main stream procurement process in Japan. Many main contractors have established their own design and architectural department. Broadly, the management of quality can be divided into two portions, design quality management and conformance quality management.

The basic techniques used in TQM in construction are detail design and planning, standardization of construction process, consistent daily meetings, quality control circle, tests and statistics, customer relationship, scheduling monitoring and continual improvement (Kaizen).

Quality management in the construction industry is already integrated into the overall company and project management. Under the TQM approach, quality management in the construction organizations cannot be separated from the management of cost, time, safety, environmental and most importantly customer's satisfaction. The implementation of TQM is not mandatory. The initiation is mostly driven by customer satisfaction and the perceived benefit of reduction of defect and increase of business opportunity.

Quality culture in the construction industry was supported by the nation-wide education principles of economic prosperity, nationalism and social stability (Tan, 2003). As part of on job training, engineers work with foreman to pick up work process experience in an efficient manner (Paulson and Aki, 1980). Entrepreneurs view that industry would benefit from a highly educated workforce (Tan, 2003).

ISO 9000 certification is widely adopted in the international Japanese main contractors.

5.2 Systems in Hong Kong

All quality management requirements in the construction industry are basically driven by the clients, in both public and private sectors.

The Performance Assessment Scoring System (PASS) was lunched by the housing authority in 1991. The system focuses on monthly output assessment which carries 70% of the score weighting. The remaining 30% weighting of the score relates to input and maintenance assessment. As an intended incentive, quality assessment scores were used systematically for assigning the maximum tendering opportunities for the public housing contractors. The system is considered as a quality performance benchmarking with inclination towards informing procurement decisions (Bakens and Bakens, 2005).

In 2000, similar performance assessment systems, also with their assessment scores being taken into consideration in tendering process, extended to other types of public construction works undertaken by the works branch. Likewise, consultant services procurement for public works has also adopted a price and quality competition selection mechanism since 1998.

Contactors and consultants are now required to be continuously ISO 9000 certified should they wish to stay in the general eligibility list for tendering public works and services. Major private developers and infrastructure incorporations have also imposed ISO 9000 certification as their pre-requisite for tendering eligibility.

5.3 Systems in Singapore

The development framework of the construction quality management in Singapore is similar to that of Hong Kong. The management and assessment schemes were also to a great extent driven by the public client but are now gradually receiving more supports from the private clients.

The Building and Construction Authority (BCA), previously known as Construction Industry and Development Board (CIDB), was set up in 1984. It administers both the development and regulatory function pertaining to the construction industry for the whole of Singapore. It introduced the CONQUAS system for housing construction back in 1989. The system focuses on inspection on completed but not rectified or corrected products. The scheme provided premium tendering advantages of up to S$5 million for high scoring contractors in the initial stage of scheme implementation. As from 1998, the premium advantages have been reduced to S$2 million. The system is considered having provided a positive impact on the reduction of defects (Bakens and Bakens, 2005). It is also classified as a benchmarking focusing on product performance in satisfying client's expectations (Bakens and Bakens, 2005).

As from 2001, all development and design submissions are controlled by the Buildability Design Appraisal System. Minimum buildability score is required for the approval of development plans by BCA.

In addition to the benchmarking scheme, BCA also requires the major contractors and consultants to be ISO 9000 standard certified as from 1999.

6. Conclusion

The literature review introduced the principles and types of construction quality systems in Japan, Hong Kong and Singapore. The physical differences between these systems are identified. In Japan, the systems are dominated by the TQM principles and culture. In Hong Kong, the systems focus on project performance assessment, the results of which are considered by the government systematically in deciding tender eligibility and in tender valuation. In Singapore, the benchmarking systems are deliberately designed to provide direct tendering premium advantages. However, all the three places cannot disregard the international prevalence of the ISO 9000 standards of which the efficiency has been confirmed in other industrial sectors.

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