

# **Building Commissioning - A Perspective and Development in Hong Kong**

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## **Summary**

Only a properly commissioned process for buildings can ensure a comfortable, cost effective, energy efficient and healthy and safe built environment in the long term building operation and maintenance. This paper presents an updated account on the perspective and development of the building and HVAC system commissioning in Hong Kong. With the increasing demand and the trend of promoting proper building and HVAC system commissioning in Hong Kong, the necessity to establish a Hong Kong Building Commissioning Centre is discussed. This paper will first start with the discussion of the background of the building and construction developments in Hong Kong. It gradually elaborates the issue through legal and contractual arrangements, social awareness from economy and environment. With the gradual introduction of the concept with HVAC commissioning models, education and trainings on some building applications, it allows full involvement of the HVAC and building services engineers in the building and HVAC commissioning process. In turn, it enhances the building and system qualities.

## **1. Introduction**

Building systems commissioning, in short, known as building commissioning (BCx) is recognized as an important tool in quality control of building projects. Good system design does not guarantee the system to have optimal performance. The purpose of the commissioning (Cx) process is to verify the performance of the systems and to provide documentation evidence that all equipment and systems are installed and functioned according to the design intents, standards and requirements of the client. Through the Cx process, all equipment and systems must be identified, labelled and set up. They are ready for efficient service and maintenance after handover. However, BCx has never been systematically and strategically promoted in the ‘program’, ‘design’, ‘construction’ and ‘acceptance’ stages. This has not been properly addressed. Very often, Cx is overlooked by owners, architects and engineers, contractors and operators mainly due to mis-conception on Cx as a “less technical and lower level task”. As a result,

commissioning process is implemented differently from project to project, firm to firm, and sometimes polarized by “personal expertise”.

Due to the increasing demand on high quality buildings, and also the stringent requirements on energy, environment and safety, construction professionals have devised various quality control tools in achieving these requirements where building commissioning is one kind adoptable as quality documentation and checking tools.

## **2. Building and Construction Developments in Hong Kong**

In the last two decades, the Hong Kong construction works were developed rapidly. The gross value of construction work performed by main contractors in the last five years is shown in Table 1 (see appendix). The construction value went up from HK\$67 billion in 1992 to HK\$133 billion in 1998. It signified a growth of 197%. Unfortunately, it fell down to HK\$113 billion in 2001 similar to the level at 1996 mainly due to the Asian financial crisis happened in 1997-1998. In 2002, the total number of submission of new and major revision building plans was 419. This was only 72% compared with the number of 586 submissions in 1997. In 2001, the total workers employed in construction industry were about 80,000 and the gross value of construction was 113 billion which was about 4.8% of GDP.

The conventional concrete structure building construction technique has been adopted for decades. Not until the early seventies, with the introduction of steel structure construction technique, the building construction process has been speeded up. At that time, the rising economy also contributed a rapid development in building construction industry.

Due to the above two reasons, the building and construction developments in Hong Kong is very efficient. Although building structures and services technology development become more and more advance and complicated, large building developments in Hong Kong could still be completed within two to three years in average. Such fast development of buildings construction in Hong Kong actually imposed certain drawbacks in the construction quality control. Because of the fast and unreasonably high yields in investment, developers are indulged by this paradoxical situation to continuously invest and develop properties without thought thinking in quality control. In such a fast construction process, time allowed for design checking and functional verifications of system and installation would not be adequate. In case of delay in construction progress caused by unforeseen reasons, the time allowed for commissioning

activities in the master program will be inevitably and unreasonably squeezed. If the building professionals are not familiar with or lacking of management and practices in the new technologies, this will lead to poor interactions of building and services in the final 'acceptance' stage. It was supplemented with insufficient time allowed in verifying systems performance and rectification of faults and defects, hence leading to poor quality buildings.

### **3. Environment and Economy Drives**

Buildings are no longer considered just a place to work and live; people set up business and make profits from buildings. So, the demand on high quality building is envisaged. With the issues of indoor air quality, occupational safety and health, and energy efficiency, public-at-large pay more attention to the built environment. Irrespective of residential and commercial buildings, sick buildings syndromes have been arousing public concern in the early eighties. Various studies on better environment such as IAQ issues have been widely discussed in last ten years. The effect of outdoor environment due to indoor pollutants exhausted from building has educated people to pay more attention to building quality that building commissioning helps to monitor the performance.

In the economy side, with the blossoms in property market from 1990 to 1997, the building values go up and up without much major concern on building quality. From the 1998 recession, the prices and rentals of buildings slip down drastically up to 50% in the last five years as shown in Table 3. Tenants or users decide to move office from a higher grade building to a lower grade building. To maintain the rental business and to attract customers, building owners have to inject new features into buildings such as IT infrastructures, better decoration and of course a reasonable rental charge resulted from the better energy utilization. Hence, owners are willing to pay more attention to the building performance through some sorts of improvement works. Building commissioning is considered as a quality control tools in monitoring the system performance after renovations, additions and alterations.

### **4. Legal Issues, Contractual Arrangement and Current Situation**

Hong Kong had been ruled by the British for 155 years since 1842. Indeed the local building and construction codes of practices are copied from the British models. The building regulations adopted in UK are generally good for the Hong Kong building

industry with certain modifications for high-rise buildings.

However, the British building regulations have no mention about building performance and energy efficiency until two years ago, the amendments on Building Regulations with a Part L – Conservation of Fuel and Power (L1 for dwellings and L2 for non-domestic dwellings) aimed to reduce the emission of CO<sub>2</sub>, that stated the requirements on building design, construction and inspection and commissioning on building services systems.

The Building Ordinance of Hong Kong was first adopted in 1956 with amendments made up to 1997. The Buildings Department has authority to approve the building plan submission with energy efficiency being one of their considerations. The regulation is known as the Building (Energy Efficiency) Regulation enforced since 1995 which specified the ‘overall thermal transfer value’ (OTTV) for the building envelope of the podium and tower not to exceed 80W/m<sup>2</sup> and 35W/m<sup>2</sup> respectively. On the other hand, the use of energy in building services system for Government buildings is administered with data gathering for statistical analysis by the Energy Efficiency Office of the Electrical and Mechanical Services Department (EMSD) of the Government. EMSD also publishes various documents in the form of codes of practices and guidelines. They promote the implementation of building energy codes which set out the minimum energy efficiency for air-conditioning, electrical, lifts and escalators and lighting systems inside buildings. Moreover, the EMSD is also responsible for the certification of the electrical appliances on Energy Efficiency Ratio (EER) which is a product benchmark in electrical energy efficiency. Nevertheless, apart from the regulations, the above schemes are purely voluntary, building owners have no direct tangible benefits in participation.

Before 1970, most construction professionals were recruited from the UK. They brought in construction technique and know-how, also the construction and project management model and practice. In the UK construction management model, the architect is the project leader with engineers and surveyors working as part of his team. Traditionally, the architect will first design the layout with structures and services input from the structural and services engineers; quantity surveyor helps to compile the contract document and bills of quantities so that cost control is vitalized. Construction work is usually monitored by the architect with assistance from Engineers, Clerks of Works and Inspectors for architectural and E&M installations. Such arrangement is well illustrated in the Architect’s Handbook of Practice Management by the Royal Institute of British Architects. Obviously, the building quality is heavily relied on the project team led by the architect. It is quite well adopted that architects do not receive much training in building commissioning process.

The Chartered Institution of Building Services Engineers (CIBSE) drafted the first commissioning code in 1966. The Cx documents were brought to Hong Kong in the early eighties. CIBSE defines the term “commissioning” as “the advancement of systems from static completion to dynamic operation according to requirements”. This is obviously a process to test the building systems after completion before the owner and operators take over them. This model is being adopted for years in Hong Kong and up to now, there is no sign of changing in the building industry.

In the UK and USA, professional negligence and indemnity lawsuit alert architects and engineers to pay good attention in quality control. Commissioning policy and process becomes an important tool in helping and maintaining quality. In Hong Kong, the legal framework indeed does not well support and encourage commissioning development as it is quite difficult to prove professional negligence and the excessive time in lawsuit procedure and course involved make people prefer to compromise in commercial settlement. Back to the contract, the only contractual binding in system commissioning is only a short paragraph in the technical specification. It states that building services systems shall be tested to the satisfaction of the Architects or Engineers, the scope and extent of works are not properly documented in the Conditions of Contract. Without a well-recognized and objective document from professionals, statutory and educational institutions, the commissioning goal will be jeopardized by personal judgment or somehow, including some commercial factors. Although certain services in relation to safety such as fire protection, lifts and escalators required a certified test record as demanded by the authorities, the guidelines in achieving the goal and how the contractors to perform the works are not well formulated. Contractors are always stated to be specialist contractors and they are all deemed to do the job properly according to practice. Moreover, there is no adoptable scheme or an acceptable standard in recognizing the academic qualifications, practical experiences, trade skill; and the contractors practice, documentation methodology and quality checks in commissioning for the commissioning people. The final results can be foreseen as the building quality differs from project to project; company to company; of course even worse, person to person.

For Government building projects, the Building Services Branch (BSB) of the Architectural Services Department (ArchSD) of the Hong Kong Government have been using a set of twelve Testing and Commissioning Procedures published since 1990. They were the first available commissioning documents covering the inspection and testing of HVAC, electrical, fire services, boiler and other services in buildings during the acceptance stage. Nevertheless, these procedures are applicable to government

buildings only such as hospitals, government offices designed by the ArchSD. For buildings developed by private sectors, they are still heavily relied on the owner's and construction professionals' perceptions in building systems commissioning.

## **5. Roles of the Hong Kong Building Commissioning Centre**

The excellent reputation of Hong Kong construction industry was seriously damaged by the discovery of the “short piling” scandals in 1998-1999. The Construction Industry Review Committee's report published in January 2001 suggested that the construction process and quality control shall be revised and remodeled. The Provisional Construction Industry Co-ordination Board (PCICB) established on 28<sup>th</sup> September 2001 was to spearhead industry reforms and to propagate a new culture of change in the Hong Kong construction industry. A group of local engineers who are working in owners, consulting firms; academic institutions, contractors and suppliers have discussed the recent issue on building commissioning. They decide to set up a focal point in promoting building systems commissioning, and to produce commissioning models that will be adoptable in local construction industry, and probably extended the applications to the Mainland China. In the light of the above, the Hong Kong Building Commissioning Centre (HKBCxC) was formed in June 2002 as a non-profit making entity and strategically affiliated with the Hong Kong Institute of Vocational Education (Tsing Yi Nexus). To formulate a better model and practice in building commissioning, the HKBCxC aims to develop in three fields, namely commissioning, energy utilization and operation and maintenance. Besides, short, medium and long terms policies and goals are defined in order to serve the public-at-large. Tentatively, three different categories of buildings, and three trade persons will fit in the commissioning circle as shown in Table 4.

Due to the fact that the British model for commissioning in the ‘acceptance’ stage has been well adopted in Hong Kong, and there are skilled technicians available in the field, the HKBCxC will first put more attention and effort in the review and refinement of the existing practices in commissioning procedures in the ‘acceptance’ stage. At a later stage, commissioning practice to be adopted in ‘construction’, ‘program’ and ‘design’ stages will be devised. This is indeed a bottom up approach. To achieve the initial goals, the HKBCxC will concentrate their effort in the following ways.

### **5.1 Education and Training**

In the USA and UK, there are academic institutions, research and development bodies

provide Cx education and training. The situation in Hong Kong is far different as trainings on building commissioning have not been properly emphasized. University degree courses in architectural studies, building technology and management, building services do not offer practically detailed illustrations on commissioning. In private sectors, the issue on commissioning as a company goal is not addressed. Precisely, the planning, formulating and implementing of commissioning between government and private sectors in different stages have never been coordinated. The sub-degree courses in colleges do include commissioning but it is not comprehensive enough for students to understand the whole Cx process. Indeed students only learn testing procedures, with some basic introduction on Cx process. The integration of Cx with other building quality control processes is not incorporated. Therefore, commissioning is still being considered by most people as a single process before handover.

Local engineers are now beginning to realize that the Cx ad-hoc courses conducted by foreign speakers have given them the insight of the importance of commissioning as a continuous process. However, such courses do not have sufficient focus and coverage with respect to local situations and practices. Being practical, the HKBCxC will focus to formulate a series of proper testing procedures for the application to systems commissioning. It is intended to conduct practical courses for the Cx technicians and to certify their competencies after they have satisfied some trade tests applicable to the acceptance stage of Cx. This scheme will gradually further extend to Cx supervisors and administrators who wish to be certified in competency in the Cx process applicable to the erection and program/design stages respectively.

## **5.2 Documentation**

The currently available documentation on building commissioning is the CIBSE commissioning codes which state the inspection and regulating procedures for the air, water, control, refrigeration and boiler systems. The ASHARE Guideline 1-1996 is not widely aware by local construction professionals. The Testing and Commissioning Procedures published by ArchSD are good for Government projects but may only be used for reference in commercial buildings.

In view of the existing shortage of a practical standard, HKBCxC will draft a set of Commissioning Specifications with the sections describing Cx as a general requirement, and with subsequent focus on respective services such as HVAC, Electrical etc. Apart from the above big document, a series of check lists and inspection forms will also be issued in order to enable the certified persons to handle Cx jobs systematically in various

stages.

## **6. Conclusion**

To the author's best knowledge and understanding, there is no local field research in building commissioning in Hong Kong. For Cx practice model, Cx cost and Cx professional competency are all varied in levels.

The formation of HKBCxC will somehow change the situation. In manpower training, competent persons in the levels of administrator, supervisor and technician will be trained and certified to cater for Cx processes. For documentation, a set of commissioning guidelines for HVAC, Electrical, Public Health, Fire and Safety, Building Management and Energy, Telecommunication and Extra-low Voltage, Lift and Escalator transportation services and Building Envelope shall be drafted. With the recent development in better built environment implemented by the Government authorities and the formation of Professional Green Building Council which is established by the four local professional institutions amongst architects and landscape architects, engineers and surveyors, the demand on proper Cx process will be gradually developed and promoted.

It is obvious from the previous discussion that Hong Kong is requiring a practical standard in commissioning of building systems. The standard has to adopt the best practices from UK and also USA. Moreover, this standard shall blend into the practical features, experience, knowledge and requirements of local practices. The Hong Kong Building Commissioning Centre missions that the Cx documents to be developed can become the most comprehensive and widely adopted documentation in the subject of its kind in future and can offer the most practical training to the commissioning professionals in the industry.

## 7. Reference

1. Tseng, P.C. "Building Commissioning: Benefits and Costs", Heating/Piping/Air-conditioning (HPAC), April 1998, p.51-59.
2. "Retrocommissioning Handbook for Facility Managers", Portland Energy Conservation, Inc. (PECI), March 2001.
3. Wong, Leo C.F., "Building Quality Audit and Inspection: Total Building Commissioning Process", Proceedings of Year 2002 Mainland and Hong Kong Conference – The Reform and Development of the Construction Industry; October 2002, Nanjing, China. (in Chinese)
4. Dicks, M., "Commissioning Management", Application Guide 5/2002. Building Services Research Information Association (BSRIA), 2002.
5. RIBA, "Architect's Handbook of Practice Management", 7<sup>th</sup> Edition, Royal Institute of British Architects, 2002.
6. Hong Kong Statistics, Census and Statistics Department, The Government of Hong Kong Special Administrative Region, 1997 - 2002.

## 8. Appendix

**Table 1**

Gross value of construction work performed by main contractors analyzed by broad trade group (from Buildings Department of HKSAR)

Year	Quarter	Private	Public	Locations other than site	Total (HK\$ Million )
1997		56,837	42,146	32,518	131,500
1998		61,233	40,742	31,341	133,316
1999		44,380	49,173	32,884	126,437
2000		39,094	50,817	32,161	122,071
2001		40,497	41,793	31,696	113,986
2002	1 <sup>st</sup>	9900	9,007	7,981	26,888
	2 <sup>nd</sup>	11143	8,464	7,809	27,416
	3 <sup>rd</sup>	10627	7,180	7,797	25,604
					79908 (Provisional)

**Table 2**

Private Buildings Newly Completed by End-use  
(From Census and Statistics Department of HKSAR)

End-use	Usable floor area of '000m <sup>2</sup>		
	1997	2001	2002
<b>Total usable floor area</b>	<b>1 848 (+0.8)</b>	<b>1 354 (-10.6)</b>	<b>1 960 (+44.7)</b>
Residential	712 (-7.5)	963 (-12.5)	1 411 (+46.5)
Commercial	541 (+28.7)	171 (+7.1)	289 (+68.6)
Industrial	392 (-8.1)	71 (-31.3)	20 (-72.6)
Others	204 (-6.7)	148 (-1.2)	240 (+61.9)
<b>Total cost of construction (HK\$ billion)</b>	<b>29.0</b>	<b>27.8*</b>	<b>42.3</b>

**Table 3**

Property Transactions (from Census and Statistics Department of HKSAR)

	1997	2001	2002
Value of registered agreements for sale and purchase of property (HK\$ billion)			
Residential property	690.3	150.9	154.3
Non-residential property	177.7	41.9	31.1
Total	868.0 (+82.9)	192.8 (-13.4)	185.4 (-3.8)
Property price index (1999=100)			
Private domestic units	163.1 (+39.5)	78.7 (-12.2)	69.8 <sup>#</sup> (-11.3) <sup>#</sup>
Private offices (Grades A, B and C)	213.1 (+13.1)	78.7 (-12.5)	68.0 <sup>#</sup> (-13.6) <sup>#</sup>
Property rental index (1999=100)			
Private domestic units	134.5 (+13.0)	95.4 (-2.8)	83.6 <sup>#</sup> (-12.4) <sup>#</sup>
Private offices (Grades, A, B and C)	156.8 (+3.0)	101.0 (+2.5)	85.4 <sup>#</sup> (-15.4) <sup>#</sup>

# Provisional figures / estimates

**Table 4**

Proposed Commissioning Circle - Buildings Categories and Trade Persons for Building Project (Proposed by HKBCxC)

Buildings Categories	Cx Process	Project Stages	Supervision	Trade Persons
Essential		Program / Design		Certified Cx Administrator
Elegant		Construction / Erection		Certified Cx Supervisor
Typical		Acceptance / post acceptance		Certified Cx Technician

Essential Buildings - daily operations and processes inside the building are ESSENTIAL to the public. In case of failure, it will be seriously affected or leading to communal disturbance and social violence

Elegant Buildings - built environment is ELEGANT to the owner and occupants for accommodation. In case of failure, the occupants will be affected and leading to disturbance. Besides, it is encouraged on major projects with \$50 million or more in total construction costs.

Typical Buildings - TYPICAL in nature. In case of failure, the effect to occupants and inside operations will be inconvenienced. Besides, it is encouraged on major projects with \$10 million or more in total construction costs.

Commissioning Administrator - A certified person who could oversee the Cx process from program to acceptance stages.

Commissioning Supervisor - A certified person who could supervise the erection process and monitor acceptance test on site.

Commissioning Technician - A certified person who could execute acceptance test on site.