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Building Operation and Maintenance: Education Needs in Hong Kong

Structured abstract

Purpose
Built facilities, in order to be sustainable, have to be operated and maintained by practitioners who possess the appropriate types and levels of knowledge. The study reported in this paper aimed to identify the available higher education programmes in this relation and investigate what kinds of education are needed by the O&M practitioners in Hong Kong.

Methodology/approach
The published information of the building-related programmes offered by the local higher education institutions was reviewed. A questionnaire, designed, piloted and distributed with the support given by the leading O&M society in Hong Kong, was used to survey the perceptions and opinions of the practitioners.

Findings
No education programme had been tailored for producing professionals to meet the rising demand for O&M works. The practitioners indicated their strong wish to learn more, in particular, about energy and environmental management, and testing and commissioning. Their desire for dedicated O&M programmes was also overwhelming.

Research implications
The survey and analysis method used in the study may be taken to investigate the education needs in other developing industries.

Practical implications
The relatively low levels that the practitioners perceived about their knowledge in most aspects of their works imply that there is room for improving work quality through enhancing O&M education.

Originality/value
The survey findings unveiled the contemporary education needs of the O&M practitioners, which are essential information that supports the development of some matching courses.

Paper type
Research paper

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Building Operation and Maintenance: Education Needs in Hong Kong

Introduction

Hong Kong, one of the most densely populated places (6,410 persons per square kilometer) in the world, is jam-packed with high-rise buildings. Buildings aged over 30 years, according to the Buildings Department (2005), account for one-third of the private buildings but they are often in lack of maintenance and thus dilapidated (Housing, Planning and Lands Bureau, 2007). Modern buildings, in order to meet the demanding user needs, are commonly constructed with quality fabrics and sophisticated facilities like air-conditioning systems, lifts, fire services installations, etc. Increasingly, new buildings are fitted with advanced green technologies such as resources recycling, energy recovery, and utilisation of renewable energy. All these existing buildings, be they old or new, would not be sustainable without proper operation and maintenance (O&M).

As evidenced by the diminishing gross value of construction work (Census and Statistics Department, 2009), the desire of investors to develop new buildings in this international financial centre (Information Services Department, 2008) has significantly declined since the Asian financial crisis in 1997. Consolidating data of the Rating and Valuation Department (2004; 2009), on the other hand, finds a steady growth of the private building stock which comprises office, commercial and factory premises (Figure 1). Statistics maintained by the Housing Authority (2009) also show 24.1% increase in private and public residential flats, from 2,004 thousands units in 1998 to 2,486 thousands in 2008.

"Take in Figure 1"

With fewer new developments after 1997, the building and civil engineering manpower, except a slight rebound in 2006, has dropped persistently (Figure 2). Whereas fluctuations in the architectural, surveying and project engineering manpower are not apparent, it is evident that the manpower directly engaged in real estate, leasing, brokerage and maintenance management, which embraces O&M practitioners, has increased continually. In meeting this demand, three possible scenarios have been suggested (Lai and Yik, 2007): i) some practitioners who used to work on new building projects may have switched their jobs to the O&M sector; ii) some experienced practitioners may have been sourced abroad; and iii) some fresh practitioners may have been produced by local educational institutions. Without relevant statistics, it is not sure which or which combination of these scenarios has taken place. But, whatever the case may be, the added workforce needs to have right and adequate knowledge for building operation and maintenance.

"Take in Figure 2"

According to an earlier analysis of the state of Hong Kong's buildings, however, higher education focusing on the use and upkeep of buildings seemed unavailable (Faculty of Construction and Land Use, 2007). Whether the O&M practitioners possessed the necessary knowledge is uncertain. How or how effectively they enriched their knowledge is also unknown. Aimed at addressing these questions, a two-stage research study was conducted. In the first stage, a desktop study was carried out to review the contents of building-related academic programmes which are locally available. In the second stage, a questionnaire survey was done to solicit perceptions and opinions of O&M practitioners. The data

collected from these two stages were analysed, based on which recommendations are made in respect of education for building O&M.

Programmes Relevant to Building O&M

The University Grants Committee, the supervising body of the higher education sector in Hong Kong, is funding seven universities and one educational institution. The City University of Hong Kong (CityU), the Hong Kong Polytechnic University (PolyU) and the University of Hong Kong (HKU) are the main ones which offer academic programmes involving application of engineering or surveying knowledge to buildings. Their extension arms, namely CityU SCOPE, PolyU SPEED and HKU SPACE, also run similar continuing education programmes. HKU SPACE Po Leung Kuk (PLK) is another one devoted to delivering sub-degree programmes.

The Hong Kong Institute of Vocational Education (IVE), operated under the Vocational Training Council of Hong Kong, provides sub-degree courses. Two of its nine campuses, Morrison Hill and Tsing Yi, offer courses particularly related to buildings.

Apart from operating its higher diploma programmes, the Hong Kong College of Technology collaborates with some overseas universities to deliver degree programmes. Besides, the Construction Industry Council Training Academy (CICTA) provides courses primarily for training practitioners at operational level.

While the current 3-year higher education system in Hong Kong is going to change to a 4-year system by 2012, there is, as yet, no published review of the construction or building

related courses. As such, a review of the course schemes and information posted in the websites of the foregoing institutions was carried out as part of the study. The programmes with subject titles relevant to building O&M are summarised in Table 1, with their study mode (FT: full-time; PT: part-time) and duration also indicated. Despite the previous critics that only "lip-service" education was paid to the use of buildings over time (Nutt, 1991), most of the subjects of these programmes remain design- or construction-oriented. Even though there exists an increasing number of programmes entitled "facilities management" (FM) and some of their subjects touch upon O&M issues, greater emphasis is placed on the *soft* side like lease management and customer service, rather than the *hard* side, e.g. fault detection and diagnosis, reliability of engineering systems.

Besides educational institutions, government departments such as the Electrical and Mechanical Services Department (EMSD) and some non-government organizations, e.g. the Hong Kong Building Environmental Assessment Method (HK-BEAM) Society, have introduced a range of codes of practice, guidelines and assessment schemes to promote best O&M practices for achieving sustainable buildings. From time to time, they collaborate with professional institutions, e.g. the Hong Kong Institution of Engineers (HKIE) and the Chartered Institution of Building Services Engineers (CIBSE), as well as learned societies like the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) and the Building Services Operation and Maintenance Executives Society (BSOMES), etc. in organizing some continuing professional development (CPD) courses for building practitioners. Unfortunately, an earlier study (Lai and Yik, 2006) found that the knowledge level of O&M practitioners about sustainable buildings bears little correlation with their attendance to CPD courses.

Table 1 Academic programmes relevant to building O&M

Institution	Programme	Mode	Duration
HKU	BEng in Mechanical Engineering (Building Services Engineering)	FT	3 yrs
	BSc in Surveying	FT	3 yrs
	MSc(Eng) in Building Services Engineering	PT	2-3 yrs
	MSc in Real Estate	FT/PT	1-2 yrs
HKU SPACE	ADip / Dip in Facility and Property Management	PT	2-5 yrs
	ProfDip in Facilities Management	PT	16 mths
	PgDip in Facilities Management	PT	1 yr
	MSc in Facilities Management	FT	2 yrs
HKU SPACE PLK	HD in Property and Real Estate Administration	FT	3 yrs
PolyU	HD in Building Technology and Management (Engineering)	FT	2 yrs
	HD in Building Technology and Management (Surveying)	FT	2 yrs
	HD in Building Services Engineering	FT	2 yrs
	BSc(Hons) in Building Engineering and Management	FT	3-4 yrs
	BSc(Hons) in Property Management	FT	3-4 yrs
	BSc(Hons) in Surveying	FT	3-4 yrs
	BEng(Hons) in Building Services Engineering	FT/PT	2-4 yrs
	MEng / MSc in Building Service Engineering	FT/PT	1-2.5 yrs
	MSc in Facility Management	FT/PT	1-2.5 yrs
	MSc in Construction and Real Estate	FT/PT	1-2.5 yrs
PolyU SPEED	BA in Housing Management	FT	1.5 yrs
CityU	ASc in Building Services Engineering	FT	2 yrs
	ASc in Surveying	FT	2 yrs
	BEng(Hons) in Building Engineering (Building Services Engineering)	FT/PT	3-4 yrs
	MSc in Building Engineering (Building Services Cost Management)	PT	2 yrs
	MSc in Building Engineering (Intelligent Building)	PT	2 yrs
CityU SCOPE	Dip in Facility Management	PT	2 yrs
IVE (Morrison Hill)	HD in Building Studies	FT/PT	3-8 yrs
	HD in Surveying	FT/PT	3-8 yrs
	HD in Real Estate Management	FT/PT	1-6 yrs
	HD in Facilities Management	FT	4 yrs
	HD in Building Services Engineering	FT/PT	2-5 yrs
IVE (Tsing Yi)	HD in Urban Renewal, Building Inspection and Maintenance	FT	2-4 yrs
	HD in Building Studies	PT	4 yrs
HKCT	HD in Building Technology	FT	2 yrs
	BSc(Hons) in Facilities Management	PT	15 mths
CICTA	Dip in Building Construction Supervision	FT	2 yrs
	Dip in Building Services Supervision	FT	2 yrs

Dip: Diploma; HD: Higher Diploma; ASc: Associate of Science; ADip: Advanced Diploma; ProfDip: Professional Diploma; BEng: Bachelor of Engineering; BSc: Bachelor of Science; MEng: Master of Engineering; PgDip: Postgraduate Diploma; MSc: Master of Science.

Questionnaire Survey

To facilitate the formulation of a questionnaire survey for collecting data from the building industry, support was sought from BSOMES, which is the leading learned society for O&M practitioners in Hong Kong. A taskforce, comprising three of its executive committee members, was formed to help devise the questions.

Questions in the first section of the questionnaire solicit personal information including age, sex, academic qualification, work experience and position of the respondents. After a series of meetings, the taskforce constructed Table 2. It shows that given the multi-discipline nature of building (Lansley, 1991), O&M works embrace a wide range of trades. Each of them can be subdivided into a variety of natures, which require different levels (i.e. managerial, supervisory, operational) of competence for accomplishing the work. This table helped designing the second section of questions, which enquire into: the respondents' workloads due to different trades and natures of work; their perceived extents of O&M knowledge and wish to enrich such knowledge; the knowledge enrichment ways used, the resources devoted for such and the corresponding satisfaction levels; and whether they consider dedicated academic programmes necessary and if so, the level of study they prefer.

Table 2 Trade and nature of work, and competence levels

Trade	Nature	Competence
Air-conditioning and ventilation	Engineering calculation and drawing preparation	
Heating and hot water	Site supervision and coordination	Operational
Building management system (BMS)	Testing and commissioning	
Electrical	Condition survey and data logging	
Telecommunication and information system	Fault attendance and disaster recovery	
Security and access control system	Work programming and quality control	
Lift and escalator	Budgeting and cost control	Supervisory
Fire services	Procurement and contract management	
Plumbing, drainage and sewage treatment	Legal issues and safety management	
Pool water treatment system	Human resources and customer management	
Building fabric and structure	Energy and environmental management	Managerial
Recreational and leisure facilities	Space management	

Before conduction of the survey, the taskforce members were invited to try out a pilot questionnaire. Their comments were taken in finalizing the questionnaire, which was distributed in full swing in three ways. First, an electronic version of the questionnaire was posted in the official website of BSOMES, with a message sent to its members inviting them to participate in the survey. Second, the Executive Committee members of BSOMES, 15 of

them in total, distributed the questionnaire to their colleagues. Third, the questionnaire was disseminated to the graduates and part-time students of the building-related programmes.

After several rounds of reminders, 147 questionnaires were returned. For assuring the quality of data, each return was checked to identify any incomplete or unreasonable entries. Those spotted from this checking were emailed a message, asking them to supplement or clarify the relevant information. Eventually the data analysis was carried out based on the useful responses of 145 respondents, among them 91.0% were male. Ranging from fresh practitioners to veterans, the respondents were on average 36.6 years old (standard deviation; *SD* = 9.0), with 12.4 years working in the building industry and 9.0 years in the O&M field (Table 3). The main group (48.3%) carried out managerial work and a slightly less proportion (40.7%) worked as supervisors. While only 11.0% whose positions were at strategic level, a much higher (28.3%) proportion possessed postgraduate qualifications. Degree (41.4%) or sub-degree (30.3%) holders account for the majority of the samples.

Table 3 Demography of the respondents

	Mean	Min.	Max.	*SD*
Age	36.6	20	62	9.0
Experience in building industry	12.4	0	42	8.5
Experience in building O&M field	9.0	0	37	8.2
Position:				
Strategic	11.0%			
Managerial	48.3%			
Supervisory	40.7%			
Qualification:				
Postgraduate	28.3%			
Degree	41.4%			
Sub-degree	30.3%			

Findings and Discussion

Trades of work

The respondents were asked to indicate the percentage of time they spent on different trades of work to represent the corresponding workloads. The overall average workload and those classified by three levels of practitioners, namely strategic, managerial and supervisory, are plotted in Figure 3. There appears no substantial difference between the classified workloads within each trade. The dominant workload was on air-conditioning and ventilation, followed by electrical. The rest of their work was to mainly deal with building fabric and structure, plumbing, drainage and sewage treatment, fire services, and building management system (BMS). While proper O&M work is crucial to the safety of lifts and escalators, only a small proportion of their time was devoted to this trade. The probable reason is its highly specialised nature of work which must be performed by registered parties (Lai and Yik, 2004) whereas most of the respondents did not have such statutory title.

"Take in Figure 3"

Other trades of work which consumed relatively little time of the respondents include security and control system, telecommunication and information system, and recreational and leisure facilities. The mild winter and the occasional provision of water pools for buildings in Hong Kong should have contributed to the minimal amount of time for dealing with heating and hot water, and water treatment systems.

Apart from workload, the questionnaire also asked the respondents to indicate their perceived extents (0: nil; 1: very small; 2: small; 3: fair; 4: great; 5: very great) of knowledge and wish to enrich the knowledge of different trades of work. The perceived ratings, as Figure 4 shows,

are all above the iso-rating diagonal. This indicates that the knowledge levels the respondents perceived are lower than the corresponding levels of their wish to enrich knowledge throughout the whole spectrum of work trades.

"Take in Figure 4"

A Pareto analysis of the findings in Figure 3 shows that it would be economically efficient if 20% of available resources is utilized for covering 80% of the required work, viz. Trades A (air-conditioning and ventilation), C (BMS), D (electrical), H (fire services), I (plumbing, drainage and sewage treatment) and K (building fabric and structure), which are underlined in Figure 4.

Air-conditioning and ventilation, being the most time-demanding trade (see Figure 3), was given the highest (3.23) yet just-above-fair knowledge rating. Three other trades bearing a perceived knowledge rating slightly higher than "fair" are: electrical, fire services and plumbing, drainage and sewage treatment. While the perceived knowledge levels of these four trades are relatively higher than the remainders, the respondents' greater wish to learn more about them may be because their aggregate workloads are dominant. Given that the workloads of BMS and building fabric and structure are significant and their perceived knowledge levels are lower-than-fair, the wish of the respondents to enrich their knowledge in these two trades is reasonable.

The workloads of telecommunication and information system (Trade E) and security and control system (Trade F) are indeed low. The wishes of the respondents to learn more about them (equal ratings of 3.22), though being slightly above the fair level, are insignificantly

different from that (3.18) pertaining to building fabric and structure. Trade G, i.e. lift and escalator, recorded a wish rating of 3.08, which is marginally fair.

Among the remaining trades (i.e. B, J and L), the perceived extent of knowledge of recreational and leisure facilities is the lowest (1.86). This may be a result of the uncommon inclusion of this aspect in traditional engineering or surveying education programmes. The weak "wish" (2.82) of the respondents to enrich their knowledge may be ascribed to the minimal workload (1.9%) due to this trade.

To test the relative agreement of the perceived knowledge and wish ratings among different groups of respondents, the Kendall coefficient of concordance (W), which may lie between "0" (no community of preference) and "1" (perfect agreement), was calculated using Equation (1). The sum of squares of the deviations (S) of the row rank sums (R_i) from their mean value $m(n+1)/2$ pertaining to n attributes rated by m groups of subject was computed by Equation (2), where u_j is the number of consecutive members of the j^{th} tied rank (Kendall and Gibbons, 1990). In order to further examine the consistency of the perceived ratings between pairs among the groups, the Spearman rank correlation coefficient (r_s), which may range from "–1" (entirely opposite ranking) through "0" (no correlation) to "+1" (perfect agreement in ranking), was computed using Equation (3), where d_a is the difference in rank between pairs of items being compared and N is the number of such pairs.

$$W = \frac{12S}{m^2(n^3 - n) - m\sum_j (u_j{}^3 - u_j)} \tag{1}$$

$$S = \sum_{i=1}^{n} \left[R_i - \frac{m(n+1)}{2} \right]^2 \tag{2}$$

$$r_s = 1 - \frac{6\sum_{a=1}^{N} d_a^{\,2}}{N^3 - N} \qquad (3)$$

The calculation results categorized by practitioners at three different levels of position are summarized in Table 4. There exists a strong agreement among the responses given by the three groups on their perceived levels of knowledge (W = 0.893) and wish (W = 0.820). All the pair-wise correlations, with r_s ranging between 0.699 and 0.839, are strongly positive, except that the correlation between the strategic group and the managerial group is moderate (r_s = 0.600). Grouping the calculated correlation coefficients according to different qualifications of the respondents, as in Table 5, also indicates strong agreements (W = 0.903 and 0.852; r_s ranges between 0.684 and 0.914) between the perceptions of different groups.

Table 4 Rank correlations of perceived knowledge and wish levels of various trades (by positions)

	Knowledge (W = 0.893)			Wish (W = 0.820)		
	Strategic	Managerial	Supervisory	Strategic	Managerial	Supervisory
Strategic	1.000	0.860	0.818	1.000	0.600	0.699
Managerial	-	1.000	0.839	-	1.000	0.893
Supervisory	-	-	1.000	-	-	1.000

Table 5 Rank correlations of perceived knowledge and wish levels of various trades (by qualifications)

	Knowledge (W = 0.903)			Wish (W = 0.852)		
	Postgraduate	Degree	Sub-degree	Postgraduate	Degree	Sub-degree
Postgraduate	1.000	0.914	0.846	1.000	0.823	0.684
Degree	-	1.000	0.802	-	1.000	0.829
Sub-degree	-	-	1.000	-	-	1.000

The above results illustrate that the practitioners, regardless of their work levels and academic qualifications, perceived their extents of knowledge and wish to enrich knowledge about the various trades of work in highly similar ranking orders.

Natures of work

From the answers to the question on workload distribution by different work natures, the overall response and the responses given by different groups are graphed in Figure 5. The workloads of the groups, unlike the rather consistent workloads on various work trades (see Figure 3), vary significantly in a few work natures. In particular, the supervisory group spent a significant portion of time on site supervision and coordination (24.5%) and engineering calculation and drawing preparation (13.3%), which are more than triple of the corresponding amounts (7.3% and 4.1% respectively) of the strategic group. Conversely, the strategic group participated much in two other natures of work: energy and environment management (13.6%) and legal issues and safety management (10.1%), as compared to the minimal involvements (3.9% and 4.3% respectively) of the supervisory group.

"Take in Figure 5"

Overall, site supervision and coordination ranks first, representing 18.5% of the practitioners' workload (Figure 5). This kind of regular work, together with the other three: procurement and contract management, engineering calculation and drawing preparation, and budgeting and cost control, amount to over half of their workload. Other works including work programming and quality control, testing and commissioning, and human resources and customer management are less regular. Their workloads range between 6.8% and 9.4%.

Fault attendance and disaster recovery are needed occasionally when systems or equipments fail, and so accounted for only 4.2% of the practitioners' workload. An equally minimal effort was made on condition survey and data logging although, in principle, they should be performed regularly. Space management work incurred an even smaller workload (2.6%). This runs counter to the importance of optimizing use of space which is a precious business resource in Hong Kong, and suggests that the limited adoption of alternative workplace strategies (Gilleard and Rees, 1998) remains common.

Figure 6, which displays the average perceived ratings of knowledge level of the respondents and their wish to enrich knowledge, uncovers two rather extreme observations. First, while regarding their knowledge about space management (Nature l) as particularly low (2.33), the practitioners' wish to enrich this nature of knowledge is only marginally fair (3.09). Second, the practitioners perceived their level of knowledge about site supervision and coordination (Nature b) as the highest (3.46) and indicated a fair level of wish (3.33) to further learn about it. Furthermore, with the exception of this nature, the wish ratings of all others lie above the iso-rating diagonal, which reflects that the respondents generally perceived a greater extent about their wish to learn than their knowledge level.

"Take in Figure 6"

From a Pareto-efficient perspective, the underlined natures of work in Figure 6 were determined in the same way as that in Figure 3. They include: a (engineering calculation and drawing preparation), b (site supervision and coordination), c (testing and commissioning), f (work programming and quality control), g (budgeting and cost control), h (procurement and

contract management) and j (human resources and customer management). Given the relatively high workloads due to these natures of work, it is not difficult to understand why the respondents had relatively great wishes to learn more about them. But, the amounts of time devoted to work on Nature i (legal issues and safety management) and Nature k (energy and environmental management), 5.5% and 5.8% respectively, are small. The highest wish ratings (3.50 and 3.55) associated with these two natures may be derived from the onerous liabilities for non-compliance with legal governances (Lai and Yik, 2004) and the pressing need of implementing energy and environmental conservations (Environment Bureau, 2004; 2008).

Three remaining natures of work with which the associated wish ratings slightly exceed the fair level include: condition survey and data logging (Nature d), fault attendance and disaster recovery (Nature e), and space management (Nature l). Particularly, the knowledge rating of space management was the lowest, which echoes with its insignificant workload as seen in Figure 5.

Using the same set of equations, i.e. (1) to (3), the Kendall coefficients of concordance and the Spearman rank correlation coefficients based on the ranking orders of knowledge and wish levels perceived by different respondent groups about various natures of work were calculated. Table 6 summarises the results corresponding to practitioners at different levels and Table 7 shows those grouped by their qualifications.

Table 6 Rank correlations of perceived knowledge and wish levels of various natures (by positions)

	Knowledge (W = 0.647)			Wish (W = 0.416)		
	Strategic	Managerial	Supervisory	Strategic	Managerial	Supervisory
Strategic	1.000	0.512	0.063	1.000	0.348	-0.414
Managerial	-	1.000	0.844	-	1.000	0.479
Supervisory	-	-	1.000	-	-	1.000

Table 7 Rank correlations of perceived knowledge and wish levels of various natures (by qualifications)

	Knowledge (W = 0.788)			Wish (W = 0.558)		
	Postgraduate	Degree	Sub-degree	Postgraduate	Degree	Sub-degree
Postgraduate	1.000	0.851	0.456	1.000	0.287	0.414
Degree	-	1.000	0.741	-	1.000	0.315
Sub-degree	-	-	1.000	-	-	1.000

Dissimilar to the strong correlation results pertaining to work trades (see Tables 4 and 5), there are lesser agreements (W = 0.416 to 0.788) between the ranks of knowledge and wish levels that the different groups perceived with respect to various work natures. The correlation between the postgraduate and degree groups is the only case where a strongly positive agreement (r_s = 0.851) is found. Most of the pair-wise correlations between the other groups, as shown in Tables 6 and 7, are moderately (r_s ranges between 0.414 and 0.741) or weakly (r_s = 0.287 or 0.315) positive. The correlation between the perceived rankings of the strategic group and the supervisory group about knowledge is nearly none (r_s = 0.063), and that about wish is even moderately opposite (r_s = -0.414). These results reveal not only the generally varied perceptions across different groups of respondents, but also the particular discrepancies in perception between practitioners at strategic level and those at supervisory level.

Education means

The respondents were asked to indicate the ways used for enriching their O&M knowledge in the twelve months preceding the survey. As summarized in Table 8, the majority relied on reading reference materials, internet surfing and discussion with peers, which require low or virtually no cost. Almost half enriched themselves through attending CPD courses. A lesser proportion (40.7%) attended some academic programmes. Whereas the primary intention of this group may be to enrich their O&M knowledge, the non-existence of bespoke O&M programmes (see Table 1) may not have satisfied their needs (as will be analysed in Figure 7). The rest of the respondents (33.1%) simply did not take any of the above ways to enrich their knowledge. Whether they considered themselves so knowledgeable that further learning is unnecessary or what gave rise to their lack of learning motivation, however, is beyond the scope of this study.

Table 8 Resources devoted to enriching O&M knowledge

Enrichment way	%*	Mean (hours)	Min. (hours)	Max. (hours)	*SD* (hours)	No. of usable samples**
Reading reference materials	66.9	55.2	1	365	59.5	86
Internet surfing	64.8	95.5	1	720	138.1	82
Discussion with peers	60.0	74.1	1	365	75.5	72
Attending CPD	48.3	35.1	1	200	33.4	64
		[4,705]	[500]	[30,000]	[6,655]	20
Attending academic programmes	40.7	95.2	1	324	81.8	47
		[19,258]	[1,000]	[65,000]	[14,945]	26

*Proportion based on total no. of samples. **No. of samples which indicated the amount of resources devoted. Figures in square brackets represent the amounts of money spent, in HK$.

Based on the usable responses, statistics of time and money the respondents spent in various ways to enrich their knowledge were compiled. The mean times of the ways are of the same order of magnitude, but the small amount of minimum time spent on attending academic programmes suggests that it refers to a short course. On the contrary, the maximum time

devoted to CPD attendance is as high as 200 hours, which probably corresponds to attending a comprehensive course or multiple short courses.

As compared to the response on time spent, much less respondents indicated the amounts of money spent on attending CPD courses (n = 20) and academic programmes (n = 26). On average, the annual expenditure for attending academic programmes is HK$19,258, or 4.5 times of that for attending CPD courses.

The respondents were further asked to use a five-point scale (1: very small; 2: small; 3: fair; 4: great; 5: very great) to rate their perceived levels of satisfaction with the various enrichment ways. The average ratings and the average times taken to enrich knowledge are shown in Figure 7, where "Time B" is the average among all the samples and "Time A" represents the average based on those who indicated that the corresponding way was used to enrich their knowledge.

"Take in Figure 7"

The time spent on internet surfing (95.5 hours) tops among the enrichment ways and that for attending academic programmes (95.2 hours) is negligibly different. While this latter way was perceived by the respondents as slightly above satisfactory; its rating (3.32) is lower than that of "discussion with peers" (3.43) and much lower than the rating of "attending CPD" (3.55). These findings together with the highest cost spent (HK$19,258) imply that the academic programmes attended could not effectively enrich the respondents' knowledge. On the other hand, the much lower cost (HK$4,705), the least time (35.1 hours) devoted and the highest satisfaction rating (3.55) evidence that attending CPD courses is the most effective.

Nevertheless, "3.55" is only slightly above satisfactory, which suggests that attending CPD courses is not meeting adequately the needs of the practitioners in enriching their knowledge.

Finally, 88.7% of the respondents considered that a dedicated O&M academic programme is needed. Unlike some overseas experience (e.g. Knezevic, 1997) where the industrial operations sector called for a postgraduate maintenance programme, the majority (44.0%) in the current study opined that such a programme should be offered at bachelor level (Table 9).

Table 9 Distribution of opinions on the need of a dedicated O&M programme

Respondents	HD	ADeg	BDeg	PgDip	MDeg	Others
Overall[a]	8.5%	5.7%	44.0%	6.4%	22.0%	2.1%
Position[b]:						
Strategic	20.0%	13.3%	20.0%	6.7%	40.0%	0.0%
Managerial	5.0%	6.7%	51.7%	10.0%	25.0%	1.7%
Supervisory	11.8%	3.9%	54.9%	3.9%	19.6%	5.9%
Qualification[b]:						
Postgraduate	5.4%	5.4%	45.9%	13.5%	27.0%	2.7%
Degree	7.5%	5.7%	41.5%	5.7%	35.8%	3.8%
Sub-degree	16.7%	8.3%	63.9%	2.8%	5.6%	2.8%

[a] Distribution among all respondents; [b] Distribution among those who support the need of a dedicated programme.
HD: Higher Diploma; ADeg: Associate Degree; BDeg: Bachelor Degree; PgDip: Postgraduate Diploma; MDeg: Master Degree.

The responses were further analysed by grouping them according to working positions of the respondents. 40.0% of those at strategic level would like to see the programme offered at master degree level. Given that this group of practitioners has substantial work experience and they may have attended prior courses at lower-than-master levels, this major response is expectable. Nonetheless, a significant portion of them considered that a higher diploma (20%) or a bachelor degree (20%) programme should be offered. These opinions were probably made on behalf of their subordinates, whom they considered enriching their O&M knowledge is necessary.

Over half of the supporters, both at managerial and supervisory levels, affirmed the need of a bachelor degree programme. Their votes for a master degree programme are also significant, at 25.0% and 19.6%. Such findings suggest that practitioners working at these two levels may not have possessed a bachelor or master degree, or even if they have, the knowledge they gained are inadequate for their work.

If the practitioners are keen to earn a qualification higher than that they already possessed, those who have a postgraduate diploma would like to obtain a master degree and likewise, bachelor degree holders would like to pursue a postgraduate diploma or master degree study; so on and so forth. The responses grouped by their qualifications, however, did not support this hypothesis. The majority (45.9%) of the postgraduate group, instead of seeking a programme at postgraduate or master degree level, opined that such a programme should be at bachelor degree level. The same response was given by a comparable proportion (41.5%) of the degree holders and an even larger proportion (63.9%) of the respondents possessing only sub-degree qualifications. The dominant proportion of the latter group, in addition, highlights their strong desire to study a bachelor degree programme.

Concluding Remarks

The decline in new building developments, yet ever-increasing building stocks, has rendered the rising demand for facilities operation and maintenance in Hong Kong. A proper supply of competent practitioners, therefore, is essential for this growing sector. However, the study has unveiled that higher education programmes tailored for producing O&M professionals were unavailable, exposing a mismatch between the demand and the supply.

The existing practitioners generally perceived their extents of knowledge about most trades or natures of work as only fair, if not small. Among the dominant trades of workload, air-conditioning and ventilation, electrical, fire services and BMS are those that the practitioners wished to enrich most even though they perceived their knowledge about them as better than that of the remaining trades. Although their workload was dominated by regular site supervision and coordination work, the natures of work that the practitioners were most desirous to learn about include energy and environmental management, testing and commissioning, legal issues and safety, and budgeting and cost control. A greater emphasis of O&M education, therefore, should be placed on these aspects.

The orders of perceived levels of knowledge and wish to enrich knowledge about various trades of work between practitioners with different qualifications or at different levels were largely consistent. But the significant variations of the counterparts about various work natures, especially between those at strategic and supervisory levels, must be taken into account when designing O&M education programmes.

Without customized education means, most practitioners resorted to reading reference materials, internet surfing and discussion with peers to enrich their knowledge. With only fair satisfactions with the CPD courses or academic programmes attended, they overwhelmingly considered it necessary to have dedicated O&M programmes, and one offered at bachelor level was well-supported. This clear demand of the O&M industry should justify the development of some matching courses (The Royal Academy of Engineering, 2007).

Nevertheless, launching a new programme in a higher education institution has to match with its defined role (Lee, 2005). Whereas the study has informed the key trades and natures of

knowledge in need, much is needed to work out the programme contents in detail. Given that building O&M is a field which highly demands the application of knowledge into practice, cooperation with the industry to incorporate appropriate industrial training into the programme is necessary (Au Yeung et al., 1993). Other concerns like availability of funding, teaching expertise and research support for the new subject area have to be cleared too. These are among the challenges to realisation of a sustainable environment, which the society definitely needs.

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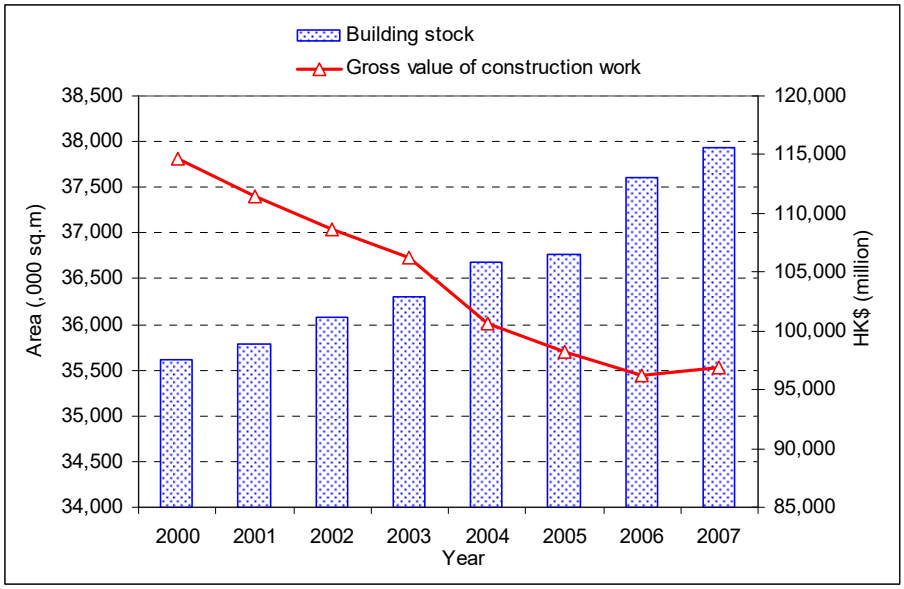

Figure 1 Building stock and gross value of construction work

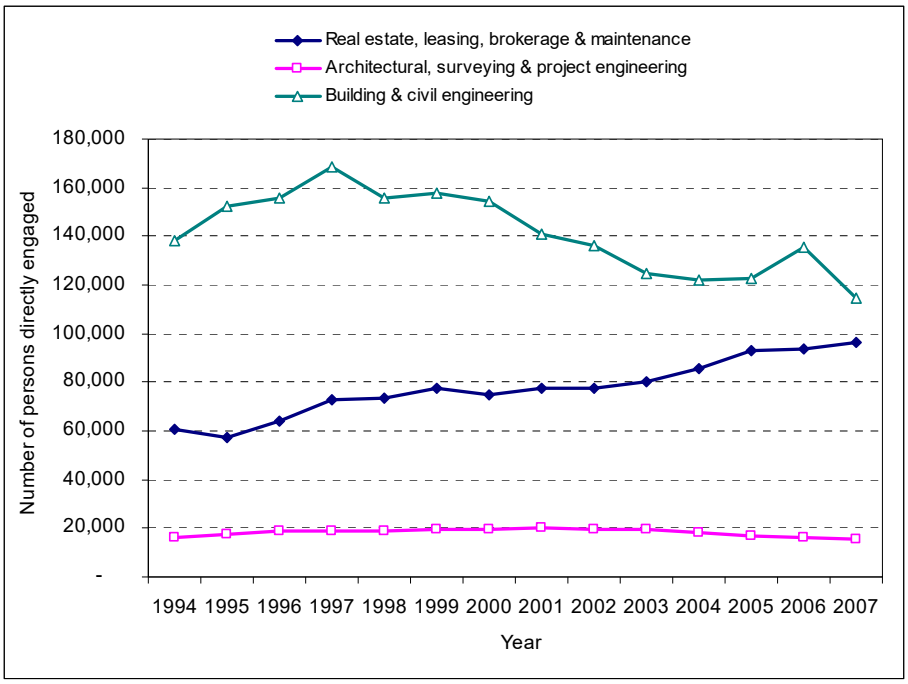

Figure 2 Manpower of building-related sectors

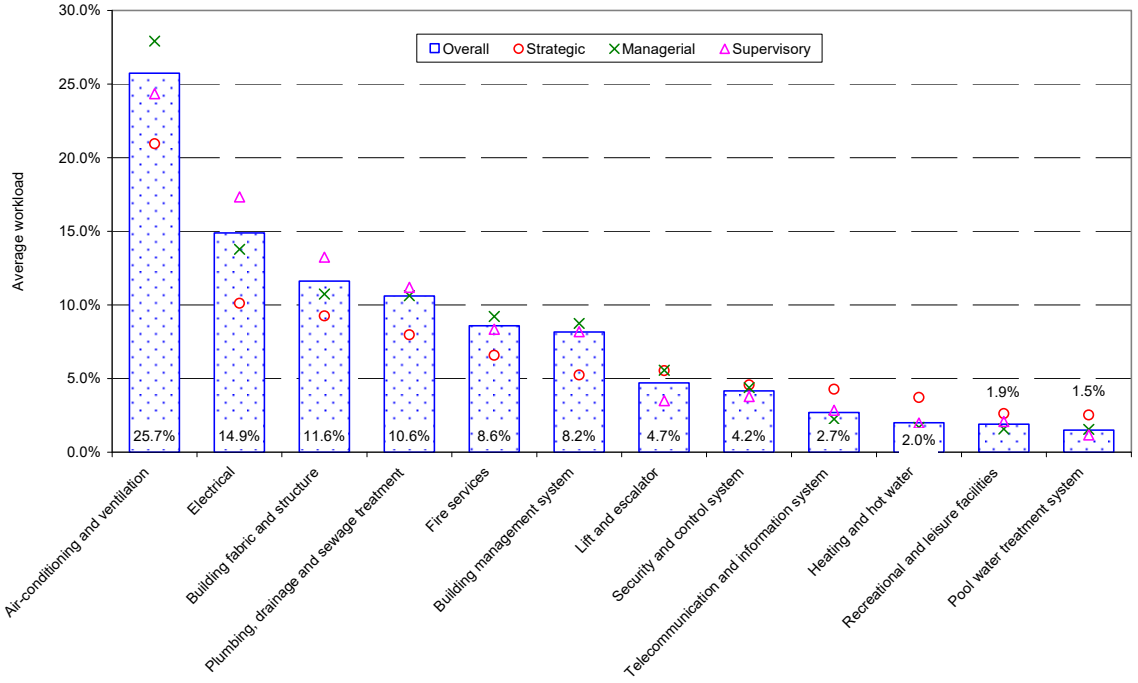

Figure 3 Average workloads (by trades)

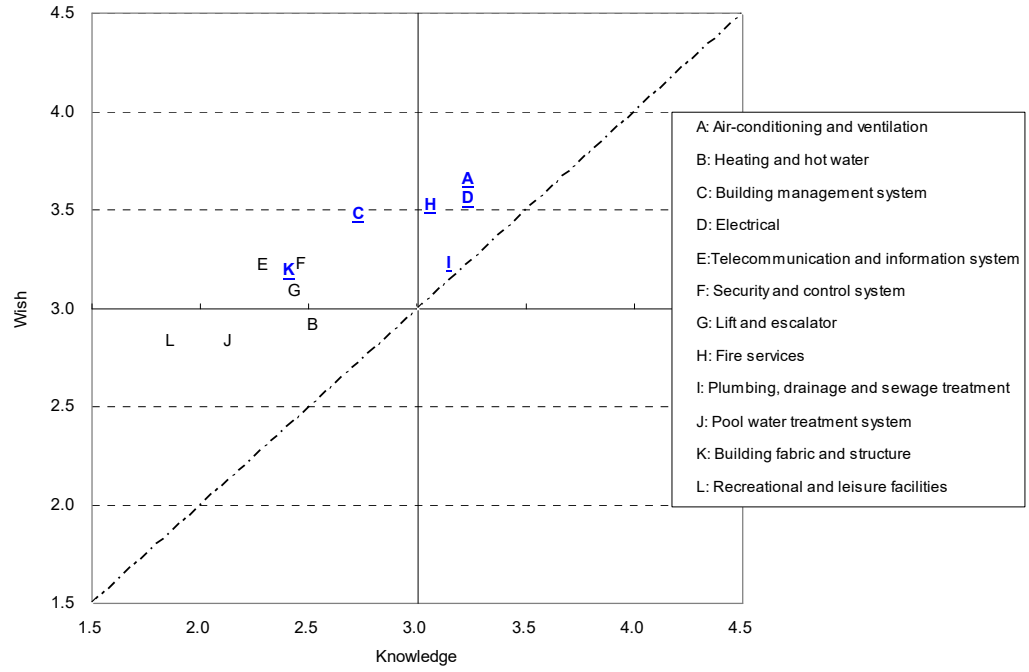

Figure 4 Perceived ratings of knowledge level and wish to enrich knowledge of different work trades

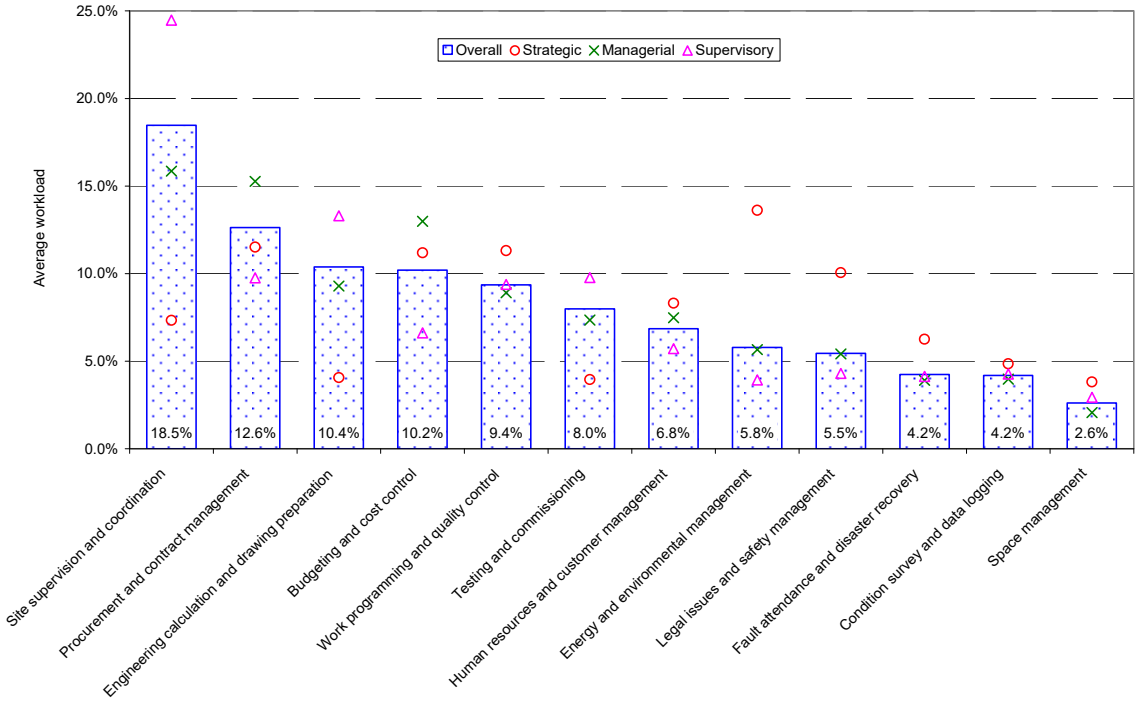

Figure 5 Average workloads (by natures)

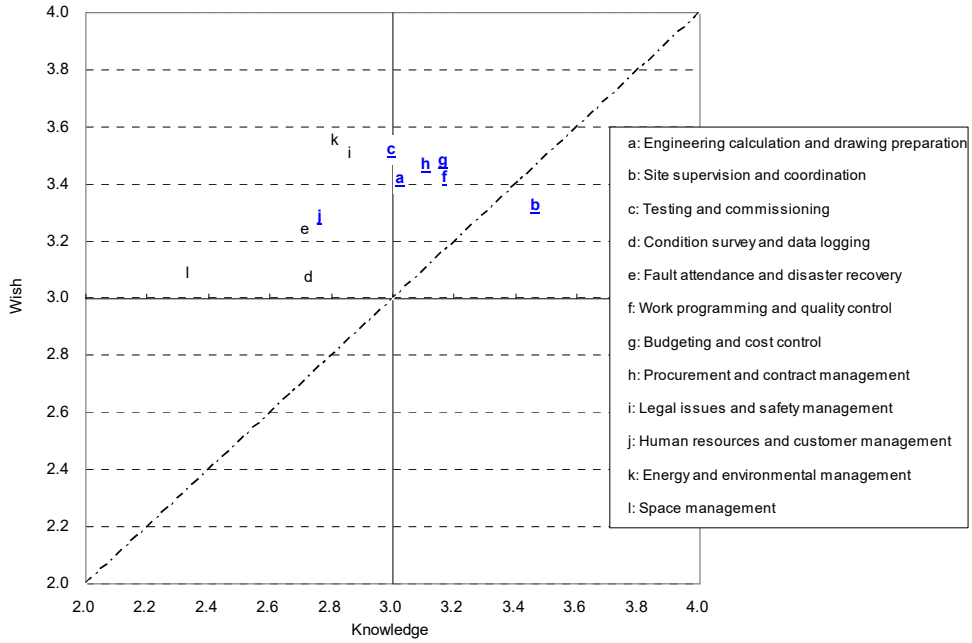

Figure 6 Perceived ratings of knowledge level and wish to enrich knowledge of different work natures

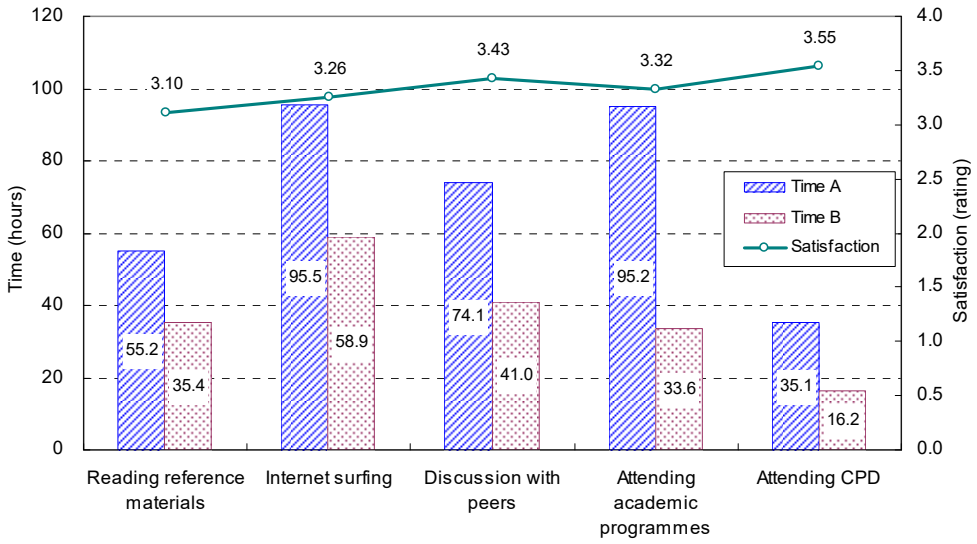

Figure 7 Time for enriching knowledge and perceived level of satisfaction