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A portrait of building services engineers in Hong Kong

Structured abstract

Purpose
As part of a study that aimed at enhancing the future roles and functions of building services (BS) engineers in Hong Kong, a survey was carried out to obtain demographic information about BS practitioners as well as their views and opinions on a range of issues which affect professional practices of BS engineers and recognition of their contributions by others.

Design/methodology/approach
A series of statistical analyses was conducted based on the responses given by the BS practitioners, which included their qualifications, experience, job field, annual income and the number of trades of BS systems that they are competent in and responsible for.

Findings
The statistics shows that: i) competence gap exists in that BS engineers are required to handle more trades of BS systems than those they are competent in; and ii) the academic and professional qualifications, years of experience and job position are the key influential factors to the annual income of BS engineers but little differences exist in the average annual income of engineers in different job fields.

Originality/value
The competence gap is a concern that needs to be addressed to ensure BS engineers are competent in handling the common trades of BS systems, which is increasingly important for them to perform effectively in integrated professional teams for turning out holistic solutions for sustainable building developments.

Keywords
Building services engineers, competence, construction industry, Hong Kong, professional practice

Paper type
Research paper

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Introduction

The success and the sustainable development of the construction industry rest on a concerted effort dedicated by a variety of professionals. Recognising the importance of ensuring the quality of these professionals, research efforts (e.g. Hackett and Hicks, 2007; Ahadzie et al., 2009) have been devoted to studying their roles and competencies.

Among the construction professionals, building services (BS) engineers play a key role in design, construction, commissioning, operation and maintenance (O&M) of building facilities (e.g. electrical, air-conditioning, fire protection, and piped services, etc.). Since the emergence of BS engineering as a professional discipline in Hong Kong a couple of decades ago (Yik et al., 2010a), no industry-wide investigations had been made to review the development or inform the current state of this discipline.

Aimed at enhancing the future roles and functions of BS engineers, a research study on the BS profession in Hong Kong (hereinafter referred to as "the Study") (Yik et al., 2008) has been conducted jointly by the BS Division (BSD) of the Hong Kong Institution of Engineers (HIKE) and The Hong Kong Polytechnic University, over the period from September 2007 to January 2010. As shown in Figure 1, the Study was carried out in three stages and included reviews of the evolvement of the BS profession (Yik et al., 2010a), the past and current roles and functions of BS engineers and regulatory controls over BS works in Hong Kong (Lai et al., 2011), as well as a comparison with the BS profession and practices in the UK, Singapore and China (with inputs from a research team in each country), and a few other regimes (by

questionnaire survey).

"Take in Figure 1"

In Stage II (Figure 1), the first questionnaire survey conducted was to obtain an understanding of the general public's perception about BS and BS practitioners in Hong Kong (Yik et al., 2010b). The second questionnaire survey was carried out to obtain demographic information about the BS practitioners as well as their views and opinions on issues which affect professional practices of BS engineers and recognition of their contributions by others. The information collected from these two surveys underpinned an in-depth, face-to-face interview survey of key stakeholders in the construction industry. Towards the end of Stage II, a Delphi study was carried out, which involved deliberations among expert panel members on issues on which diverse responses were obtained from different survey respondents (Yik et al., 2012). These findings formed the basis upon which recommendations were formulated in the Study (Yik et al., 2010c).

In the ensuing section, the design and implementation of the second questionnaire survey conducted in Stage II of the Study (Figure 1) will be described, which is followed by presentation and discussions of the findings from statistical analysis of the demographic data about BS practitioners in Hong Kong. This contemporary portrait of BS engineers, which was hitherto unavailable, will provide a useful reference for future comparison of the BS profession with its current state as well as with other construction professions in Hong Kong and elsewhere.

Survey design

Three key issues had been identified in Stage I of the Study (Figure 1). For investigating into the second and the third issues, three categories of information had to be sought from BS practitioners in Hong Kong: i) their academic and professional qualifications, career development and practices; ii) their views and opinions on the current practices within the BS profession and in the construction industry; and iii) their views and opinions on relevant regulatory controls in force in Hong Kong. For this purpose, a questionnaire comprising three parts, each for collecting one of these categories of information, was prepared.

The major objective of collecting demographic data of BS practitioners and information about their practices (covered in Part 1 of the questionnaire), was to enable an assessment to be made of:

a) How significantly academic, professional and statutory credentials would influence the specialism(s), career development and income of BS practitioners.

b) Whether BS practitioners tend to specialize in one or a few types of BS systems and how common it is to find BS practitioners who are competent in handling all major types of BS systems.

The information sought from the survey respondents included academic and professional qualifications and licenses / statutory titles they possessed; their past career history; and their current employment, including their job field, the trades of BS systems that they were competent in and responsible for handling, and their annual income.

Figure 2 shows the steps taken in the questionnaire survey. In designing the questionnaire, reference had been made to good survey practices (e.g. Flynn et al., 1990; Forza, 2002) as well as survey methods adopted in previous research studies conducted by the research team members (e.g. Lai and Yik, 2007) and by others (e.g. Lee et al., 1995; Fan et al., 2001; UK DTI, 2005). Inevitably, the ambitious scope of information intended to be covered by the questionnaire would compromise the rate of questionnaire returns and, in turn, the representativeness of the collected data. However, a sample size that may fall short of the requirement for achieving a high enough statistical significance level was considered acceptable because the collected data were not intended for building or verifying a theory (Flynn et al., 1990). Nevertheless, caution was taken to ensure:

a) Clear explanations were given to the respondents on the kind of information that they were requested to provide;

b) The total amount of time and effort that a respondent would need to spend would not deter him/her from completing and returning a questionnaire; and

c) Effective measures would be taken to boost the rate of questionnaire returns to as high as possible, but participation would remain voluntary.

"Take in Figure 2"

In respect of a) & b) above, a brief introduction is given before questions on each topic were listed in the questionnaire to inform the respondents of the purpose of enquiring into the topic. The draft questionnaire was distributed for comment by members of a working group, which

was formed by representatives of the BSD. The draft was subsequently revised to address the comments and was then sent by the working group members to a small number of target respondents for a pilot run. The answers given in the pilot questionnaire returns were examined which verified that the questions therein could be correctly interpreted. However, feedbacks were received that the time required to complete some of the questions was too long. After discussions with the working group members, it was decided to add an explanatory note to the questionnaire suggesting that for each of those questions, if the respondent had spent about 3 minutes but still could not formulate an answer, he/she should skip that question and move on to the next.

HKIE members in the BS discipline, including Graduate and Associate Members (who have not yet acquired the professional engineer status) and Corporate Members (who are professional engineers) were the target respondents. For inviting them to participate in the survey, the HKIE Headquarter sent them an email notice, which included a link for downloading the questionnaire. Members of the working group and the study team also sent the questionnaire direct to suitable target respondents with whom they are familiar. Finally, a total of 196 questionnaires were returned.

Survey results and findings

Credentials of the respondents

Table 1 summarizes the statistics that reflect the job fields, years of experience and academic and professional qualifications of the respondents. The major job fields of BS engineers, which include consulting, contracting, facility management or operation and maintenance

(FM/O&M), project client and government, are well represented by the respondents, although there were more (about 40%) respondents in the consulting field (Table 1(a)). Among the 182 respondents who indicated the year they embarked on their first job, their years of work experience ranged from 0 to 39 years and the mean was 18.4 years.

The respondents are well qualified academically. All the respondents, except 10 of them, had one to three or more degrees (Table 1(b)). Out of the first degree holders (176), 44% of them held a degree in BS engineering while those who held a first degree in either electrical or mechanical engineering amounted to 47%. Further examination of the year of attainment of their first degree unveiled that, on average, respondents holding a first degree in BS engineering graduated more recently than those from electrical and mechanical (E&M) engineering programmes, by 8 and 11 years respectively.

The above statistical findings concur with the observation of Chan and Burnett (2004) that E&M engineering degree programmes have been, and still are, supplying the BS profession of Hong Kong with a significant number of fresh graduates from year to year but BS engineering programmes have already become a major source of new breeds of BS engineers. The statistics (Table 1(b)) reveal also that many E&M engineering graduates, having embarked on BS engineering as their career, had made use of taught master degree programmes to enrich themselves with knowledge in BS engineering, which would help them acquire membership with professional institutions in the BS discipline.

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Table 1 Summary of credentials of respondents

(a) Job field and years of experience

	No. of Respondents		Years of experience by job fields			
Job field	Job Known	Exp. Known	Max.	Min.	Mean	Std. Dev.
Consulting	80	79	35	0	15.4	9.4
Contracting	30	25	37	6	20.6	7.9
FM / O&M	20	20	38	7	21.4	9.0
Project Client	20	17	31	13	19.3	6.3
Government	32	30	39	4	21.2	10.6
Others [1]	11	11	29	12	20.4	5.2
Unknown	3					
Total	196	182	39	0	18.4	9.2

[1] Job fields include utilities, education, public transport, etc.

(b) Academic qualifications

Respondents:	No.
Without any degree	10
With one (1st or higher) degree only	100
With two degrees only	74
With more than two degrees	12
Without 1st degree but with higher degree	10

Respondents:	No.	Year of Graduation			
With 1st degree in any field	176	Latest	Oldest	Mean	Std. Dev.
With 1st degree in Building services engineering (BS)	78	2008	1979	1998	6.3
With 1st degree in Electrical engineering (EE)	39	2005	1977	1990	8.6
With 1st degree in Mechanical engineering (ME)	44	2005	1952	1987	10.0
With 1st degree in Fire engineering (FE)	4	2002	1998	2000	2.1
With 1st degree in Other fields	2				
With 1st degree in Unknown fields	9				

Respondents:	No.
With Master or higher degree in BS	43
With 1st degree in BS and higher degree in BS	17
With 1st degree in EE and higher degree in BS	9
With 1st degree in ME and higher degree in BS	10
With 1st degree in FE and higher degree in BS	1
With 1st degree in other fields and higher degree in BS	0
With 1st degree in unknown fields and higher degree in BS	2
Without 1st degree but with higher degree in BS	4

(c) Professional qualifications

Respondents:	No.	Respondents with membership:**	No.
Without any professional qualification	56	With CIBSE	84
With at least one professional qualification	140	With IET	35
With 1 professional qualification only	27	With IMechE	27
With 2 professional qualifications	62	With IFireE	8
With 3 professional qualifications	38		
With 4 or more professional qualifications	13		

Respondents:	No.	With dual membership:**	No.
With MHKIE	103	With HKIE and CIBSE	78
With FHKIE	12	With HKIE and IET	30
With MHKIE or FHKIE	115	With HKIE and IMechE	24
With (MHKIE or FHKIE) in BS Discipliine*	47	With HKIE and IFireE	5
With (MHKIE or FHKIE) in Electrical Discipliine	14	With CIBSE and IET	14
With (MHKIE or FHKIE) in Mechanical Discipliine	10	With CIBSE and IMechE	16
With (MHKIE or FHKIE) in Fire Discipliine	3	With CIBSE and IFireE	3
With (MHKIE or FHKIE) in Other Disciplines	0	With IET and IMechE	1
With (MHKIE or FHKIE) in Unknown Disciplines	41		

*For respondents with HKIE membership in disciplines that include BS and others, they were regarded as in the BS discipline

** Member or Fellow

A respondent was regarded as possessing professional qualification if he/she was a Corporate Member of a recognized professional institution, such as HKIE, the Chartered Institution of Building Services Engineers (CIBSE), Institution of Mechanical Engineers (IMechE), Institution of Engineering and Technology (IET, formerly Institution of Electrical Engineers), Institution of Fire Engineers (IFireE), etc. As shown in Table 1(c), whilst 56 respondents did not have any professional qualification, 140 respondents possessed from 1 to 4 or more professional qualifications, and 115 were corporate members of HKIE (103 Member; 12 Fellow), mostly in the BS, electrical and mechanical disciplines. Many also had dual professional membership.

Registered Professional Engineer qualification

The Engineers Registration Ordinance, enacted in 1990 (HKSAR, 2009), embraces BS as one of the disciplines it covers. A person may become a Registered Professional Engineer if he/she: i) is a member of the HKIE in a discipline or has equivalent qualification and experience; ii) has had at least one year's relevant professional experience in Hong Kong before the date of application; iii) is ordinarily resident in Hong Kong; and iv) is not subject to any of the stipulated conditions that preclude him/her from registration. Engineers registered under this Ordinance are entitled to use the title 'Registered Professional Engineer' (RPE), and for those in the BS discipline, the abbreviation of their title is RPE(BSS).

Although RPE(BSS) is a legally protected title for professional BS engineers in Hong Kong, as at 17 March 2009 (ERB, 2009), there were 622 RPE(BSS) only, which is less than half (49%) of the Corporate Members of HKIE in the BS discipline. The rate of RPE registration is low because, at present, very few regulatory requirements provide that specific BS works

can only be carried out by RPEs. Congruent observation can also be made from the survey results: only 52 out of the 140 professionally qualified respondents indicated that they were RPEs, and 38 were RPE(BSS). The other disciplines of RPE registration held by the respondents included electrical, mechanical and fire. Ten of them held dual discipline registration (BS & electrical).

As shown in Table 2, among those respondents with up to 5 years of experience, none had acquired membership with a professional institution, which basically barred them from registration as a RPE. Among those with 6 to 10 years of experience, 46% of them still did not have profession qualification and among those who had, none of them had registered as a RPE. For those with over 10 years of experience, 43% to 67% of them were members of professional institutions but only 19% to 43% of them were RPEs. Figure 3 shows the proportions of respondents in various job fields who were and were not RPEs.

"Take in Figure 3"

Table 2 Relation between years of experience and professional qualification and RPE title of respondents

Work experience (years)		% of respondents		
	No.	w/oM	w/M w/oR	w/M&R
0 to 5	15	100.0	0.0	0.0
6 to 10	11	45.5	54.5	0.0
11 to 15	26	23.1	57.7	19.2
16 to 20	18	0.0	61.1	38.9
21 to 25	17	17.6	47.1	35.3
26 to 30	22	4.5	59.1	36.4
31 to 35	7	14.3	42.9	42.9
36 to 40	3	0.0	66.7	33.3

Notes: w/M means with professional qualification(s); w/oM means without any professional qualification; w/R means with RPE title; w/oR means without RPE title

Career development

Among the respondents who held a first degree, the mean years of work experience before and after acquiring a first degree were 3.3 years and 15.2 years respectively, and the duration between attainment of a first degree and getting the next new position was about 1 year on average (Table 3 (a)). These results show that in the BS discipline in Hong Kong, pursuing a first degree after one has already embarked on his/her career is common, and acquiring a first degree would enable a fresh graduate to find the first job or one already practicing to get a better job within a short period of time.

The statistical data (Table 3(a)) show also that, on average, by the time a BS practitioner acquired the first professional qualification, he/she would have accumulated 8.9 years of work experience, but it would take a first degree holder a shorter time (6.2 years on average) to reach the same status. Acquisition of a professional qualification would enable a BS practitioner to get a better job, within an average post-qualification period of 1.7 years. Job field switching (e.g. between consulting and contracting) was found to be not frequent but also not uncommon.

The statistics in Table 3(c) show that the mean number of years of experience of respondents at the Junior/Technical level (Assistant Engineer, Technical Officer, etc.) was 8.7, which is also close to the mean value of the number of years of experience at the time that respondents acquired their first professional qualification (8.9). The mean years of experience of respondents at the Professional level (Project Engineer, Facility Manager, etc.) is 17.3. The corresponding figures for respondents at the Senior Professional (Senior Engineer, Assistant

Director, etc.) and Directorate levels (Director, General Manager, etc.) are respectively: 19.6 and 28.2.

Table 3 Summary of years of work experience of respondents

	Sample	Years of experience			
(a) Respondents' work experience	size (no.)	Max.	Min.	Mean	Std. Dev.
Years of experience since 1st job	182	39	0	18.4	9.2
Years of experience prior to 1st degree	157	26	0	3.3	5.6
Years of experience from 1st degree	181	56	0	15.2	9.6
Years from 1st degree to next new position	183	19	0	1.0	2.2
Years of experience prior to 1st professional qualification	136	25	0	8.9	5.0
Years of experience from 1st professional qualification	138	30	0	12.2	8.1
Years from 1st degree to 1st professional qualification	138	30	0	6.2	4.3
Years from 1st professional qualification to next new position	188	16	0	1.7	3.1
Years from 1st job to 1st switch in job nature	116	28	0	5.6	5.5
No. of times of job nature switching	196	4	0	0.9	1.1
(b) Respondents' work experience by work field	No.	Max.	Min.	Mean	Std. Dev.
Who work in the consulting field	79	35	0	15.4	9.4
Who work in the contracting field	25	37	6	20.6	7.9
Who work in the FM/O&M field	20	38	7	21.4	9.0
Who work for project clients	17	31	13	19.3	6.3
Who work in the government	30	39	4	21.2	10.6
Who work in other fields	11	29	12	20.4	5.2
Total in sample	182				
(c) Respondents' work experience by job position	No.	Max.	Min.	Mean	Std. Dev.
Junior / Technical	24	32	0	8.7	9.2
Professional	89	31	4	17.3	7.6
Senior professional	41	38	6	19.6	7.3
Directorate	27	39	12	28.2	5.7
Total in sample	190				

Scope of competence and responsibility

The respondents were asked to indicate which trades of BS installations they were competent in and were responsible for handling. Eight common trades of BS systems were listed in the questionnaire, including Heating, Ventilating and Air-Conditioning (HVAC), Electrical (Elec), Fire services (Fire), Plumbing and Drainage (P&D), Lifts and Escalators (L&E), Gas, Building Automation (BA) and Security and Low voltage (S/L) systems. The respondents could include any other BS trades outside the list in which they were competent.

The statistics compiled from 190 responses to this question are summarized in Tables 4 to 8. All such respondents indicated that they were competent in at least one trade systems; 72% in

two or more trades; 47% in three or more trades; and the number drops with increasing number of trades (Figure 4). Only two respondents (1.1%) indicated that they were competent in as many as nine trades. The average number of BS trades that the respondents were competent in is 2.91, which is very close to the median (about 2.9).

"Take in Figure 4"

The BS trades that these respondents were competent in are mostly HVAC (62%) and Elec (54%) whereas the number of respondents with expertise in Gas (9.5%) is the least (Table 4(a)). The other expertise that the respondents had in addition to expertise in the eight trades listed include general building works, energy conservation, project management, tunnel ventilation, swimming pool filtration and treatment, medical gases and environmental protection.

Table 4 Number of respondents competent in handling various combinations of trades

(a) Single trades

Trades	HVAC	Elec	Fire	P&D	L&E	Gas	BA	S/L
No.	118	102	85	62	59	18	45	47

(b) Combinations of two trades

	HVAC	Elec	Fire	P&D	L&E	Gas	BA	S/L
HVAC		56	68	46	34	16	41	26
Elec			47	29	53	15	33	46
Fire				54	29	16	30	23
P&D					20	14	23	17
L&E						16	25	34
Gas							15	13
BA								25
S/L								

(c) Combinations of three trades

	HVAC	Elec	Fire	P&D	L&E	Gas	BA	S/L
HVAC & Elec			43	27	31	14	29	26
Elec & Fire				29	28	14	24	23
Fire & P&D	43				18	13	23	27
P&D & L&E	20	17				12	14	14
L&E & Gas	15	15	14				14	13
Gas & BA	15	14	15	12				13
BA & S/L	22	25	19	15	21			

The combinations of two trades that they were competent in are as summarized in Table 4(b), which show that HVAC & Fire services is the most common combination, followed by HVAC & Electrical systems, Fire and P&D systems and Electrical and L&E. Among those who could handle three or more trades (Table 4(c)), the most common combination is HVAC, Electrical & Fire, followed by HVAC, Electrical and L&E and then HVAC, Electrical & BA.

As shown in Table 5(a), across the job fields, the majority of the respondents were competent in one to four trades although more respondents in the FM/O&M, project client and government fields were competent in a wider range of trades. Table 5(b) shows the statistics of the number of trades that respondents at different job levels were competent in handling. which shows that there are progressively more respondents competent in four or more trades at higher positions.

Table 5 Number of trades which respondents were competent in handling

(a) By job fields

No. of BS Trades	Consult.	%	Contract.	%	FM/O&M	%	Client	%	Govn't	%
1	20	25.6	16	55.2	4	20.0	6	30.0	5	16.1
2	25	32.1	5	17.2	5	25.0	4	20.0	4	12.9
3	19	24.4	5	17.2	2	10.0	0	0.0	8	25.8
4	5	6.4	2	6.9	3	15.0	4	20.0	7	22.6
5	4	5.1	0	0.0	2	10.0	2	10.0	0	0.0
6	3	3.8	0	0.0	2	10.0	1	5.0	1	3.2
7	1	1.3	0	0.0	0	0.0	0	0.0	2	6.5
8	1	1.3	1	3.4	1	5.0	3	15.0	3	9.7
9	0	0.0	0	0.0	1	5.0	0	0.0	1	3.2
Total	78	100.0	29	100.0	20	100.0	20	100.0	31	100.0
Average No. of Trades	2.6		2.0		3.6		3.5		3.8	

(b) By job positions

No. of BS Trades	Junior / Tech.		Professional		Senior Professional		Directorate	
	No.	%	No.	%	No.	%	No.	%
1	4	40.0	9	31.0	4	17.4	2	13.3
2	4	40.0	6	20.7	10	43.5	5	33.3
3	1	10.0	10	34.5	6	26.1	2	13.3
4	0	0.0	0	0.0	2	8.7	3	20.0
5	1	10.0	1	3.4	1	4.3	1	6.7
6	0	0.0	3	10.3	0	0.0	0	0.0
7	0	0.0	0	0.0	0	0.0	1	6.7
8	0	0.0	0	0.0	0	0.0	1	6.7
9	0	0.0	0	0.0	0	0.0	0	0.0
Total	10	100.0	29	100.0	23	100.0	15	100.0
Average No. of Trades	2.0		2.6		2.4		3.3	

All respondents indicated that they were responsible for handling at least one trade of BS systems; 76% for two or more trades; 65% for three or more trades; 53% for four or more trades and the number drops gradually with increasing number of trades (Figure 4). Nonetheless, 16 respondents (8.4%) indicated that they were responsible for as many as nine trades. The average number of trades that the respondents were responsible for is 4.52 while the median is about 4.1.

The BS trades that these respondents were responsible for are: HVAC (67%) and Elec (64%), followed by Fire (63%), P&D (55%), L&E (52%), S/L (50%), BA (41%) and Gas (38%) (Table 6(a)). Comparing the number of trades that the respondents were competent in against the number of trades that they were responsible for unveils that the respondents were responsible for more trades than they were competent in, as shown in Figure 4, which shows that 'competence gap' existed.

As shown in Table 6(b) and (c), among various combinations of two trades, HVAC & Fire is the most common combination, followed by HVAC & Electrical systems and Fire and P&D systems, and then Electrical and Fire services and Electrical and L&E. Among those who had the responsibility for handling three or more trades, the most common combination that they were responsible for is HVAC, Electrical and Fire, followed by HVAC, Fire and P&D and HVAC, Electrical and S/L.

Table 6 Combinations of two and three trades for which the respondents were responsible

(a) Single trades

Trades	HVAC	Elec	Fire	P&D	L&E	Gas	BA	S/L
No.	128	121	119	105	98	72	78	95

(b) Combinations of two trades

	HVAC	Elec	Fire	P&D	L&E	Gas	BA	S/L
HVAC		95	105	88	79	69	75	82
Elec			94	81	90	64	71	93
Fire				95	78	70	73	80
P&D					69	67	67	71
L&E						65	67	81
Gas							62	63
BA								67
S/L								

(c) Combination of three trades

	HVAC	Elec	Fire	P&D	L&E	Gas	BA	S/L
HVAC & Elec			91	77	76	63	69	80
Elec & Fire				78	76	63	67	79
Fire & P&D	84				67	66	65	70
P&D & L&E	67	66				60	60	63
L&E & Gas	64	62	63				59	61
Gas & BA	61	58	62	59				56
BA & S/L	65	66	64	59	63			

As Table 7(a) shows, the majority of the respondents in the contracting field were responsible for just one trade whereas being responsible for multiple trades was common in the other fields, including consulting, FM/O&M, project client and government. The statistics of the number of trades that respondents at different levels of job positions were responsible for handling (Table 7(b)) shows that, generally, respondents at the Directorate level shouldered responsibility for a wider range of trades.

Table 7 Number of trades for which respondents in different job fields were responsible

(a) By job fields

No. of Trades	Consult.	%	Contract.	%	FM/O&M	%	Client	%	Govn't	%
1	14	17.5	16	55.2	1	5.3	1	5.0	7	22.6
2	11	13.8	2	6.9	2	10.5	1	5.0	2	6.5
3	17	21.3	4	13.8	1	5.3	0	0.0	0	0.0
4	2	2.5	1	3.4	4	21.1	3	15.0	2	6.5
5	3	3.8	1	3.4	0	0.0	1	5.0	4	12.9
6	6	7.5	1	3.4	2	10.5	1	5.0	5	16.1
7	6	7.5	0	0.0	1	5.3	2	10.0	2	6.5
8	17	21.3	3	10.3	1	5.3	9	45.0	7	22.6
9	4	5.0	1	3.4	7	36.8	2	10.0	2	6.5
Total	80.0	100.0	29.0	100.0	19.0	100.0	20.0	100.0	31.0	100.0
Average No. of Trades	4.5		2.8		6.0		6.5		5.1	

(b) By job positions

No. of Trades	Junior / Tech.		Professional		Senior Professional		Directorate	
	No.	%	No.	%	No.	%	No.	%
1	4	16.7	27	28.7	12	26.7	2	8.0
2	5	20.8	9	9.6	6	13.3	0	0.0
3	2	8.3	12	12.8	7	15.6	2	8.0
4	0	0.0	10	10.6	1	2.2	1	4.0
5	1	4.2	5	5.3	0	0.0	3	12.0
6	4	16.7	8	8.5	3	6.7	0	0.0
7	1	4.2	4	4.3	3	6.7	3	12.0
8	4	16.7	13	13.8	10	22.2	10	40.0
9	3	12.5	6	6.4	3	6.7	4	16.0
Total	24	100.0	94	100.0	45	100.0	25	100.0
Average No. of Trades	4.8		4.0		4.3		6.6	

For obtaining a more detailed picture of the ‘competence gap’ faced by the respondents, the number of respondents who did not regard themselves as competent in specific BS trades but were responsible for those trades was analyzed. The result (Table 8) shows that competence gap existed in all the trades, most seriously in the Gas trade, followed by the S/L trade, the BA trade, the P&D trade and the L&E trade. Competence gap was comparatively less severe for the major BS trades, including Fire, Electrical and, the least seriously, HVAC.

Table 8 Competence gap by BS trades

	HVAC	Elec	Fire	P&D	L&E	Gas	BA	S/L
No. responsible for the BS trade*	123	116	114	100	96	72	76	91
No. not competent but responsible	22	30	40	52	46	58	44	55
% not competent but responsible	17.9	25.9	35.1	52.0	47.9	80.6	57.9	60.4

* The numbers in this row were based on 169 records with data on BS trades that the respondents were both competent in and responsible for.

Annual income

Only 121 (62%) of the respondents were willing to disclose their annual income in their questionnaire returns. Figure 5 shows the annual income distribution of the respondents. The highest annual income among the respondents was HK$2,000,000, the minimum was HK$120,000, and their mean and medium annual income values are both close to HK$600,000.

"Take in Figure 5"

As Figure 6(a) shows, years of experience is highly influential to the income of the practitioners. A drop in annual income can be observed for respondents with more than 35 years of experience, but there are only three respondents in this group (Table 2), which is insufficient to verify that this is generally true. From a linear regression analysis on the mean income of the respondents in the eight ranges of years of experience, the average starting salary of the respondents (the intercept of the regression line) was found to be about HK$153,000 per annum and the rate of increase in annual income (the slope) was about HK$25,500 per year ($R^2 = 0.94$).

"Take in Figure 6"

As shown in Figure 6(b), the mean annual income of respondents in the consulting field was significantly lower than those in the contracting, FM/O&M, project client, government and other fields. This is mainly because there are a greater number of younger and less experienced practitioners in the consulting field compared to practitioners in the other fields

in the sample. Nonetheless, the practitioners who had the highest annual income belong to the consulting field. It is encouraging to find that practitioners in the FM/O&M field, which was traditionally regarded as involving more routine works and requiring lower technical skills, were remunerated at a level compatible with practitioners in the other fields.

The influence of academic qualification and job position on the annual income of the respondents was analyzed and the relevant statistical findings are summarized in Tables 9 and 10. It can be seen that no significant difference in annual income could be found between those respondents without a degree and those with one degree only, but apparently those with more academic qualifications were able to earn, on average, higher incomes (Table 9). A clear positive correlation between job position and mean annual income can also be seen (Table 10).

Table 9 Annual income and number of degrees of the respondents

	No	% Tot	Max	Min	Mean	StdDev
Without a degree	6	5.0	1000000	260000	551333	268288
With 1 degree (first or higher)	59	48.8	2000000	120000	552007	371697
With 2 degrees	45	37.2	1400000	132000	643724	303014
With 3 or more degrees	11	9.1	1500000	348000	752545	396892
Total	121	100.0				

Table 10 Annual income and job position of the respondents

Position	No.	% Tot	Max	Min	Mean	StdDev
Junior / Technical	20	16.5	600000	120000	251320	163523
Professional	61	50.4	1400000	220000	558262	250257
Senior professional	23	19.0	1080000	342000	675722	223602
Directorate	17	14.0	2000000	550000	1088235	386705
Total	121	100.0				

As to the influence of professional qualification and RPE registration, the relevant statistical findings are shown in Figure 7. Although exceptions can be found, the general trends are that those respondents with these professional qualifications had higher incomes and their income could grow to higher levels with increase in experience.

"Take in Figure 7"

Discussions

Representation of the findings

According to HKIE's data, as at April 2008, the membership in the BS discipline included 110 Fellows, 1,170 Members and 339 Associate Members. For the entire institution, the ratio of the number of Graduate Members (4,144) to the total number of Fellows, Members and Associate Members (13,460) was about 31%. Assuming that this ratio would apply to the BS discipline, the total number of members in the four grades in the BS discipline would amount to about 2,120 (Student Members discounted as they are not yet BS practitioners). Because there are BS practitioners in Hong Kong who are professionally qualified (being members of CIBSE, IMechE or IET, etc.) but are not members of HKIE (there are 25 such practitioners in the sample), the BS practitioners in the present sample (196) would only account for less than 9% of the population. There is no evidence to justify that a sample of this size can provide a sufficiently accurate picture of the population of BS practitioners in Hong Kong in all the aspects analyzed above.

The limitation of the sample data, therefore, should be borne in mind in interpreting some of the statistical results. For example, the distributions of the number of BS practitioners in different job fields, job positions, age ranges, income ranges, etc., cannot be regarded as an accurate reflection of the true distributions of the population. For the mean years of experience of BS practitioners at different job positions and the mean annual income of the practitioners in different ranges of years of experience, *t*-tests on the differences between the class means (Aron et al., 2005) actually showed that some of the classes may not be

statistically distinguishable from their respective adjacent classes (e.g. on the mean years of experience between the groups of respondents at the Professional and Senior professional levels).

Nevertheless, the limitation of the sample size cannot nullify other observations of facts, such as the diversity in the number of trades that the practitioners are competent in and the presence of competence gap. Furthermore, the demographic picture conveyed by the collected data, though not statistically proven to be an accurate reflection of all BS practitioners in Hong Kong, is still highly informative given that such a picture was hitherto unavailable.

Divergence in competence among professional BS engineers

For various reasons, including the relatively short history of degree programmes dedicated to nurturing building services engineers (Chan and Burnett, 2004) and the ways in which BS works are organized in companies in Hong Kong, BS practitioners tend to specialize in just a few trades (on average about 3 as found in the survey), which could be fewer than the number of trades that they are responsible for (on average 4.5 as found in the survey), although some of them, especially those more experienced ones, are capable of overseeing a wider range of trades. Cognizant of this fact, professional institutions in BS engineering do not insist in requiring applicants to be competent in a designated range of BS trades in their membership admission assessment. Reportedly, there is a similar situation in the UK in that BS works are typically streamed and undertaken by practitioners specialized in mechanical and electrical engineering, at a ratio of about 2:1 in number (Underwood and Giddings, 2009).

In order that the clientele of their services and the general public may appreciate the value of their work, professionals must interpret, translate or mediate their work to make their works understandable to others (Brown, 1992). The divergence in the competence of professional BS engineers, therefore, is a hindrance to promoting the BS profession. Furthermore, a key function of a professional qualification is that the general expectation on the performance of holders of the same qualification can be taken as a benchmark for gauging if a specific professional holding that qualification has performed due care and diligence in discharging his professional duties. This, in turn, provides the clients an assurance of the performance of the professionals to be expected, which is a cornerstone of professional status. However, with the diverse competence among professional BS engineers, they cannot be compared against each other like-to-like. Their professional qualifications, such as MHKIE and RPE in the BS discipline, therefore, cannot serve well the purposes of a professional qualification.

There is also the danger that the BS profession could become fragmented. Members having competence in a sub-discipline of BS which other members do not have may prefer to establish a discipline specific to that area of competence. This could happen when there is a change in the prospect of a sub-discipline, triggered, e.g. by a change in regulatory control on the works in that sub-discipline. In Hong Kong, a separate fire discipline has recently been established under HKIE, largely because of the prospect of third party certification of fire safety of buildings (FSD, 2007).

Traditionally, there was no strong market demand for professional BS engineers to be competent in multiple BS trades in Hong Kong. However, this demand is anticipated to grow as increasing emphasis is given to sustainable building development through using holistic solutions turned out by integrated teams of building professionals. For the professional BS

engineers to perform well as a member of the integrated team, competence in handling multiple BS systems will become essential. A few examples follow:

i. Evaluation of a building integrated photovoltaic (BIPV) system requires simulation of solar irradiance upon the BIPV surfaces, which is an extension of the technique used in building cooling load simulation typically done by an engineer competent in HVAC systems, but determining how the variable amount of electric power generated by the BIPV system can be effectively utilized requires competence in electrical systems.

ii. Evaluation of smoke & fire spread and natural ventilation are respectively the concerns of the fire services and HVAC system designers but computational fluid dynamics (CFD) technique can be applied to both. Therefore, a BS engineer competent in both fire services and HVAC, when additionally equipped with skills in CFD simulation, can serve both purposes.

iii. For achieving the highest possible environmental performance of a building within a limited budget, system evaluations to inform selection of the optimal combination of alternative means, e.g. smart glass, BIPV, energy efficient lighting, light pipes, demand control ventilation, etc., would need to be done, which will require competence in multiple kinds of systems.

Given that BS systems are intertwined in that the design and performance of one system could affect and could be affected by those of other systems, competence in multiple BS systems will become increasingly important to professional BS engineers, especially when

innovative BS systems are to be adopted for which design has to start from fundamental considerations.

There is, therefore, a need for professional institutions in BS engineering to reflect on whether a minimum scope of competence needs to be set as a requirement for admission of members such that the diversity in competence of professional BS engineers can be minimized in future.

Conclusion

As part of a comprehensive research study which aimed at enhancing the future roles and functions of building services (BS) engineers in Hong Kong, a survey was carried out to obtain demographic information about BS practitioners as well as their views and opinions on a range of issues which affect professional practices of BS engineers. A series of statistical analyses was conducted based on the responses given by the BS practitioners, which included their qualifications, experience, job field, annual income and number of BS trades that they are competent in and responsible for.

The statistics shows that: i) competence gap exists in that BS engineers are required to handle more trades of BS systems than those they are competent in; and ii) the academic and professional qualifications, years of experience and job position are the key influential factors to the annual income of BS engineers. Whereas O&M is traditionally a job field less preferred by BS practitioners (Lai, 2010), it is encouraging to find that little differences exist in the income of engineers in different job fields, including the FM/O&M field.

The competence gap is a concern that needs to be addressed to ensure BS engineers are competent in handling the common trades of BS systems, which is increasingly important for them to perform effectively in integrated professional teams for turning out holistic solutions for sustainable building developments.

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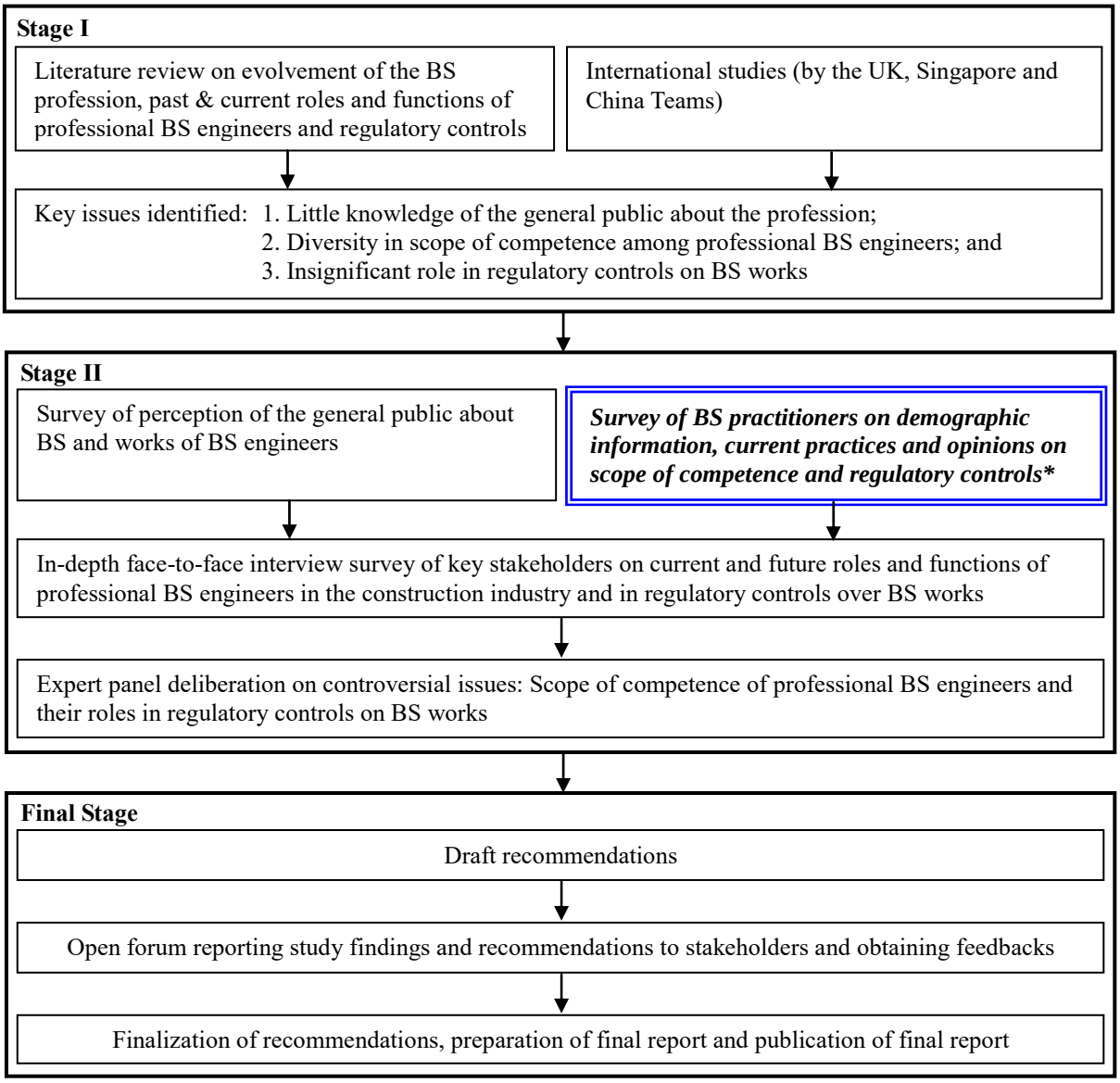
List of figures



* Key findings of the BS practitioner survey are reported in this paper

Figure 1 Stages of work of the Research Study on Hong Kong's BS Profession

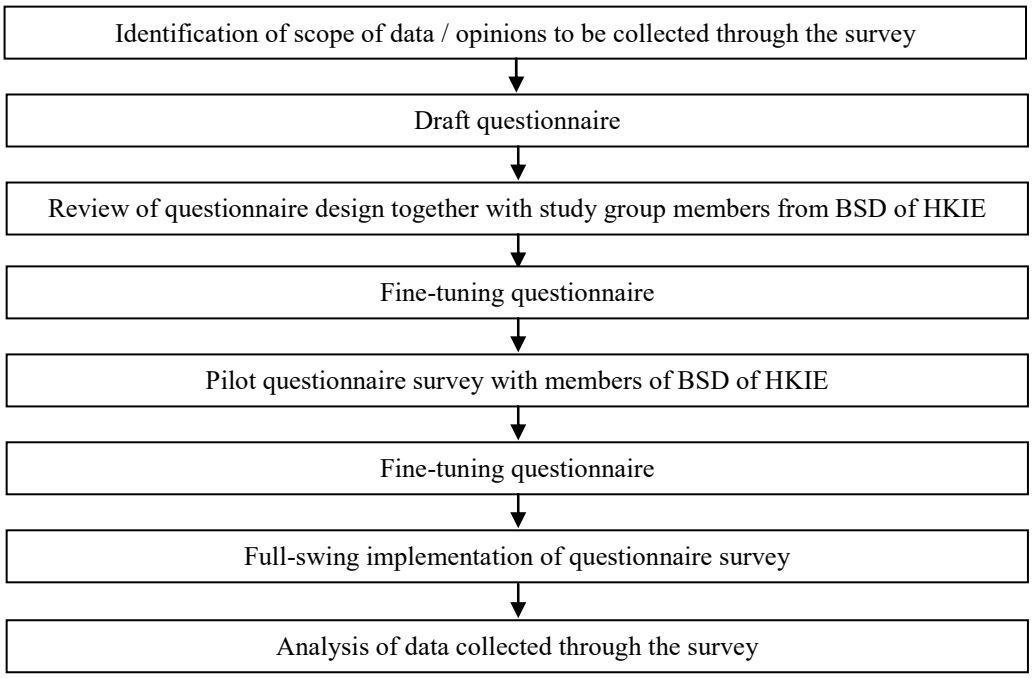


Figure 2 Steps of questionnaire survey of BS practitioners

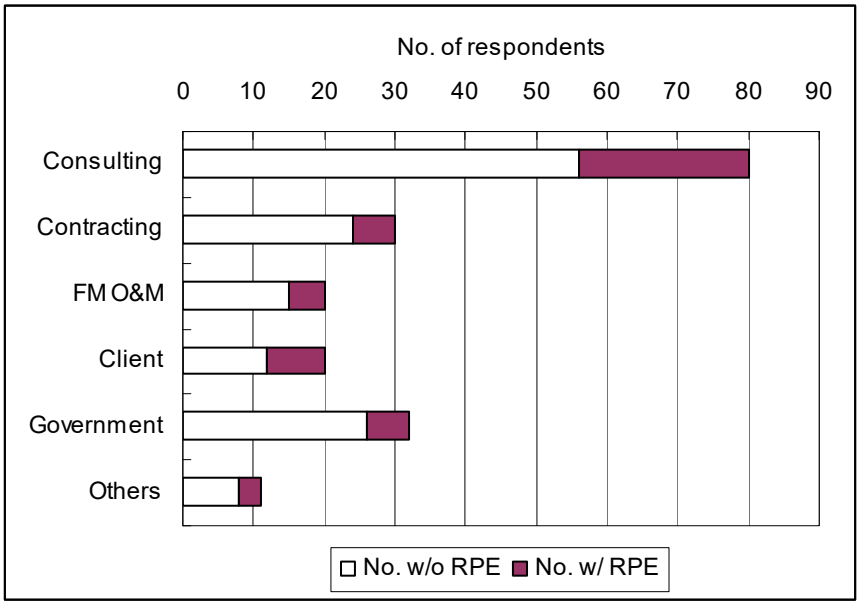


Figure 3 Numbers of respondents with (w/) and without (w/o) RPE registration in different job fields

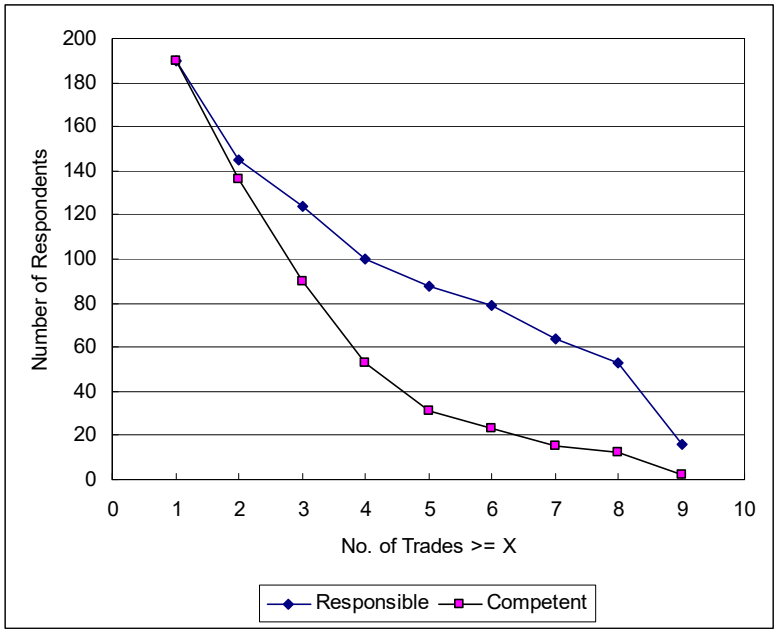


Figure 4 Cumulative numbers of respondents competent in and responsible for various number of trades of building services systems

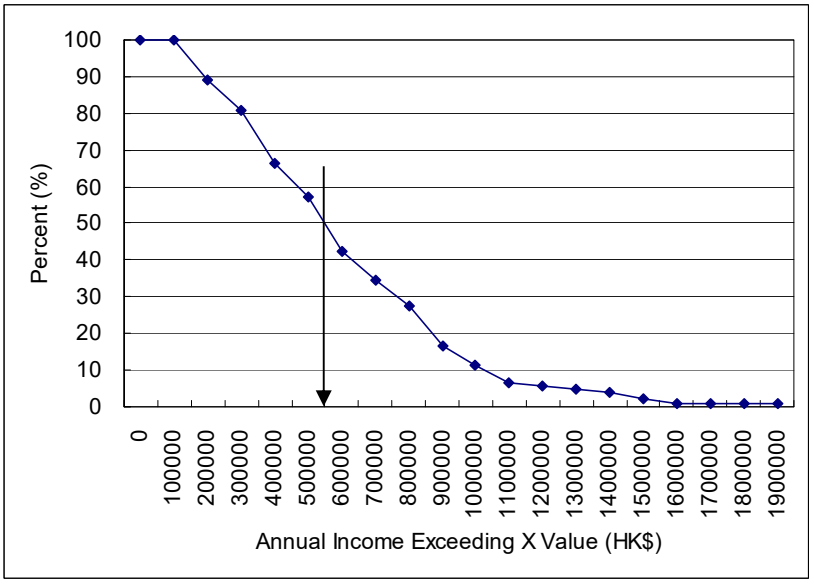
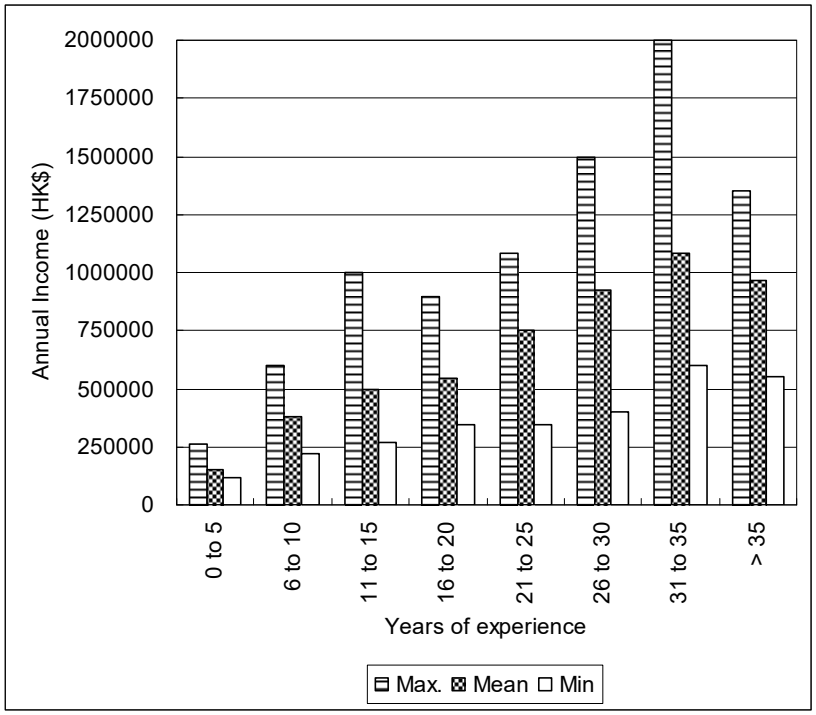
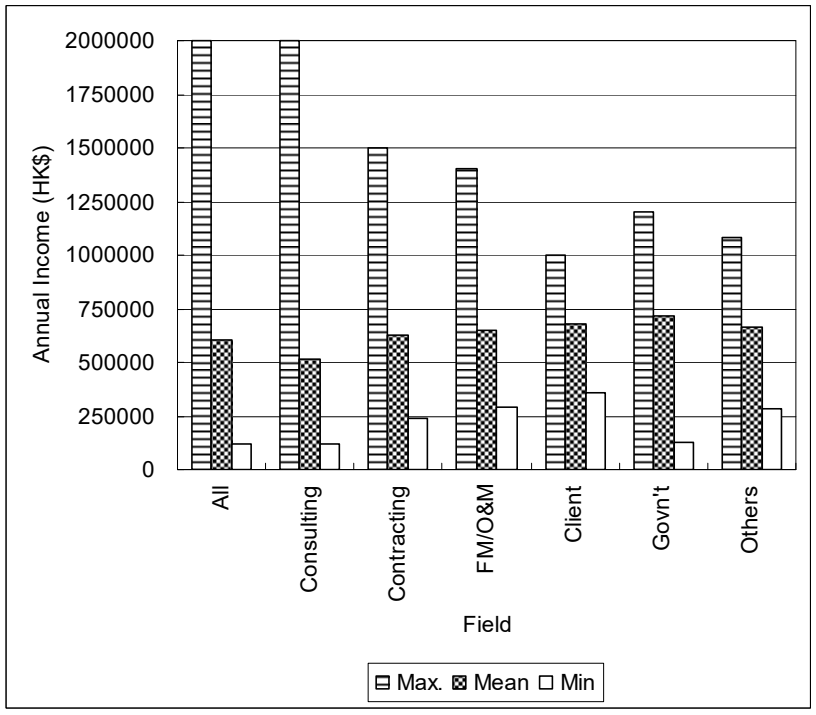


Figure 5 Cumulative distribution of the annual income of the respondents



(a)



(b)

Figure 6 Annual incomes of the respondents classified by: a) years of experience and b) job fields of the respondents

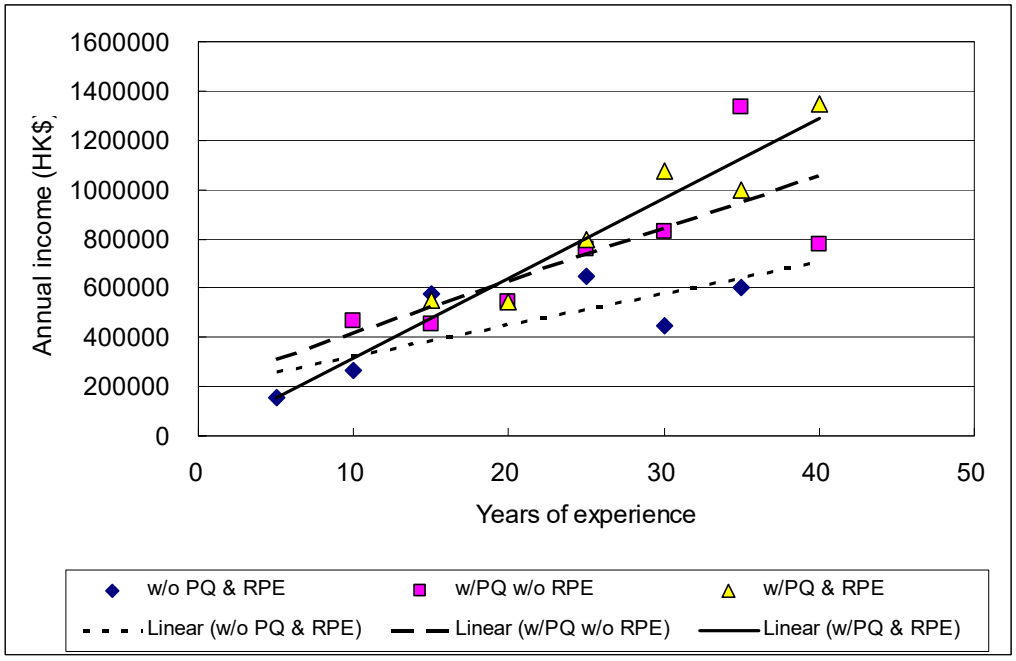


Figure 7 Annual incomes and years of experience for respondents without any professional qualification (PQ), with PQ but without RPE registration, and with PQ and RPE registration