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## **Building Operation and Maintenance: Manpower in Hong Kong**

### Structured abstract

#### **Purpose**

Building operation and maintenance (O&M), an industry demanding substantial human resources, is a key part of modern economies. Aimed at revealing the state of O&M manpower for the dense-built environment of Hong Kong, an academia-industry collaborative study was conducted.

#### **Methodology/approach**

After developing a model that integrates manpower levels (L), trades (T) and natures (N) of O&M works (named as “LTN” model), a full spectrum of O&M jobs were established followed by collecting data of 75 organizations and 402 stakeholders through two surveys.

#### **Findings**

Besides the large O&M workforce, vacancy rates of the jobs were found to be significant. For the different trades and natures of O&M works, the knowledge/ skills levels perceived by the stakeholders were lower than the corresponding importance levels.

#### **Research implications**

The methodology of the study can be used in future research for revealing the state of O&M manpower in Hong Kong and cities alike. The way in which the “LTN” model was developed may be used as a reference for constructing similar models for manpower research in various industries.

#### **Practical implications**

The findings and the measures for improving the O&M manpower can assist policy makers and human resources departments to formulate necessary education and training courses for the building industry.

#### **Originality/value**

The study is the first of its kind focusing on building O&M manpower. The state of the manpower it unveiled forms a basis for comparison with similar findings in future.

#### **Paper type**

Research paper

#### **Keywords**

Construction; education; maintenance; manpower; professional; training.

## **Building Operation and Maintenance: Manpower in Hong Kong**

### **Introduction**

Urban development is characterized by progressive construction of buildings, which often represents one of the largest industrial sectors in modern economies (Raja et al., 2013). On top of elaborate planning, design and construction, proper upkeep of the buildings throughout their long post-occupancy periods requires considerable human and material resources (Building Maintenance Information, 1996). Central to the upkeep are efficient building operations (e.g. minimized energy use for facilities in buildings) and effective maintenance for buildings (e.g. optimal repair for dilapidated façade). Achieving these targets is a common goal, yet also a typical challenge, for cities across the world.

Hong Kong is a vibrant metropolis with an ever-changing city profile (Sparrow, 1988; Cullinane and Cullinane, 2003). Associated with the thriving cityscape of Hong Kong is continuous expansion of its building stock (Rating and Valuation Department, 2015). With a limited land area and an extreme population density of 6,544/km<sup>2</sup>, there are 776,162 public housing flats, 1,123,633 private domestic flats and over 46,178,000m<sup>2</sup> private non-domestic premises (Census and Statistics Department, 2014). The demand for effective management and maintenance, for both newly completed and aging buildings, has intensified (Housing, Planning and Lands Bureau, 2005; Chan and Choi, 2015). Meeting such a demand entails not only appropriate hardware, which involves advanced maintenance technologies, but also suitable software, which requires competent and sufficient manpower (Wegelin, 1990). Provision of proper education and training (Hamdi, 1986; Benninger, 1987), therefore, is needed for those who operate and maintain buildings (Sidabutar et al., 1991; Martin, 1991).

Operation and maintenance (O&M) works for a building, as illustrated by Lai (2010a), are typically executed in one or a combination of three ways: (i) an in-house workforce directly employed by the building owner, (ii) a management company which sublets the works to some O&M contractors, and (iii) multiple contractors directly appointed by the owner. As such, deployment of manpower for the works is a complex human resources management issue that involves multiple groups of stakeholders across various sectors of the building industry.

### **Background of the study**

In recent years, the Building Services Operation and Maintenance Executives Society (BSOMES), which is the leading organization of professionals dealing with O&M works for buildings in Hong Kong, has noticed the less-than-satisfactory development of O&M manpower for buildings. Therefore, a collaborative research study which aimed at revealing the state of the manpower was jointly conducted by BSOMES and The Hong Kong Polytechnic University. The objectives of the study were to investigate the supply and demand of building O&M practitioners; find out any gaps between the required and possessed competences of the practitioners; and identify ways to meet the manpower needs.

Undoubtedly, manpower planning has been an important issue for the construction market (Schuster, 1987). Apart from a significant volume of research studies on construction labor productivity (Yi and Chan, 2014), various efforts have been made on manpower forecast. The work of Wong et al. (2008), using some modelling techniques, developed 11 models for forecasting manpower demand for construction projects. Utilizing both quantitative and

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qualitative data, Sing et al. (2014) devised a sustainable workforce model to predict and monitor workforce conditions. Recently, Liu et al. (2015) developed a model that incorporates a global economic perspective to forecast construction workforce demand.

Besides the above modelling studies, the research of Druker and White (1995) investigated the nature of personnel in the construction industry. The work of Forde and MacKenzie (2004) explored the questions of labor reproduction and skill development. Furthermore, Egbu (1999) established an inventory of knowledge, skills and competencies for managing construction refurbishment works, and Wang et al. (2008) examined the state and effectiveness of training programmes for construction craft workers. Realizing the importance of O&M works for attaining a sustainable built environment, Lai and Yik (2006) investigated the knowledge and perception of O&M practitioners about sustainable buildings and, according to a later study, there was no tertiary academic programme dedicated for educating building O&M personnel (Lai, 2010b). Given that resources available for building upkeep are often constrained, Lai (2010a) examined the budgetary practices for O&M works and developed a manpower deployment indicator (MDI) for measuring the amount of manpower used in budgeting.

The survey of Yik et al. (2010) found that O&M practitioners working in management offices of buildings, who are approached by most people when problems with building facilities arise, are influential to the perceived image of building services professionals. A further study of Yik et al. (2013), through analyzing qualifications, experiences, job fields, incomes and competences of building services practitioners, produced a portrait of building services engineers, including those who handle O&M works.

For classifying the roles and duties of construction workers, the Construction Workers Registration Authority (2014) has defined a list of designated trades. Most of them cover some technical positions (e.g. electrician, carpenter) but not non-technical O&M works (e.g. management). The Vocational Training Council, which is the largest provider of vocational education and training in Hong Kong, regularly conducts manpower surveys of various industries. But none of the surveys provides specific statistics on building O&M manpower. While some of the industries, namely Electrical and Mechanical Services (Vocational Training Council, 2011a), Building and Civil Engineering (Vocational Training Council, 2011b) and Real Estate Services (Vocational Training Council, 2011c), are related to the building O&M sector, their job classifications are not tailored for building O&M works. Even though Munns and Al-Arjani (1993) had proposed a method for identifying different works types in maintenance projects, a set of well-defined O&M job titles and duties remains unavailable.

After releasing the collaborative study's findings (Lai, 2015), further analyses were made. In the next section, the composition of an integrated model of manpower levels, trades and natures of O&M works was explained, followed by describing the target sources of data for the study and the data collection methods. After showing the demography of the collected samples, findings about the status quo of the building O&M industry are analyzed and discussed. Suggested measures that can improve the manpower, which are vital for cities having a similar situation of Hong Kong, are given before a conclusion section at the end.

## **Research Method**

In addition to a study team who undertook the research tasks, a project committee comprising O&M experts (including the president, vice president and committee members of BSOMES) was formed to oversee the progress of the study, liaise with relevant parties to facilitate data collection, and provide advice during the study.

Under the study there were three stages of works. At the beginning of Stage 1, the study team issued invitation letters to solicit support from 20 building-related organizations in order to maximize the volume of data to be collected. Such organizations include government departments (e.g. Electrical and Mechanical Services Department, Fire Services Department), company associations (e.g. Hong Kong Association of Property Management Companies, Hong Kong Federation of Electrical and Mechanical Contractors Limited) and professional institutions (e.g. International Facility Management Association - Hong Kong Chapter, Hong Kong Institution of Engineers - Building Services Division). At the same time, a literature review was carried out. It showed that the job classifications of the Construction Workers Registration Authority (2014) and the Vocational Training Council (2011a; 2011b; 2011c), as summarized in Table 1, are not tailored for building O&M works. But they are useful references for defining O&M jobs and so were adapted to suit the O&M context. In this way, a summary of O&M job titles and duties was prepared and, after incorporating the comments of the project committee, a total of 74 job categories were defined. And they were divided into 3 groups, namely (i) managerial, (ii) technical/ supervisory and (iii) frontline, as shown in Appendixes A, B and C respectively.

“Insert Table 1 here”

With reference to the above job classifications, the expert opinions of the project committee and an established education framework comprising various trades and natures of O&M works (Lai, 2010b), a conceptual model (Fig. 1) was developed as a basis upon which the study was carried out. Resembling the outlook of a house, the model integrates manpower levels (L), trades (T) and natures (N) of O&M works. According to this “LTN” model, there are three main levels of manpower, namely strategic (senior management), tactical (middle management) and operational (frontline). Practitioners at different manpower levels, depending on individual competences and organizational settings, may be responsible for one or a range of the work trades. Individual work scopes under each trade may cover one or some of the work natures. Some of the natures involve knowledge/ skills on the soft side of facilities management (FM), e.g. human resources and customer management (British Institute of Facilities Management, 2014) while some others need to be handled with hard-side knowledge/ skills such as engineering calculation and drawing preparation. As shown in Table 2, there are 16 trades and 12 natures of the works.

“Insert Fig. 1 here”

“Insert Table 2 here”

In Stage 2, two project committee meetings were held, from which it was noted that the major sectors of the building O&M industry include: (i) building management companies; (ii) electrical and mechanical contractors; (iii) minor works contractors; (iv) educational institutions; (v) utilities companies; (vi) hotels; (vii) building owners (without forming subsidiary management companies); and (viii) government departments, public bodies, and non-government organizations (NGOs).

With due consideration of the study objectives and the types of data required, two questionnaires were devised. The first questionnaire consists of 3 parts. The first part asks the respondents to provide information about their organizations, including name, type and total number of employees. The second part asks for number of persons employed and number of vacancies for each job category listed in the Appendixes. A series of questions in the final part enquire about recruitment and manpower matters, including whether the target organizations encountered difficulties in recruiting O&M personnel, reasons for such difficulties, any expected change in manpower and, if there is, the extent of and reasons for the change. An online version and a hard-copy version of this questionnaire were prepared. The online one was distributed to organizations whose email addresses were readily available and the hard-copy version was posted to the rest (Table 3). After distributing the questionnaires, two rounds of reminders were issued to the email recipients.

“Insert Table 3 here”

Intended to gather opinions of building O&M stakeholders, the second questionnaire comprises four parts. The first part requests the respondents to provide their personal particulars including any membership of the organizers or supporting organizations; type of their employer organization; and their job position, work experience, age and highest education level. The second part asks them to indicate based on a 5-point scale (1: very little; 2: little; 3: moderate; 4: high; 5: very high) their perceived levels of demand and supply for each of the three O&M job groups. The third part asks them to, based on the same rating scale, indicate their perceived levels of importance and knowledge/ skills of practitioners for each trade of O&M work, and then for each nature of the works. Further opinions of the respondents, collected via the final part, include: whether the existing O&M education means are appropriate and, if not, for what reasons; what measures could improve the existing O&M manpower; and any other opinions. An online version of this questionnaire was emailed to members of the organizers and the supporting organizations. Afterwards, two rounds of reminder messages were issued.

Data collected from the two surveys were analyzed; the findings were discussed and reviewed in meetings of the project committee. Finally, two project committee meetings were held in Stage 3 to discuss the results. Inputs from the committee members, including suggestions for improving the issues found, were taken in drawing conclusions for the project.

## **Findings**

### ***Respondents of the surveys***

For the first survey, the responses came from 75 organizations - 31 contractors, 20 building management companies, 14 building owners, and 10 others including 4 government departments and 4 educational institutions. The aggregate number of persons they engaged amounted to 47206; each organization on average employed 629 persons. As shown in Fig. 2, most of the respondent groups were either small-scale ( $\leq 100$  persons) or large-scale ( $> 500$  persons) organizations.

“Insert Fig. 2 here”

Respondents of the second survey were 402 practitioners, including fresh graduates, the experienced as well as veterans. On average, they had worked in the building industry for

18.4 years. The proportion of those working for building management companies was the largest, and the proportions of those employed by building owners and contractors were comparable (Table 4). Over half of the respondents belonged to the technical/ supervisory groups. Around two-thirds were middle-aged (35-54), and most were highly educated, possessing a bachelor or master degree.

“Insert Table 4 here”

### ***Manpower size, vacancy and income***

The total O&M manpower of the sampled organizations consisted of 17712 persons and the vacancies summed to 727. Under the managerial group, the total number of persons employed was 1592. Among the 11 managerial job categories, M10 (Assistant Estate Manager/ Assistant Area Manager/ Assistant Building Manager/ Assistant Property Manager) recorded the largest number of personnel, amounting to 578 (i.e. 36.31% of the group). In contrast, only four persons (0.25%) were employed as Facilities Manager (M07).

The total number of vacancies of the managerial group was 58, or 3.52%. The greatest job demands were found with M03 (Estate Manager/ Area Manager/ Building Manager/ Property Manager) and M10 (Assistant Estate Manager/ Assistant Area Manager/ Assistant Building Manager/ Assistant Property Manager). While there were large amounts of managers with soft knowledge and skills (e.g. M03: Estate Manager/ Area Manager/ Building Manager/ Property Manager), the amounts of managers with knowledge and skills on the hard side of FM, e.g. under categories M05 (Engineering Manager) and M06 (Project Manager), were comparatively small.

In the technical/ supervisory group, there were a total of 10631 persons. The top three job categories, in descending order, were T13 (Building Services and Engineering Supervisor), T17 (Maintenance Officer/ Technical Officer/ Clerk of Works), and T16 (Property/Estate Officer/ Administrative Officer). Among the 310 vacancies (i.e. a vacancy rate of 2.83%) of the technical/ supervisory group, over one-third were for T19 (Assistant Property Officer/ Assistant Estate Officer/ Assistant Administrative Officer/ Estate Assistant/ Engineering Assistant). Both job categories T13 and T01 covered a large number of multi-skilled building services practitioners and the numbers of persons engaged were 2507 and 868 respectively.

A total of 5489 persons belonged to the 44 job categories of the frontline group and the total number of vacancies was 359, or 6.14%. Building services technician (F01), which is a multi-skilled job category, recorded the largest number of persons (910). Regarding vacancies, the posts of 62 building services technicians (F01) and 134 lift/escalator technicians (F05) were open. The demand for such posts, being dominant among the vacancies of the frontline group, is an issue that warrants attention.

Fig. 3 further shows the proportions of persons engaged by the three main organization types - owner, management company, and contractor. Clearly, the manpower proportions of owner and contractor organizations share the same pyramid pattern, with the largest proportion of their workforce belonging to frontline staff, followed by technical/ supervisory staff and managerial staff. On the other hand, the manpower distribution of management companies is different; the largest subgroup comprised technical/ supervisory staff instead of frontline staff. Across the three organization types, those working at the managerial level for contractors constituted the smallest subgroup.

“Insert Fig. 3 here”

Based on the income data, Fig. 4 was made to illustrate the distribution of monthly salaries of the three job groups. Obviously, technical/ supervisory practitioners earning HK\$25,001-35,000 a month (HK\$1  $\approx$  £0.09, or €0.11) represented a major portion (27.6%). The salaries of the frontline group, with its largest subgroup (15.9%) earning HK\$15,001-25000, were distributed over the low range, from  $\leq$  HK\$15,000 up to 55,000. Those of the managerial group spread across the whole range of incomes, with the highest income group (e.g. Director, General Manager) receiving a monthly salary of more than HK\$95,000. Detailed inspection on the data found that a small portion (0.1%) at the low-salary range were those working at the managerial level of contractors, who may have a remuneration package of low salary plus generous bonus/benefit.

“Insert Fig. 4 here”

### ***Recruitment and manpower change***

The majority (68%) of the organizations indicated that they encountered difficulties in the recruitment of building O&M personnel in the 12 months preceding the survey. 16% neither had any recruitment nor tried to recruit any new staff, and the remaining 16% did not encounter any difficulties in the recruitment. Fig. 5 shows the proportions of the reasons for encountering difficulties in recruiting different groups of staff. Most (78.4%) of those having such difficulties indicated the lack of frontline candidates with relevant experience. The second most common reason (62.7%) was insufficient trained/ qualified manpower for the frontline group.

“Insert Fig. 5 here”

Over half of the organizations (56%) expected to have no manpower change in the next 12 months; yet there was a significant proportion (44%) anticipating a change in manpower. For those expecting to have manpower changes, 36.4% would increase their managerial group size, in contrast to a small proportion (3.0%) that would reduce their managerial manpower. 60.6% would have their manpower unchanged.

For technical/ supervisory manpower, 45.5% of the organizations expected to have increases while only 6.1% indicated an expected drop. A moderate proportion (57.6%) would expand their frontline manpower but 12.1% expected that their frontline manpower sizes would decrease.

As shown in Fig. 6, the top reason (51.5%) for change in the frontline manpower in the next 12 months was change in economic outlook. Change of manpower cost, as indicated by a slightly smaller proportion (48.5%), was the second most common reason for change in the same group of manpower. Generally, outsourcing or in-sourcing of work was regarded as the least common reason for manpower change in the various groups. In particular, outsourcing or in-sourcing was indicated by only 3.0% as a reason for change in managerial manpower.

“Insert Fig. 6 here”

### ***Manpower demand and supply***

The respondents of the second survey were asked to indicate their perceived levels of demand and supply for each of the three groups of manpower. The majority (43.5%) indicated a high level of demand for managerial manpower whereas most (62.4%) perceived a moderate level of supply for the same group of manpower. For the demand of manpower for the technical/ supervisory group, exactly half of the respondents indicated that the demand was at a high level. A comparable proportion (51.7%), however, perceived a moderate level of supply for technical/ supervisory manpower. As regards the perceived levels of manpower demand for the frontline group, the distribution skewed towards the high end, and over half (52.5%) of the respondents considered the demand level very high whereas only 8.2% perceived a very high supply level.

Referring to the calculated mean values of the perceived levels of demand and supply, Fig. 7 was constructed. It shows that same for all the three manpower groups, the level of demand exceeds the level of supply. The highest supply level was found with the managerial group, followed by the technical/ supervisory group and the frontline group. On the contrary, the order of demand levels of the three groups reversed, with the demand level of the frontline group being the highest. The gap between the demand and supply levels of the frontline group is the biggest, which concurs with the earlier finding that this manpower group had the largest vacancy rate.

“Insert Fig. 7 here”

In order to find out whether the manpower demand and supply levels were different between different types of organizations, the Statistical Package of the Social Sciences (SPSS) software was used for processing a chain of non-parametric tests that can analyze subgroups of responses given on an ordinal scale. Based on the levels of manpower demand and supply indicated by the respondents for each of the three job groups (i.e. managerial, technical/ supervisory and frontline), the Mann-Whitney test was used to show if there existed significant differences between three pairs of subgroups: (i) “owner” and “management company”; (ii) “management company” and “contractor”; and (iii) “contractor” and “owner”.

The null hypothesis of the test was that the distribution of the demand (or supply) levels in each pair of subgroups was identical. The test results, which include values of mean rank, Mann-Whitney  $U$ ,  $z$ , and probability (2-tailed), are summarized in Table 5. Across the pairs of subgroups, there were no substantial differences between the mean rank values. Further inspection on the test statistics revealed that most of the  $p$ -values were greater than 0.05 and so the null hypothesis of the test cannot be rejected, meaning that there were no significant differences between the distributions of the levels in the corresponding pairs of subgroups.

“Insert Table 5 here”

For cases where the  $p$ -values were smaller than 0.05, the null hypothesis can be rejected and hence the distributions of the levels in the corresponding pairs of subgroups were significantly different. The four cases belonging to this category are demand levels for: (i) managerial manpower between the management and contractor subgroups; (ii) managerial manpower between the contractor and owner subgroups; (iii) technical/ supervisory manpower between the management and contractor subgroups; and (iv) technical/ supervisory manpower between the contractor and owner subgroups.

### ***Importance and knowledge/ skills of O&M works***



For each of the 16 work trades (Table 2), the respondents were asked to indicate their perceived levels of importance and knowledge/skills of the O&M practitioners. Similar to the analyses made on the perceived levels of knowledge and wish to enrich knowledge in a previous study about building O&M education (Lai, 2010b), Fig. 8 shows a plot of the mean perceived levels of knowledge/ skills against the mean perceived levels of importance of different trades of works.

“Insert Fig. 8 here”

For 11 of the 16 work trades, their data points fall within the upper right quadrant, reflecting that the respondents regarded them as of high importance and that the corresponding knowledge/ skills levels of practitioners were also high. The remaining trades of work, namely pool water treatment system, carpentry, plastering and painting, cement and mason, and metal work and glazing, though regarded as of high importance, their knowledge/ skills levels were perceived as relatively low. This is evidenced by the observation that the data points of these five work trades are in the lower right quadrant.

It is further noted that the data points of all the 16 trades lie below the iso-rating diagonal, which indicate that the levels of importance of the different trades were perceived as higher when compared against the respective levels of knowledge/ skills that the practitioners possessed. A closer inspection found that electrical was regarded as the most important trade and its level of knowledge/ skills was perceived as the highest. Metal work and glazing, which was considered the least important trade, is among the trades with the lowest levels of knowledge/ skills.

For each of the work natures listed in Table 2, likewise, the respondents were asked to indicate their perceived levels of importance and knowledge/skills of the O&M practitioners. Based on the calculated mean perceived ratings of different natures of works, Fig. 9 was made.

“Insert Fig. 9 here”

For all the 12 work natures, their data points fall within the upper right quadrant, with their perceived importance levels below the iso-rating diagonal. This shows that all these natures of work were perceived as of ‘high importance’, ‘high knowledge/ skills’. The knowledge/ skills levels of the practitioners, however, were perceived as lower than the respective importance levels. In particular, space management, with its knowledge/ skills levels being marginally higher than moderate, was rated as the least important. Fault handling and recovery, on the other hand, was the most important and its level of knowledge/ skills was the highest.

In order to examine the associations of the ranking results of importance and knowledge/ skills between subgroups of stakeholders, the SPSS software was used to calculate the Kendall’s coefficient of concordance ( $W$ ) and the Spearman rank correlation coefficient ( $r_s$ ) respectively for each cluster and each pair of subgroups. Kendall’s  $W$  ranges from 0 (no agreement) to 1 (complete agreement). A Spearman’s coefficient of +1 indicates perfect positive correlation; -1 means perfect negative correlation. The calculation results, as

summarized in Table 6, show that there were strong agreements among the ranking results of the subgroups.

“Insert Table 6 here”

For the importance of work trades, the agreement among the owner, management and contractor subgroups was close to perfect ( $W = 0.954$ ), and the correlations between pairs of the subgroups were very strong ( $r_s = 0.906$  to  $0.966$ ) and significant at the 0.01 level. Similar correlation findings ( $W = 0.950$ ;  $r_s = 0.920$  to  $0.927$ ) were obtained for the knowledge/ skills of work trades among and between the ranking results of the subgroups.

As for the importance of work natures, the agreement among the three subgroups, though smaller than the counterpart of work trades, was very strong ( $W = 0.895$ ). The correlations between pairs of the subgroups were strong ( $r_s = 0.722$  to  $0.904$ ) and significant at the 0.01 level. A strong agreement ( $W = 0.808$ ) also occurred among the three subgroups of results for the knowledge/ skills of work natures. Whereas a comparatively lower correlation was found between the contractor and owner subgroups ( $r_s = 0.633$ ; significant at the 0.05 level), the correlations between the other two pairs of subgroups: (i) owner and management, and (ii) management and contractor, were strong ( $r_s = 0.724$  and  $0.781$ ) and significant at the 0.01 level.

### ***Education and training means***

When asked about the existing education means for producing university/ college graduates for the O&M market, the majority (69.2%) of the respondents opined that the means were appropriate, as opposed to 30.8% who had an opposite view. Among the latter group, 71.0% considered the knowledge/ skills of the graduates too theoretical for real-world applications. A lower, yet significant, proportion (66.9%) expressed that the knowledge/ skills of the graduates do not match with the industry needs. On the other hand, only 27.4% indicated ‘insufficient number of relevant university/ college graduates’ as the reason for the response. It is worth noting that a significant proportion (41.9%) selected ‘the levels of the existing programmes do not match with the industry needs’.

Most (71.6%) of the respondents found that the existing means of continuous professional development (CPD) provided for building O&M practitioners were appropriate, but 28.4% held an opposite view. Among those who considered the CPD means inappropriate, the majority (71.1%) indicated that the heavy workload of the practitioners often does not allow them to attend CPD courses. The contents of the courses, according to 50.9% of the respondents, do not match well with the industry needs. 45.6% indicated that the number of the existing courses is too little and 43.9% opined that the course fees are too high.

### ***Improvement measures***

Rather than submitting their own suggestions for improving the existing O&M manpower, 38.6% of the respondents showed their support to a number of suggestions listed in the questionnaire. Referring to their support rates, the suggestions were divided into three tiers, as shown in Fig. 10: Tier 1 (>60%); Tier 2 (50-60%); and Tier 3 (<50%).

“Insert Fig. 10 here”

Among those who had made selections from the listed suggestions, the majority (69.0%) picked ‘promotion of professionalism of building O&M practitioners’ - a top improvement measure in Tier 1. Understanding the importance of this measure, BSOMES formed a task force to establish core competences required for being O&M professionals. The project committee further agreed to identify what other actions should be taken to raise the professional status of the practitioners.

Of the respondents, 67.7% selected the suggestion of offering higher remuneration to building O&M practitioners. This measure, undoubtedly, is a financial incentive that can attract more graduates to join the building O&M sector. But whether this is realizable hinges on a host of factors, in particular the willingness of paying more for quality O&M works. Therefore, it is imperative for the O&M profession to demonstrate to their clients the real value of any undervalued work.

The above suggestion of promoting professionalism is among the recommendations made out of a previous study on the O&M discipline (Yik et al., 2010). It echoes with the opinion of 63.9% of the respondents that the social status of building O&M practitioners should be elevated. For this purpose, the project committee proposed to carry out publicity works, for example placing advertisements to illustrate the contributions of the practitioners to society (e.g. ensuring health and safety in buildings, providing comfortable indoor environments, etc.).

The fourth most commonly suggested measures, according to 61.3% of those who made their selections, is attracting more graduates to join the building O&M industry. To this end, offering career talks to arouse the interest of college/university students of relevant disciplines (e.g. engineering, surveying, management, etc.) is an effective way. Such talks should cover contents such as the types, functions and importance of building O&M works, as well as the career prospect of building O&M.

There are four suggestions in Tier 2; the first is to establish building O&M handbooks, manuals and best practice guides (57.4%). Over the years, the lack of standard practice manuals for the building O&M industry in Hong Kong has been well recognized. In fact, BSOMES have in recent years set up some task forces for preparing such manuals. For instance, preparation for an O&M manual for lift installations and another for fire services installations has been underway.

Running more CPD courses on building O&M (56.1%) was also regarded as helpful for improving the manpower. In the past, CPD courses have been frequently organized for building practitioners to enhance their knowledge/ skills, but in most cases the focuses of the courses were on design or construction instead of operation or maintenance. Although BSOMES has from time to time organized some CPD activities, well-structured courses with comprehensive contents of building O&M knowledge remain unavailable. Formulation of such courses is one of the actions the project committee decided to take.

‘Introduce mentorship scheme for young building O&M practitioners’ was supported by 52.3% of those who indicated their suggestions. In 2014, BSOMES already launched a mentorship scheme, under which the mentees, who are young building practitioners, are paired with veterans in the field. Through joining various activities (e.g. site visits, sharing sessions) of the scheme, many mentees have learnt the invaluable experiences of their

mentors. Upon the project committee's recommendation, BSOMES confirmed to expand the scheme to cater for more participants.

It is intriguing to note that 'introduce statutory registration for building O&M professionals' (51.0%) was not a top-rated suggestion. Expectedly, granting legal protection to the O&M profession would ensure that only the capable practitioners could undertake statutory O&M works (Lai et al., 2011). Such registered professionals, as a result, would enjoy better remuneration. But the duty to shoulder liabilities in cases of non-compliance with the statutory requirements (Lai and Yik, 2004) could be a concern for those who disagreed to introducing the statutory registration.

The four suggestions in Tier 3, in ascending proportions of support, are: allow more non-local residents to work in the building O&M industry (16.1%); conduct more research study on building O&M (31.6%); provide web-based teaching materials on building O&M (35.5%); and introduce specific tertiary education programmes for building O&M (42.6%). The project committee considered these suggestions useful but with a low implementation priority. Working groups would be formed in due course to explore how to attain such long-term targets.

## Conclusions

Under the above study, a model integrating manpower levels, trades and natures of works for operating and maintaining existing buildings was developed and a full spectrum of jobs which are specific for O&M works were established. The study, being the first of its kind focusing on building O&M manpower, unveiled not only the manpower size, vacancy and income, but also a variety of recruitment, competence and education issues which are influential to the development of the manpower.

While a large number of persons were engaged for building O&M works, the vacancy rates of the three job groups (managerial, technical/ supervisory, frontline) were significant. Most of the organizations encountered difficulties in recruiting O&M personnel, among them the majority found that frontline candidates with relevant experience were in lack. For those who would have changes in their manpower, over half would increase their frontline manpower. These findings not only show the generally great demand for O&M manpower but also highlight the particular needs of producing new blood and attracting experienced practitioners to take up the frontline jobs. To identify what factors (e.g. technological developments, new maintenance tools and materials, new operational processes, etc.) have contributed to the changes in the manpower, further research is needed.

In general, the levels of importance of the 16 different trades of O&M works were considered higher than the corresponding levels of knowledge/ skills of O&M practitioners. The same observations were noted for the 12 different natures of O&M works. Such findings imply the existence of room for enhancing the competences of the practitioners. Furthermore, the ranking orders of importance and knowledge/ skills levels of the different trades and natures of works, with which strong agreements were found among the different stakeholder groups, could help human resources policy makers to determine the emphasis and priority of competence areas to be covered in education or training programmes.

A significant proportion of the stakeholders regarded the current means for O&M education and CPD training as inappropriate. Besides addressing the problem of having college/

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university graduates whose knowledge/ skills are too theoretical for real-world applications, it is necessary to reduce the workload of O&M practitioners, allowing them to have time for attending CPD activities.

Three tiers of suggestions, including those for imminent implementation and some to be achieved in the long run, have been identified for improving the existing manpower. Such information is essential for implementing a manpower development strategy towards sustainable development of the built environment of Hong Kong. For cities alike where a dense-built environment has been developed, a similar approach of the study could be taken to investigate their states and needs of building O&M manpower. The way in which the manpower model was established may serve as a reference for developing models for manpower research in other industries, in the local as well as international contexts.

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Appendix A – Job codes and titles (Managerial group)

Code	Title
M01	Director/ General Manager
M02	Regional Manager/ Senior Estate Manager/ Senior Property Manager
M03	Estate Manager/ Area Manager/ Building Manager/ Property Manager
M04	Maintenance Manager/ Technical Manager
M05	Engineering Manager
M06	Project Manager
M07	Facilities Manager
M08	Assistant Maintenance Manager
M09	Assistant Project Manager
M10	Assistant Estate Manager/ Assistant Area Manager/ Assistant Building Manager/ Assistant Property Manager
M11	Assistant Facilities Manager

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Appendix B - Job codes and titles (Technical/ supervisory group)

Code	Title
T01	Building Services Engineer/ Mechanical & Electrical Engineer/ Building Maintenance Engineer/ Duty Engineer
T02	Electrical Engineer
T03	Refrigeration/ Air-conditioning/ Ventilation Engineer
T04	Mechanical Engineer
T05	Plumbing and Drainage Engineer
T06	Lift/ Escalator Engineer
T07	Fire Services Engineer
T08	Electronics Engineer
T09	Control and Instrumentation Engineer
T10	Building/ Maintenance Surveyor
T11	Safety Officer/ Safety Supervisor/ Registered Safety Officer
T12	Supervisor
T13	Building Services and Engineering Supervisor
T14	Building Supervisor/ Building Superintendent/ Security Officer/ Supervisor
T15	Assistant Safety Officer/ Safety Supervisor
T16	Property/Estate Officer/ Administrative Officer
T17	Maintenance Officer/ Technical Officer/ Clerk of Works
T18	Other Supporting Supervisors
T19	Assistant Property Officer/ Assistant Estate Officer/ Assistant Administrative Officer/ Estate Assistant/ Engineering Assistant

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Appendix C - Job codes and titles (Frontline group)

Code	Title
F01	Building Services Technician
F02	Electrical Engineering Technician
F03	Refrigeration/ Air-conditioning/ Ventilation Technician
F04	Mechanical Engineering Technician
F05	Lift/ Escalator Technician
F06	Fire Services Technician
F07	Electrical Instrument and Meter Technician
F08	Electronics Technician
F09	Telecommunication Technician
F10	Technician
F11	Foreman/ Chargehand
F12	Building Services Mechanic
F13	Electrician/ Electrical Fitter
F14	Control Panel Assembler
F15	Refrigeration/ Air-conditioning/ Ventilation Mechanic - Electrical Control
F16	Refrigeration/ Air-conditioning/ Ventilation Mechanic - Unitary System
F17	Refrigeration/ Air-conditioning/ Ventilation Mechanic - AirSystem/ Sheet Metal Worker
F18	Refrigeration/ Air-conditioning/ Ventilation Mechanic - Thermal Insulation/ Thermal Insulation Craftsman
F19	Refrigeration/ Air-conditioning/ Ventilation Mechanic - Water System
F20	Plumber and Pipe Fitter
F21	Plumber
F22	Mechanical Fitter/ Machinist
F23	Lift Mechanic
F24	Escalator Mechanic
F25	Fire Services Electrical Fitter
F26	Fire Services Mechanical Fitter
F27	Electrical Appliances Service Mechanic
F28	Welder
F29	Carpenter
F30	Painter
F31	AV and RF Mechanic/ AV Technician
F32	Building Security System Mechanic
F33	Communication System Mechanic
F34	Construction Plant Mechanic
F35	Other Supporting Personnel
F36	Bamboo Scaffolder
F37	Gas Plumber
F38	Joiner
F39	Metal Scaffolder
F40	Metal Worker
F41	Painter & Decorator/ Building & Decoration Technician
F42	Pipelayar
F43	Plant and Equipment Operator - Load Shifting
F44	Plasterer



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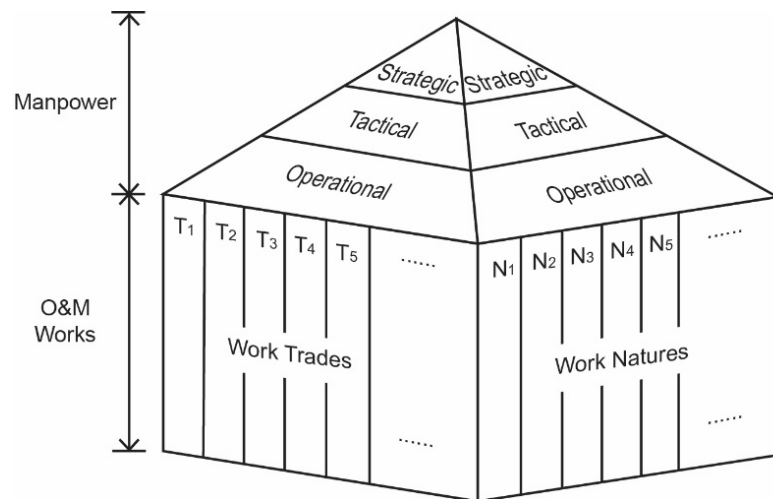
### **Acknowledgements**

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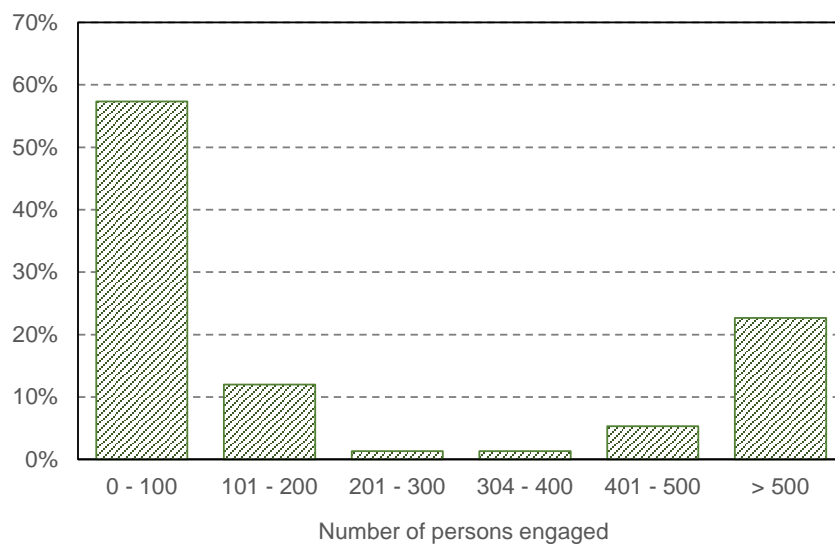
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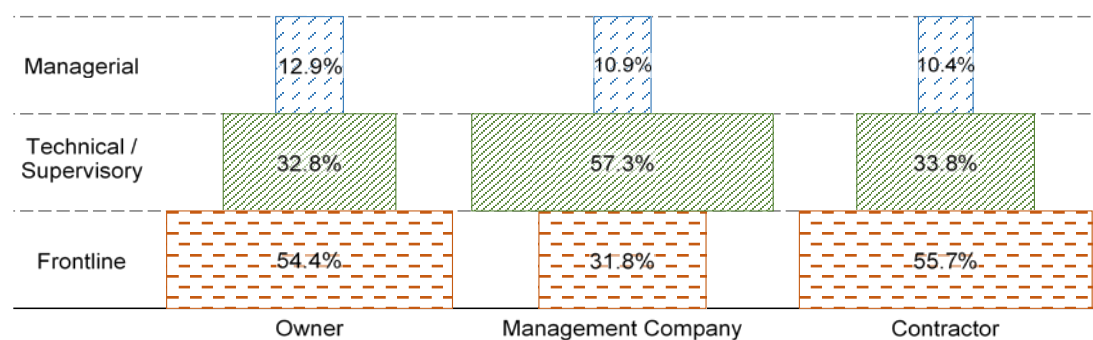
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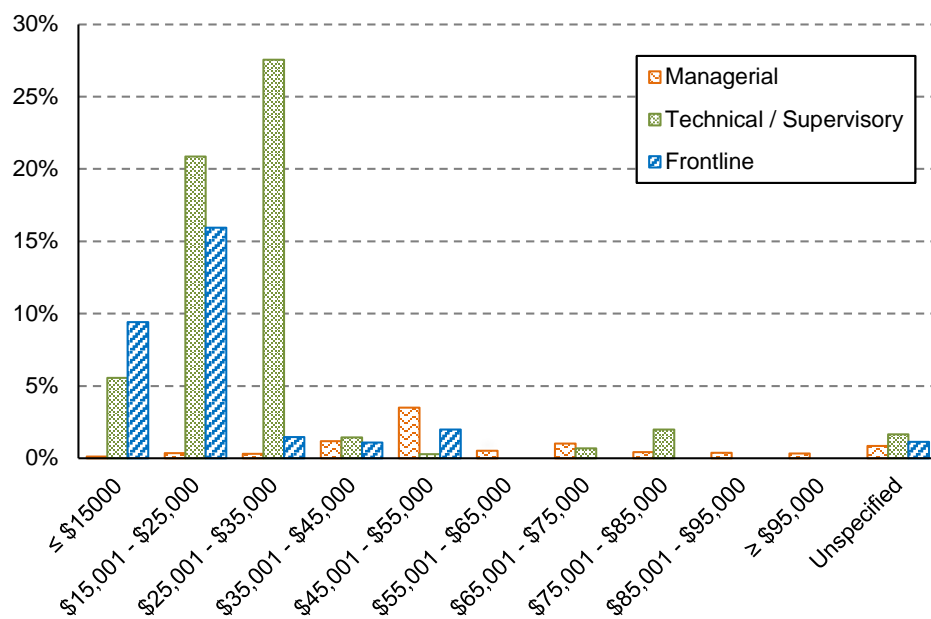
**Fig. 1.** Manpower levels (L), trades (T) and natures (N) of O&M works [“LTN” model]



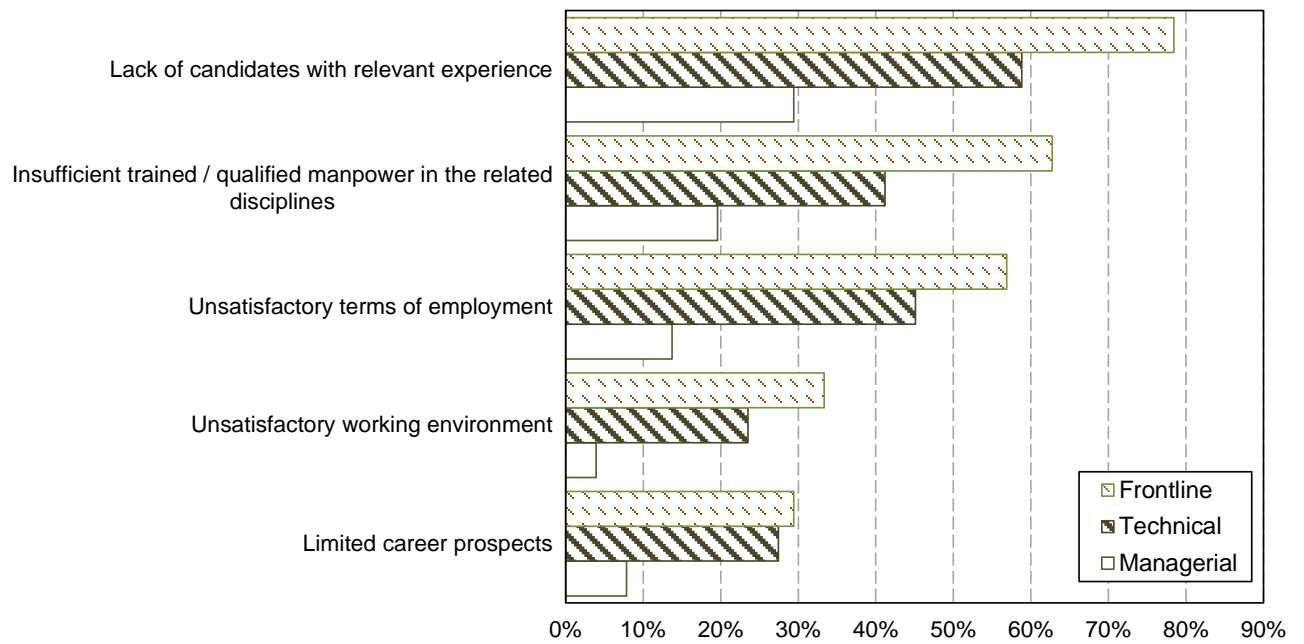
**Fig. 2.** Distribution of organization sizes



**Fig. 3.** Manpower proportions of different work groups

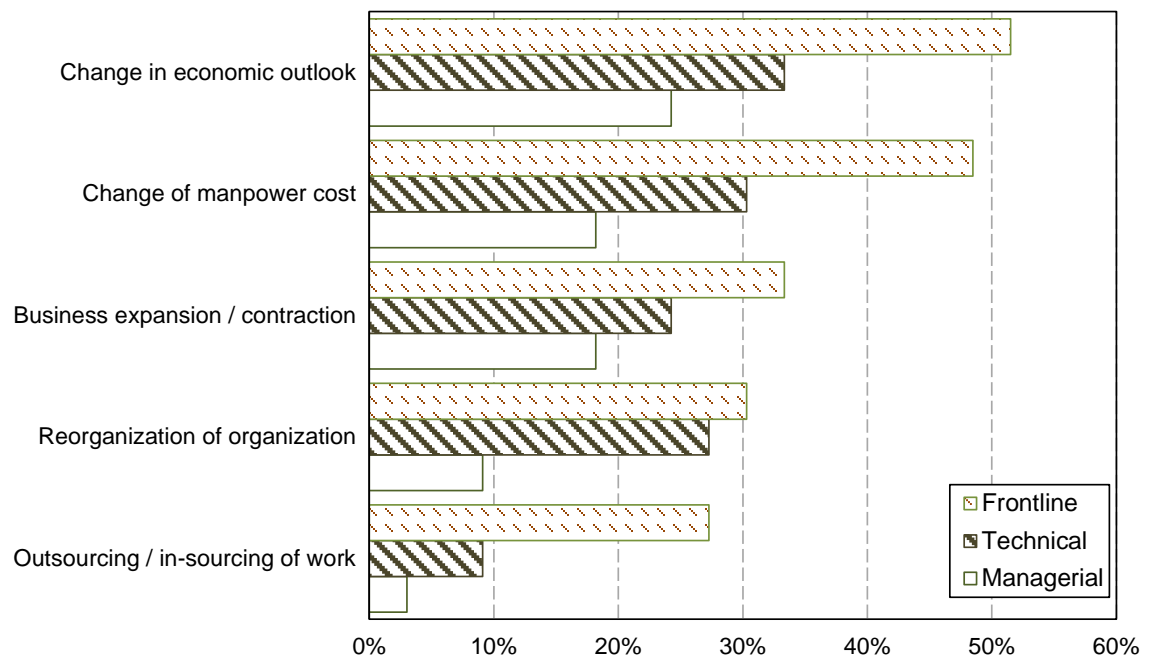


**Fig. 4.** Distribution of monthly salaries

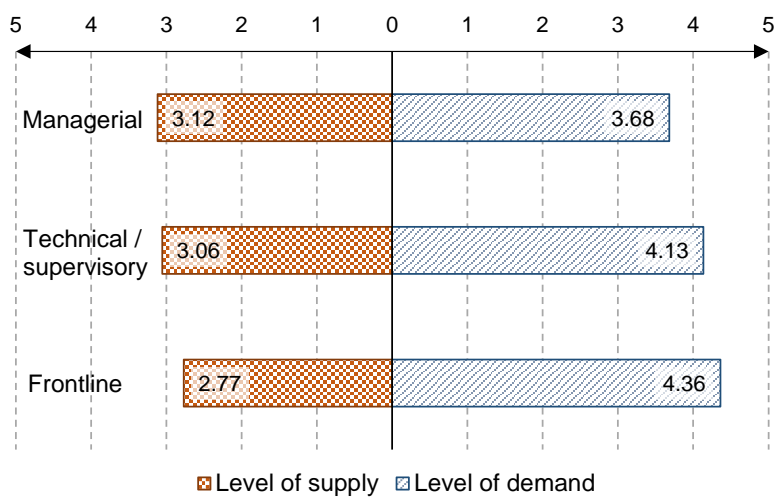


**Fig. 5.** Reasons for encountering recruitment difficulties

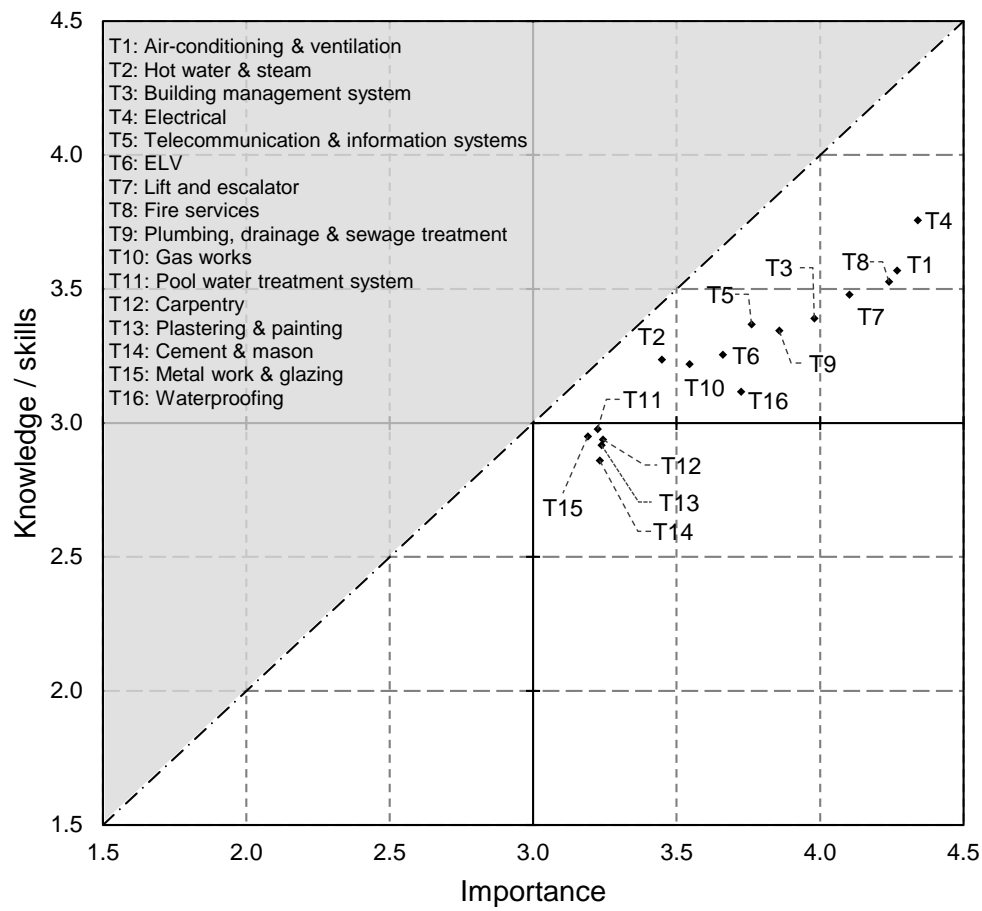




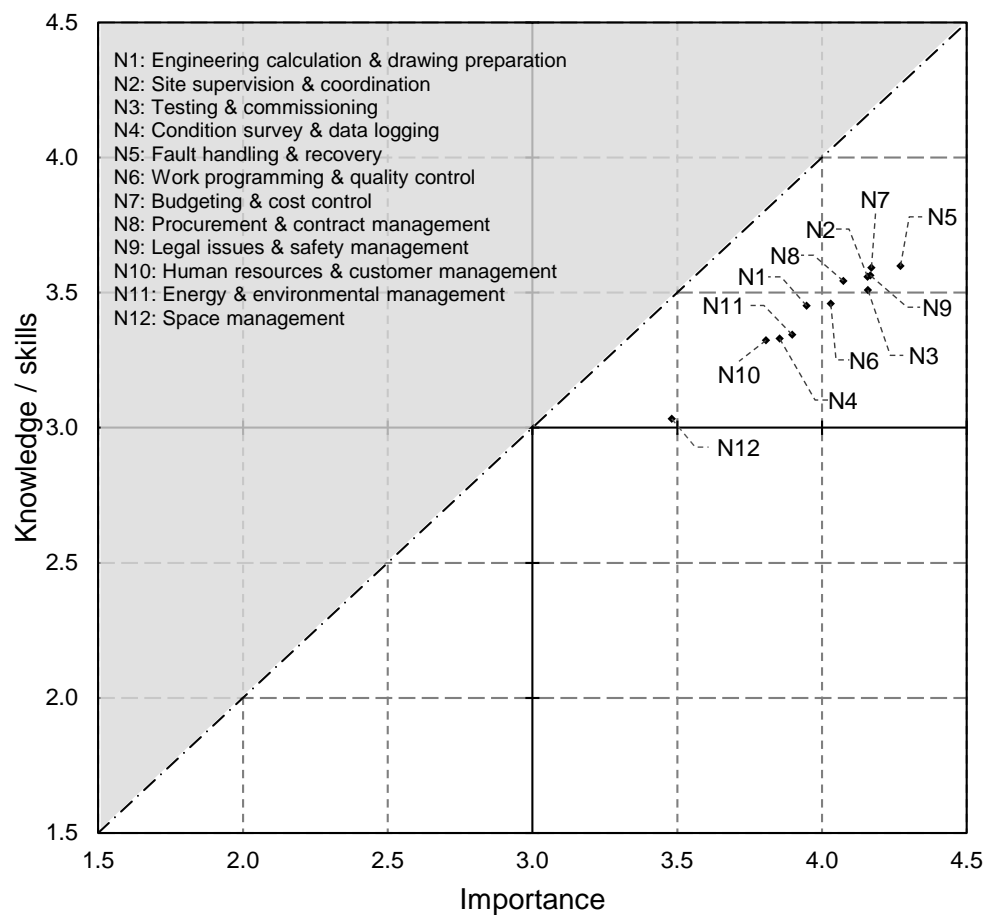
**Fig. 6.** Reasons for manpower change



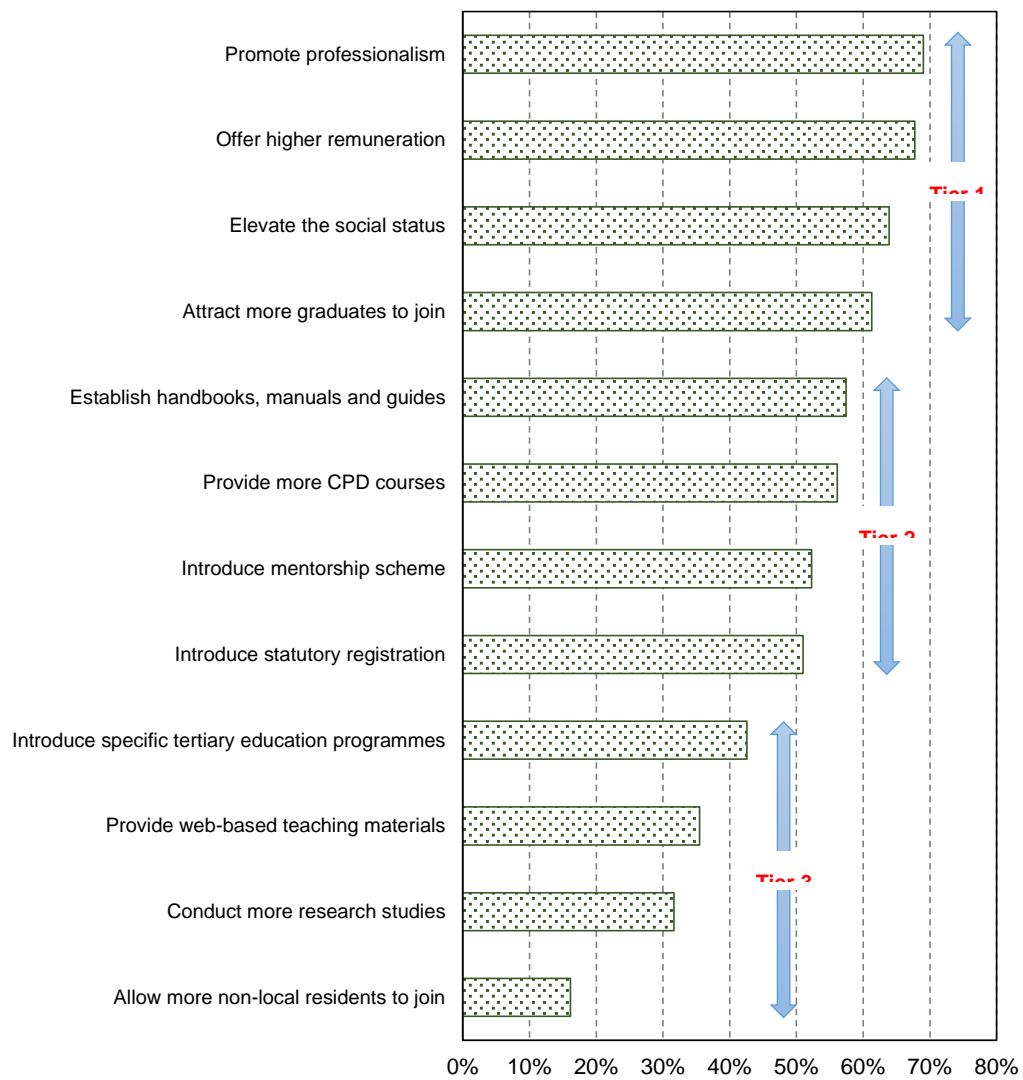
**Fig. 7.** Levels of manpower demand and supply



**Fig. 8.** Knowledge/ skills and importance levels of work trades



**Fig. 9.** Knowledge/ skills and importance levels of work natures



**Fig. 10.** Improvement suggestions

**Table 1.** Coverage and classifications of jobs in related industries

Industry	Coverage and classifications
Construction Works	<ul style="list-style-type: none"> <li>The list of designated trades for construction workers is subdivided into 2 tables of trades, namely Table A: Registered Skilled Worker and Table B: Registered Semi-skilled Worker.</li> </ul>
Electrical and Mechanical Services	<ul style="list-style-type: none"> <li>3 sectors are covered: Sector A - Electrical and Mechanical Engineering; Sector B: Shipbuilding and Ship Repair; and Sector C: Gas.</li> <li>Practitioners are classified into 4 levels: Professional/Technologist, Technician, Tradesman/Craftsman, and Semi-skilled/General Worker.</li> </ul>
Building and Civil Engineering	<ul style="list-style-type: none"> <li>9 branches are covered: Branch 1 - all active building construction sites in the public and private sectors; Branch 2 - all active civil engineering and other construction sites in the public and private sectors; Branch 3 - new construction works contractors, including site investigation, site formation, foundation works and erection works; Branch 4 - decoration, repair and maintenance contractors; Branch 5 - special trade works contractors, [excluding electrical and mechanical fitting and gas fitting, installation &amp; maintenance]; Branch 6 - architectural, surveying and project engineering services firms related to construction activities; Branch 7 - private estates developers; Branch 8 - relevant teaching departments and estate offices of training/educational institutions, and utility companies undertaking construction work or employing construction workers; and Branch 9 - government departments undertaking construction work or employing construction workers.</li> <li>Job levels are categorized into 4 groups: Professional/ Technologist; Technician; Skilled and Semi-Skilled Worker; and General Worker.</li> </ul>
Real Estate Services	<ul style="list-style-type: none"> <li>5 sectors are covered: Real Estate Development; Property Management and Maintenance; Estate Agency; Estate Surveying, Valuation and Consultancy; and Government Departments and Public Sector.</li> <li>Job levels are divided into 3 groups: Professional/ Managerial; Supervisory; and Technical Support and Operatives.</li> </ul>

**Table 2.** Main trades and natures of works

Trade (T)	Nature (N)
1. Air-conditioning and ventilation	1. Engineering calculation and drawing preparation
2. Hot water and steam	2. Site supervision and coordination
3. Building management system	3. Testing and commissioning
4. Electrical	4. Condition survey and data logging
5. Telecommunication and information systems	5. Fault handling and recovery
6. Extra low voltage	6. Work programming and quality control
7. Lift and escalator	7. Budgeting and cost control
8. Fire services	8. Procurement and contract management
9. Plumbing, drainage and sewage treatment	9. Legal issues and safety management
10. Gas works	10. Human resources and customer management
11. Pool water treatment system	11. Energy and environmental management
12. Carpentry	12. Space management
13. Plastering and painting	
14. Cement and mason	
15. Metal work and glazing	
16. Waterproofing	

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**Table 3.** Data collection methods for the first survey

Sector	Organizations	Questionnaire
Building owners	Banking corporations and non-for-profit organizations, etc.	Online
Management companies	Members of the Hong Kong Association of Property Management Companies	Online
Electrical & mechanical contractors	Members of the Hong Kong Federation of Electrical and Mechanical Contractors Limited	Online
Minor works contractors	Registered Minor Works Contractors	Online
Hotels	Members of the Hong Kong Hotels Association	Online
Education	University Grants Committee funded universities (and community colleges)	Hard copy
Utilities	Power and gas supply companies, and telecommunication companies	Hard copy
Government/public	Government departments, public bodies, and non-government organizations	Hard copy



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**Table 4.** Demography of the respondents

Classifications	%
Employer type	
Building owner	22.9
Building management company	28.1
Contractor	19.9
Consultant	3.0
Government	2.1
Others	5.2
Job group	
Managerial	45.0
Technical/ supervisory	51.5
Frontline	3.5
Age	
< 25	2.7
25 - 34	20.1
35 - 44	32.8
45 - 54	33.6
> 54	10.7
Education level	
Certificate	6.7
Diploma	8.5
Bachelor	31.8
Master	48.5
Doctorate	1.0
Others	3.5

**Table 5.** Summary of the Mann-Whitney test results

Manpower group	Respondents	Mean rank	<i>U</i>	<i>z</i>	<i>p</i>
Managerial (demand)	Owner	102.4	4871.0	-0.323	0.746
	Management	99.9			
	Management	99.5	3501.0	-1.981	0.048 <sup>a</sup>
	Contractor	84.7			
	Contractor	75.3	2796.5	-2.010	0.044 <sup>a</sup>
Managerial (supply)	Owner	89.4			
	Owner	97.3	4660.5	-0.867	0.386
	Management	103.1			
	Management	91.8	3990.0	-0.269	0.788
	Contractor	93.6			
Technical/ supervisory (demand)	Contractor	85.8	3089.5	-0.926	0.355
	Owner	79.8			
	Owner	103.1	5187.0	-0.029	0.977
	Management	102.9			
	Management	102.1	3714.5	-1.999	0.046 <sup>a</sup>
Technical/ supervisory (demand)	Contractor	87.1			
	Contractor	78.0	3001.0	-2.007	0.045 <sup>a</sup>
	Owner	91.9			
	Owner	98.7	4800.5	-1.027	0.304
	Management	106.5			
Frontline (demand)	Management	97.5	4122.0	-0.668	0.504
	Contractor	92.5			
	Contractor	86.1	3459.0	-0.281	0.779
	Owner	84.1			
	Owner	102.9	5115.0	-0.101	0.920
Frontline (supply)	Management	102.2			
	Management	101.6	3793.0	1.860	0.063
	Contractor	88.0			
	Contractor	79.3	3102.0	-1.826	0.068
	Owner	91.8			
Frontline (supply)	Owner	102.8	5121.5	-0.076	0.939
	Management	102.2			
	Management	94.1	4211.5	-0.436	0.663
	Contractor	97.5			
	Contractor	87.2	3452.5	-0.439	0.661
	Owner	84.0			

<sup>a</sup>Significant at the 0.05 level (2-tailed).

**Table 6.** Summary of rank correlation results

	Subgroups			<i>W</i>	<i>r<sub>s</sub></i>
Importance (trades)	Owner	Management	Contractor	0.954**	-
	Owner	Management	-	-	0.966 <sup>b</sup>
	Management	Contractor	-	-	0.906 <sup>b</sup>
	Contractor	Owner	-	-	0.921 <sup>b</sup>
Knowledge/ skills (trades)	Owner	Management	Contractor	0.950**	-
	Owner	Management	-	-	0.920 <sup>b</sup>
	Management	Contractor	-	-	0.926 <sup>b</sup>
	Contractor	Owner	-	-	0.927 <sup>b</sup>
Importance (natures)	Owner	Management	Contractor	0.895**	-
	Owner	Management	-	-	0.902 <sup>b</sup>
	Management	Contractor	-	-	0.722 <sup>b</sup>
	Contractor	Owner	-	-	0.904 <sup>b</sup>
Knowledge/ skills (natures)	Owner	Management	Contractor	0.808**	-
	Owner	Management	-	-	0.781 <sup>b</sup>
	Management	Contractor	-	-	0.724 <sup>b</sup>
	Contractor	Owner	-	-	0.633 <sup>a</sup>

<sup>a</sup>Significant at the 0.05 level (2-tailed).

<sup>b</sup>Significant at the 0.01 level (2-tailed).