4.0 Data Analysis

4.1 Analysis of Variables

The questionnaire was designed to capture a number of variables that may be important in controlling the results. The following variables were analysed in details in this section.

a) nature of the company
b) number of workers employed on site
c) implementation of a Safety Management System
d) job position
e) year of experience
f) highest level of education acquired

The data and the frequency calculation are given in Appendix B, pages 1-14.

a) nature of the company

About 58.1% of the respondents are working in main contracting firms including 33.5 % in civil engineering contractors and 24.6% in building contractors. About 16.8 % are working in consultants, government and laboratory (7.9%, 7.4% & 1.5% respectively). This leaves 25.2% of respondents working in sub-contracting firms which include 15.8% of domestic sub-contractors and 9.4% of specialist sub-contractors. As already mentioned before, the questionnaires were distributed by students studying part-time at various level of certificate courses. The distribution very much represents the distribution of the nature of the company that the students are working for because they will dispatch the questionnaires to their fellow

technicians. Figure 4-1 presents the percentage of respondents who are working for different types of company.

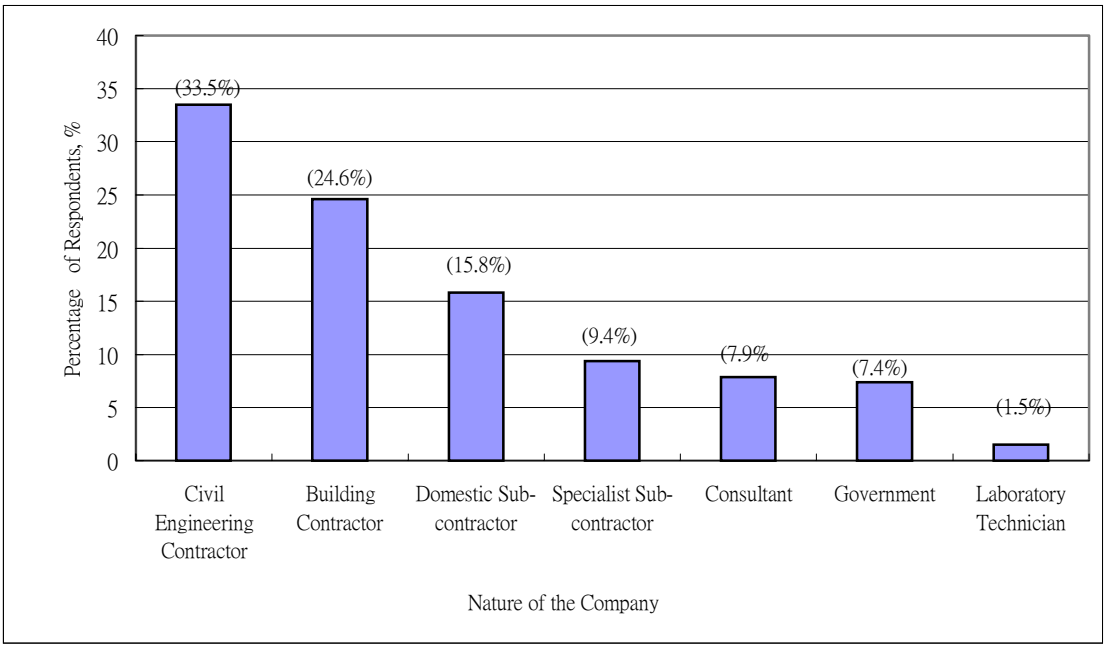

Figure 4-1 Nature of the company the respondents are working for

b) Number of Workers Employed on Site

Figure 4-2 presents the percentage of respondents who are working on sites with various numbers of workers employed. As shown in the Figure, the majority of the respondents (70.4%) are working on sites employing more than 20 workers. A safety supervisor should be expected to be working on site to assist in safety matters.

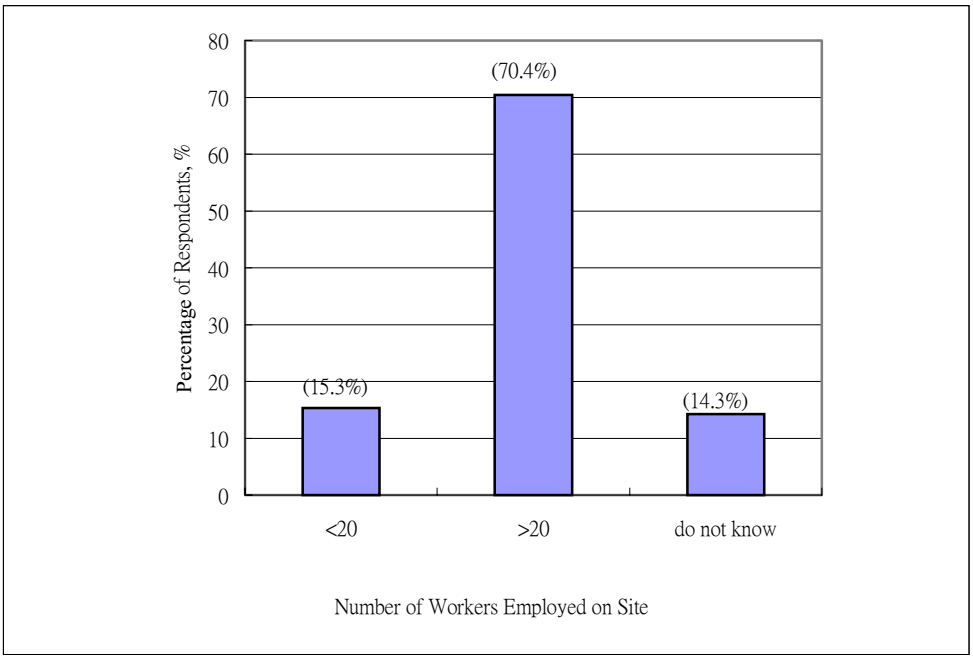

Figure 4-2 Number of workers employed on Site

c) Safety Management System

Many companies have implemented a Safety Management System. There are 71.4% of the respondents who work in companies that implement a Safety Management System. However, many respondents do not know the number of years that the Safety Management System has been in place. The relationship of safety management system and the other variables are further studied in the latter section.

d) Job Position

The number of foreman being surveyed constitutes a large portion of the respondents. As already discussed in the previous chapter, the questionnaires were distributed specifically to the targeted subject groups such that it is not surprised that site foremen have been surveyed more than the other groups of technicians. A number of land surveyors has also been included in the survey. As a practice in the construction industry in Hong Kong, particularly in the building contractors, land surveyor has been considered as a post ready to be promoted to assistant foreman. Therefore it is worth collect responses from this group of technician as well.

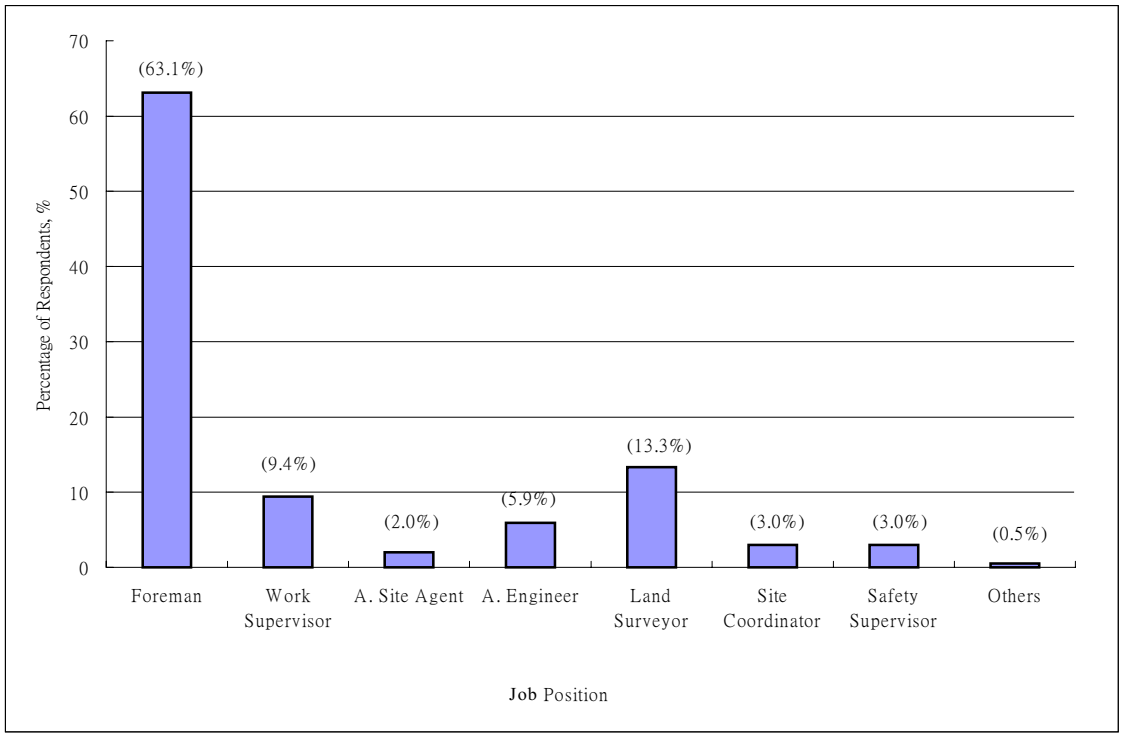

Figure 4-3 Job position held by the respondents

e) Total Experience

The experience of the respondents varies from 1 to 30 years. The distribution of the respondents with various years of experience is shown in Figure 4-4. It appears that there is a sudden increase in the number of respondents with 10 years of experience. As explained by some of the respondents verbally, they do not remember how many years they have been in the industry so that they just put down 10 years just to show that they have a long working history in the industry.

Figure 4-4 Years of experience of the respondents

Figure 4-5 presents the cumulative percentage of respondents who have acquired the number of year of experience. As shown in the Figure, over 75% of the respondents have 6 years of experience or less. Those technicians with more experience may be reluctant to response to the survey due to personal pride or may think that research projects of this type usually provide no incentives to them.

Figure 4-5 Cumulative Percentage of Respondents vs. Years of Experience

f) Level of Education

Most of the respondents (56.7%) have obtained a Secondary 5 education level. As discussed in the previous Chapter on the limitation of this study is that most of the respondents are having a basic education background. Those with lower education background would tend not to respond to questionnaires. Those with higher education levels such as higher certificate or higher diploma would consider this trivial to response to the questionnaires as they might consider themselves as senior management staff.

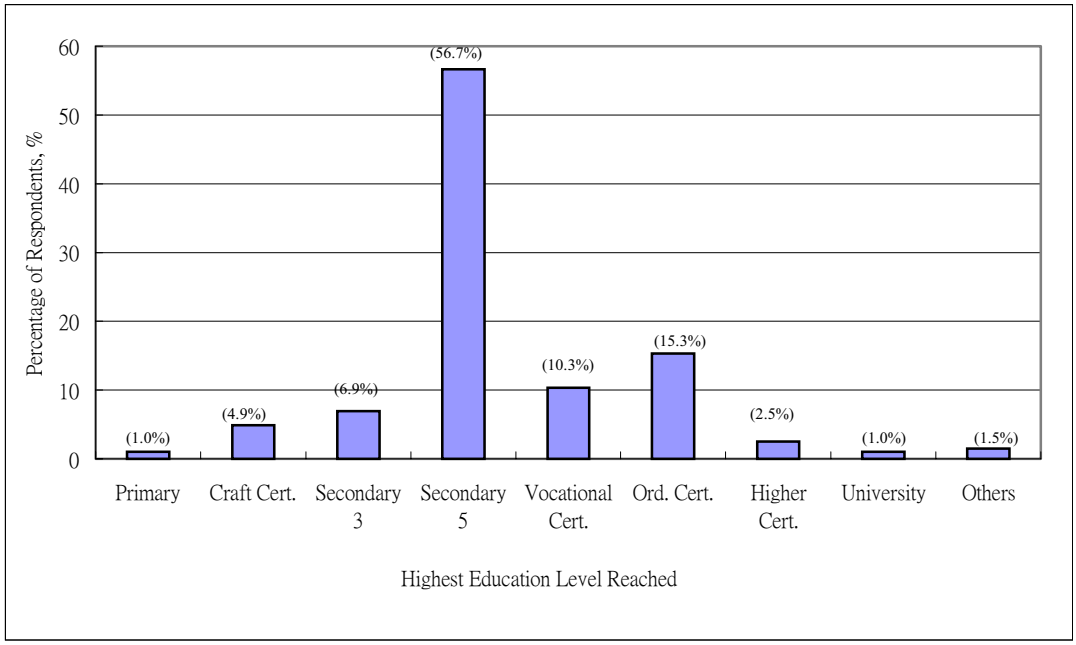

Figure 4-6 Highest level of education acquired by the respondents

4.2 Analysing the Roles of Site Technicians

Lam (1996) describes 27 safety supervisory tasks as list below:

- handle new workers
    - hire new workers
    - orient workers
    - train new workers
    - explain safety rules to workers
    - hold safety meetings
    - coach workers
- safety
    - take unsafe tools out of production
    - investigate accidents

    - establish inspection teams for hazards
    - inspect works under their own division
    - correct unsafe conditions
    - send the injured or sick workers to doctors
- discipline
    - recommend promotion or demotion to a workers
    - transfer a worker out of their division
    - grant pay raises to a worker
    - issue warnings to a worker
    - discharge a worker's duties
- coordination
    - authorize maintenance or repair of equipment
    - make suggestions to improve safety
    - discuss safety problems with the management
    - recommend changes in safety policy
    - improve work procedure through safe methods
- motivating
    - promote job satisfaction among workers
    - create feeling of belonging among workers
    - help and care for workers' personal problems
    - guarantee job security
    - recommend fringe benefit

Petersen (1996) considers that good supervisors are expected to perform certain

tasks related to accident prevention:

- provide safety orientation to new employee,
- recognize and reward safe work behaviour,
- handle employee concerning personal matters,
- discuss accidents and injuries with workers,
- discuss goals for safety performance with workers on a regular basis,
- show that they are personally concerned, and
- involve their workers in all aspects of safety.

Travers (1993) summarizes safety responsibilities for supervisors as:

- conduct safety meeting,
- enforce safe procedures,
- review unsafe conditions and unsafe acts,
- instruct employees in safety rules,
- make daily inspection,
- instruct workers of the correct tools,
- follow up incident,
- instruct use of personal protective equipment,
- be aware of change of process,
- investigate incident,
- daily inspection,
- check housekeeping,
- provide on-the-job training,
- follow up complaints related to safety issues,

- maintain safety signs and boards.

Based on the works by the above three researchers, it could be observed that supervising work, inspecting site safety, reporting hazards, training workers, conducting safety meeting, and reporting accidents are common roles to be performed by site technicians. A list of roles commonly undertaken by site technicians was then developed. A pilot survey was conducted to 40 site technicians to further evaluate the validity of the proposal and the feed back from the pilot survey resulted in a more detailed list of roles commonly undertaken by construction site technicians in Hong Kong. The list was used in Question 9 to evaluate the relatively involvement of site technicians in conducting safety roles in their daily work. The respondents can select the roles that they undertake most in their daily work. The list is shown below:

- supervise work procedures,
- inspect site safety precaution,
- record inspection results,
- carry out work safely,
- train workers,
- supervise and instruct workers on the use of Personal Protection Equipment, PPE,
- report hazards identified,
- inspect plant and lifting appliances safety installation,
- submit and execute a method statement,
- report incident,
- risk assessment,
- take part in safety committee, and
- others to be specified by the respondents.

The percentage of respondents who have undertaken safety related roles are summarized in Figure 4-7. From the survey data, it can be seen that the roles that mainly occupy the work of a technician are supervise work procedures (58.6%), inspect site safety precaution (55.2%), supervise the use of PPE (43.3%), carry out work safely on site (40.4%), report hazards (36.0%), record site inspection results (35.5%), taking part in Safety Committee (26.6%), train workers (18.7%), report incident (14.8%), inspect plant and machines (12.8%), submit and execute a safety plan (10.3%), and conduct risk reassessment (5.9%).

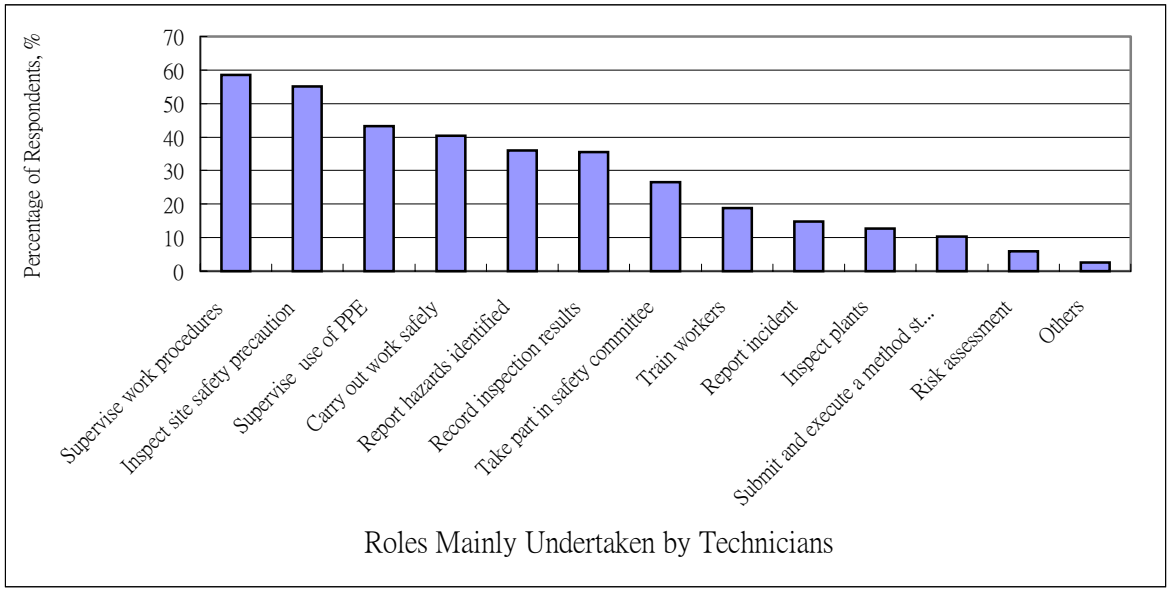

Figure 4-7 Safety related roles performed by the respondents

A further analysis by comparing the roles undertaken by average site technicians and those by foremen are shown in Table 4-1. As shown in the table, it appears that the percentage of the involvement in each type of roles by “foreman” is,

in general, higher than that by the average site technicians. For example, it can be seen that the involvement for the role, “Inspect site safety precaution” by foreman is different by 7.3 and is higher than that of the average site technicians.

Table 4-1 Safety related roles performed by site technicians

Roles	Percentage of involvement by respondents (%)	Percentage of involvement by Foreman (%)	Difference
Supervise work procedures	58.6	64.6	+6.0
Inspect site safety precaution	55.2	62.5	+7.3
Supervise use of PPE	43.3	50.0	+6.7
Carry out work safely	40.4	45.3	+4.9
Report hazards identified	36.0	38.3	+2.3
Record inspection results	35.5	43.0	+7.5
Take part in safety committee	26.6	25.8	-0.8
Train workers	18.7	22.7	+4.0
Report incident	14.8	14.8	0
Inspect plant	12.8	14.6	+1.8
Submit and execute a method statement	10.3	10.9	+0.6
Risk assessment	5.9	7.0	+1.1
Others	2.5	3.1	+0.6

However, as discussed in the previous section, the number of foreman being surveyed is higher and it may affect the results. A Chi-square test is used to evaluate whether or not the number of foreman being surveyed is associated with the

distribution of the roles. A Chi-square test can be used to compare observed and expected frequencies of a variable and to test whether the population proportions can be considered to be equal (Fellows and Liu, 1997). The results of the $\chi 2$ values are given in Table 4-2. The degree of freedom can be calculated using (n-1)(m-1) where n is 2 (foreman or not foreman) and m is also 2 (undertake the role or do not undertake the role). The degree of freedom is therefore calculated to be 1. Using the table for the Chi-square distribution (Firth, 1999), for a 90.0 % confident limit, the P value of the Chi-square distribution is 2.71. Details of the Chi-square calculation are given in Appendix B, pages 15 –27.

Table 4-2 Chi-square values calculated for foremen and site technicians

Roles	$\chi 2$ Value	Asymptotic Significance
Supervise work procedures	5.531	0.019
Inspect site safety precaution	7.521	0.006
Supervise use of PPE	6.239	0.012
Carry out work safely	3.481	0.062
Report hazards identified	0.810	0.368
Record inspection results	8.516	0.004
Take part in safety committee	0.119	0.730
Train workers	3.529	0.060
Report incident	0.001	0.973
Inspect plant	0.488	0.485
Submit and execute a method statement	0.131	0.717
Risk assessment	0.781	0.377*
Others	0.632	0.427*

* have cells with expected count less than 5

As shown from the results of the Chi-square test in Table 4-2, the results of the roles listed below are associated with the number of foreman being surveyed: supervise work procedures, inspect site safety precaution, supervise use of PPE, carry out work safely, record inspection results, and train workers. Therefore the data showing that there is a higher involvement of foremen in these roles than the average site technicians is misleading and no conclusion should be drawn.

Involvement in Safety Committee

As shown in Table 4-1, the involvement of foreman in safety committee is less than that by the average site technicians. The reason is, as explained by some of the respondents verbally, that taking part in safety committee is the duty of safety supervisors and that they should not be involved. However this is not true as pointed out by Tang et al (1998) that safety committee at project level should be established for every construction site. Participants of the safety committee should include site project manager, safety officers, safety supervisors, general forman, foremen, and representatives from sub-contractors. The committee should meet periodically and the main objective is to review and to improve site safety.

Involvement in Risk Assessment

From Table 4-1, the involvement of the respondents in risk assessment is very low, only 5.9%. However, risk assessment is considered to be an important procedure in safety management. Therefore, it is necessary to evaluate whether or not site

technicians have received sufficient training in conducting risk assessment.

4.3 Analysing Training

Green Card Training

A basic construction industry safety course also known as Green Card training was launched in June 1996 and is the largest scheme of safety training ever conducted for persons employed for construction works in Hong Kong. It is run by the Construction Industry Training Authority (CITA) and is a one-day basic safety training course for construction workers. Since then, contractors for public sector are required to provide induction safety training such as Green Card training to their site workers. With the enactment of the Factories and Industrial Undertakings (Amendment) Ordinance 1999, safety training becomes mandatory for persons employed to carry out construction work. The CITA's Green Card training course has been recognized as one of the relevant safety training course under the Ordinance. The course is now called Mandatory Basic Safety Training Course or Construction Industry Safety Card Course (Tong et al, 2000).

Safety training should be refreshed from time to time. Workers who have received Green Card training must take refresher course after the lapse of three years. CITA offers a half-day Mandatory Basic Safety Training Revalidation Course (Construction Industry Safety Card Refresher Course) that offer refreshing training to construction workers and a Two-day Advanced Safety Training Course for Construction Workers (Construction Industry Silver Card Course) that provides

advanced safety training to construction workers.

Figure 4-8 presents the percentage of respondents with Green Card training. The data indicates that except for the safety supervisors, not all site technicians have received the Green Card training. In fact only 87.5% of the site foremen has received the training.

Surprisingly, only 57.9% of work supervisors have received the basic training. Although work supervisors are less involved with direct operation of the construction works, they are responsible for inspection of works and to ensure safety procedures and precaution to be implemented on site.

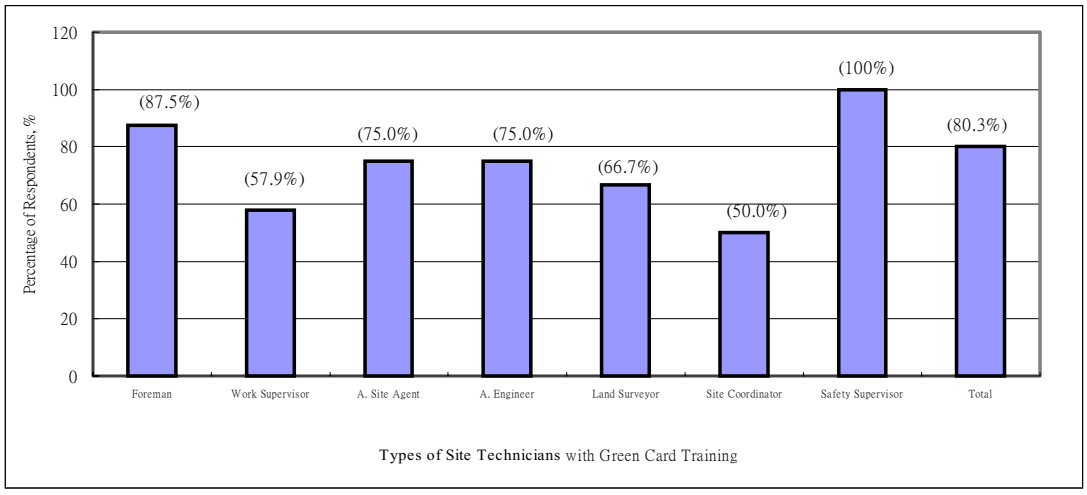

Figure 4-8 Percentage of respondents with Green Card Training

The percentage of land surveyors receiving basic safety training is 66.7%. As already mentioned previously, land surveyors sometimes take the roles of an assistant foreman, particularly in the building contractors. Therefore, it is expected that they should also receive training in basic construction industry safety.

From the data, only 50.0% of the site coordinators have received the Green Card training. In the construction industry in Hong Kong, site coordinators are referred to those technicians who supervise and coordinate works in more than one site. They usually work for smaller projects and may need to oversee several projects on various sites. They are also expected to possess a basic construction safety training in order to carry out their works safely and effectively.

Adequacy of the training

The questionnaire also attempts to evaluate whether the training is sufficient or not.

For those who have received Green Card training, only 77.9% expresses that the training is sufficient for them to carry out their work. However, if we also compare the percentage with the companies that implement a safety management system, there are more respondents (82.1%) who express that the Green Card training is sufficient. This can be explained that those working in companies that implement a safety management system have a higher degree of appreciation for safety training.

Table 4-3 Percentage of technicians expressing
Green Card training is sufficient

Types of Company	Percentage of technicians expressing Green Card Training is sufficient (%)
With Safety Management System	82.1
Without Safety Management System	65.0
Overall Results	77.9

CITA(1999) conducted a survey on construction workers on the usefulness of the Green Card training and the results are shown in Table 4-4.

Table 4-4 Usefulness of Green Card Training (CITA, 1999)

Degree of Usefulness	Percentage of respondents (%)
Extremely useful	36.3
Useful	55.6
Do not know	6.5
Useless	0.4
Extremely useless	1.1
Total	100.0

From the CITA data, 92.1% (36.3% plus 55.6%) of the respondents express that the Green Card training is extremely useful or useful. It can be seen that construction workers have in general expressed a higher degree of satisfaction on Green Card training whereas site technicians may require more training such that they will express a comparatively less (77.6%) degree of satisfaction with the Green Card training.

Additional Safety Training

Safety training in addition to the Green Card is required for continuous support of safety culture on construction site. Petersen (1996) summarized the various ways on how to provide training to workers.

Motivation and Learning – Individual will learn most efficiently when motivated toward some goal that is attainable by learning the subject. He sited examples that some people think that they have more important production problem to worry about, and will spend training time thinking about them and complaining about being taken away from the job to learn a lot of nonsense. Therefore, making sure that workers understand the direct relationship between the training and the goal is critical.

Reinforcement and Learning – Positive rewards for certain behaviour increase the probability that the behaviour will occur again, whereas negative rewards decrease the probability. Whether or not an event is rewarding depends on perception of individual. Typical examples of reinforcers are food, status, recognition, money, companionship.

Practice and Learning – Individual learns what is practiced. Therefore, follow-up and practice are as important as initial learning.

Feedback and Learning – Give the workers the feedback to measure their performance. Theorists emphasize immediate reinforcement to each bit learned.

In essence, motivating, reinforcing, practicing and feedback are

important processes in enforcing what has been learned in the training. Therefore, it is important to provide continuous training to the individual in order to fully utilize on what is learned.

The questionnaire also evaluates whether or not site technicians have received additional safety training. The results show that only 45.3% of the respondents have received training in addition to the Green Card.

Relation of Safety Management System on Green Card Training and Additional Training

A Chi-square test was conducted to see if Green Card training and additional training is associated with those companies that implement a safety management system. The results of the $\chi 2$ values are shown in Table 4-5. Details of the Chi-square are given in Appendix B, pages 28-29.

Table 4-5 Chi-square values calculated for training

	$\chi 2$ values	Degree of freedom	Asymptotic Significance
Green Card Training	7.632	2	0.018
Additional training received	13.057	2	0.002

The results as shown can conclude that Green Card training and additional training are usually provided by companies that implement safety management system and the limits of confidence are within 98.6% and 99.8% respectively.

Duration of Additional Training.

Table 4-6 presents the percentage of respondents who have received additional training with various duration. The duration of the training varies but it seldom exceeds 48 hours per year. For those respondents who have received additional training, most of them (42.4%) have only received an additional of 1-7 hours (1 day) per year of training. Less than 10% has received additional safety training of over 40 hours per year.

Table 4-6 Percentage of respondents receiving addition safety training

Duration of additional safety training (hours per year)	Percentage of respondents who have received additional safety training (%)
1- 7	42.8
8 – 16	18.7
17 – 24	18.7
25 – 32	6.6
33 – 40	4.4
41 – 48	2.2
> 48	6.6
Total	100

Effectiveness of Additional Training

The effectiveness of the additional training was also evaluated on the survey. Fifty percent of the respondents who have received addition training express that the training is not effective. This observation can be explained by the fact that the hours

of training provided in the range of 1-7 hours per year is not enough and hence the training is not effective. The results of the survey also recorded that 91.1% of the respondents agree that more safety training is required.

Table 4-7 Effectiveness of additional training

Additional Training	Percentage of respondents
Effectiveness of addition training	50.0% express not effective
More training is required	91.1% agree

It is recommended that a continuous professional development (CPD) training scheme should be implemented on site technicians so as to maintain a continuous level of safety awareness and knowledge. Tang et al (1998) pointed out that safety training schemes should be provided at different rankings and levels, including site management staff, workers and operatives of different trades.

4.4 Analysing the Effectiveness of Safety Supervisor

According to the Factory and Industrial Undertaking (Safety Officer and Safety Supervisor) Regulation, a contractor shall employ at least one safety supervisor to work full time at each work location where the number of workers engaged exceeds 20. A safety supervisor must have at least three years of experience on construction

work and must have completed an appropriate safety training for safety supervisors (Work Bureau, 1999). Safety supervisors are responsible to:

- carry out safety inspection at least daily ,
- attend safety committee,
- conduct toolbox talks.

From the survey results, 85.7% of the respondents work in sites with safety supervisors. However, only 52.3% of the respondents express that the safety supervisors are able to provide help and 47.7% of the respondents express that safety supervisors are not able to provide help when in need.

Rowlinson (1997) points out that the effectiveness of the training for safety officers / supervisors is quite limited because the number of people who benefit from this course is relatively small at present. The percentage of safety supervisors on site is also not enough (1.7% of the total number of the site technicians) as reported by the Building and Civil Engineering Industry Manpower Survey Report (VTC, 1999).

The survey also evaluated the willingness of the employers in sponsoring their employees to safety training. Only 70.9% of respondents think that their employers would sponsor them for the training. However, the survey did not evaluate whether how much in terms of the amount of time that the employers would sponsor their employees to training. The training for a safety supervisor would take 42 hours (CITA, 2000) and many employers may not be willing to sponsor their employees to that amount of training.

4.5 Evaluation of specific training topics

The questionnaire also attempts to evaluate whether the respondents are conversant with certain important safety knowledge. It is expected that a site technicians should be familiar with safety knowledge that is comparable with that of a safety supervisor, particularly in the case where there is no safety supervisor on site or the number of safety supervisors is not sufficient to provide help when in need. According to the Construction Safety Supervise Course offered by CITA, the following areas of training are provided in the 42 hours course (CITA, 2000) :

- F&IU Ordinance and its subsidiary Regulations
- Occupational Safety and Health Regulations
- Safety management and training techniques
- Principles of accidents prevention

Gow (1991) concludes that the employees preferred courses in operative level whereas employers and government officials preferred courses at management level. Table 2-4 also summarizes a profile of safety training in course content as reported by Gow (1991). The course content is divided into the following four areas :

- Safety technology
- Management
- Health and hygiene
- Legislation

The questionnaire also lists out safety training topics in the following five areas

- Legal responsibilities

    - Construction (Safety) Regulations
    - Electricity Safety Regulations
    - Fire Precautions
    - Protection of Eye Regulations
    - Lifting Related Regulations
    - Working in Confined Spaces Regulations
    - Occupational Safety & Health Ordinance
- Contractual obligation
- Safety working procedures
    - Site Safety Code of Practice
    - Accident prevention
    - Occupational Health
- Correct selection, use and maintenance of PPE
- Safety management

The respondents need to indicate whether the training is essential and whether the training on these topics is received.

Figure 4-9 presents the percentage of respondents who have expressed details of the safety training that they have received. The Figure shows that most respondents consider the list of safety training is essential in carrying out their work. However, it is also shown that the percentage of respondents who have received the training is not a lot.

About 83.3% of the respondents express that they are willing to undertake a 42

hours of safety training per year.

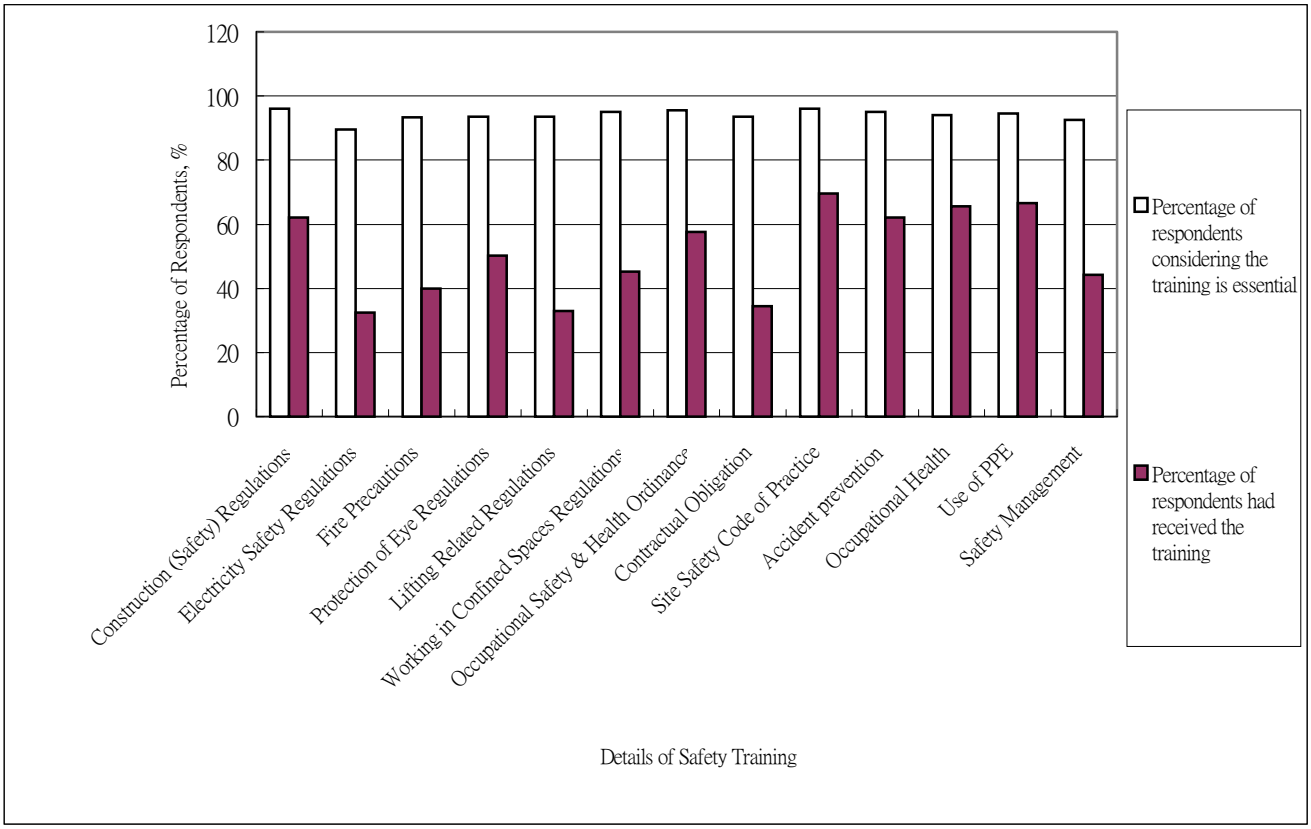

Figure 4-9 Percentage of respondents with details of training

Safety Training requested by the Respondents

The questionnaire allows the respondents to comment on any construction safety training that they wish to undertake. Table 4-8 lists out the types of construction safety training as requested by the respondents in the questionnaires.

Table 4-8 Safety training requested by the respondents

Safety training requested By the respondents	Number of respondents who raise the request
Electricity	9
Use of personal protection equipment, PPE	9
Any training related to safety	7
Confined space	7
Safety management	7
Working at height	6
Safety supervisor	5
Lifting safety	4
Safety regulations	3
Green card training	2
Risk assessment	2
Plant and machine safety	2
Scaffolding	1
Contractual obligation in safety	1
Fire protection	1
First aid	1
Total	67

4.6 Summary of the Analysis

1 There are 20,848 of construction technicians in Hong Kong and it is believed that among those technicians, 12,484 of them are working mainly on site.

2 A total of 203 questionnaires were returned.

3 Summary of the control variables

3.1 Most of the respondents (70.4%) are working on sites that employ more than 20 workers.

3.2 Most of the respondents (71.4%) are working in companies with safety management system implemented.

3.3 About 63.1% of the respondents are working as foreman.

3.4 Most of the respondents (75%) have experience of 6 years or less.

3.5 About 87.2% of the respondents are having Secondary 5, vocational certificate or above education.

4 Supervising work procedures, inspecting site safety procedures, supervising the use of PPE, carrying out work safely and reporting hazards are the top five roles that are mostly undertaken by the respondents. It is expected that the role of site technicians in enhancing site safety is increasing, particularly with the introduction of the Safety Supervision Plan.

5 The involvement of site technicians in risk assessment is very low (5.9%).

6 There are still respondents (19.7%) who have not received the mandatory safety training such as the basic construction industry safety (Green Card) training.

7 Among those technicians who have received the Green Card training, about 77.9% of the respondents express that it is useful. Compared to a survey undertaken for construction workers, there are 92.1% of construction workers who express that the Green Card training is useful.

8 Most of the respondents (91.1%) express that more safety training in addition to the Green Card is required.

9 Less than half of the respondents (45.3%) has actually received safety training in addition to the Green Card training.

10 Companies that implement safety management system provide more additional training to their employees.

11 The duration of additional training is usually 1-7 hours per year.

12 Half of the respondents (50.0%) express that the additional training is not effective as the duration is short.

13 The number of safety supervisors is not enough. There are only a total of 360 safety supervisors, which constitutes 1.7% of the total number of the construction technicians. About half of the respondents (47.7%) expresses that safety supervisor is not always there to help even though there is one working on site.

14 About 70.9% of the respondents express that their employers would sponsor them to safety training.

15 Most of the respondents (89.7-96.1%) express that they consider the safety training topics in legal responsibilities, contractual obligation, safe working procedures, correct selection, use and maintenance of PPE., safety management are essential. However, only about half of them (32.5-69.5%) have received the training. It can be concluded that safety training in these areas are required.

16 About 83.3% of the respondents express that they are willing to undertake a 42 hours of safety training per year.

17 The top 5 safety training that the respondents would most like to take are electricity, use of personal protection equipment, any safety training, confined space and safety management.

18 Based on the summary of analysis described above, the hypotheses made in Chapter 2 are therefore valid :

- Construction site technicians are playing an important role in site safety.
- The amount of training provided to site technicians is not enough.
- The number of safety supervisors on site is not enough.
- Safety training in the following areas are required :
    - Legal responsibilities
    - Contractual Obligation
    - Safe working procedures
    - Correct selection, use and maintenance of PPE.
    - Safety Management