Chapter 3

3.0 RESEARCH METHODOLOGY

3.1 Introduction
The aim of this chapter is to outline the research methodology and research methods adopted for the study. The first part of the chapter outlines the research design and how it is applicable to the study. The second part describes the process adopted for this particular research. It consists of three stages overall. The first stage involved a detailed literature review and informal interviews. The second stage consisted of a detailed Delphi survey of three rounds with a combination of structured interviews at each stage. The final stage focused on developing a risk management model and testing the practical use of the model. Chapter three discusses these stages in detail, including the methods of data analysis employed for the study and validation methods.

3.2 Research Design
Bailey (1997) defines research as the systematic investigation of a problem, area or issue, which is undertaken for the purpose of enhancing the knowledge base of a particular subject. Although there are many definitions of the term ‘research methodology’, for the purposes of this study, research methodology is defined as the system of explicit rules and procedures on which the research is based and against which claims for knowledge are evaluated (Frankfort-Nachmias & Nachmias, 1996). Choosing a proper research methodology is important as it determines the research methods to be used in the study (Liyanage, 2006). The figure 3.1 gives the different types of research methodology as illustrated by Saunders, Lewis, & Thronhill (2004):
According to Remenyi, Williams, Money, & Awartz (1998), there are two important factors which should be considered in selecting a suitable research methodology: the topic to be researched and the specific research questions. Kagioglou, Cooper, Aouad, & Sexton (2000) identified (see figure 3.2) research methodology as complying with three key steps sequentially: identification of the research philosophy, research approach and research technique. While the selection of research techniques for data collection and data analysis is based on the research approach, the selection of the research approach is based on the research philosophy.
3.2.1 Research philosophy
Selection of a research philosophy is the initial step in a research design and its determination is dependent on the researcher’s attitude towards the development of knowledge. Further, it directs the researcher to select an appropriate research strategy from among the following:

- **Positivism**: This is a stance often adopted by natural science researchers in positivism researchers’ work with an observable social actuality and the finished product of the research can be generalized (Remenyi et al., 1998).

- **Interpretivism**: Researchers who adopt this approach try to discover the details of the situation in order to understand the reality or perhaps the reality that is working behind them (Remenyi et al., 1998).

- **Realism**: Researchers subscribing to this school of thought believe that reality is subjective and interior to the people and shares the views of both positivism and interpretivism.

Since the research problem under consideration in this study requires vigilant observation and identification of construction project risks for the purpose of managing the project risks for the construction parties throughout the project life cycle, ‘interpretivism’ is selected as the research philosophy for this research.

3.2.2 Research approach
The research approach describes the organization of research activities, especially the collection of data from the population in a way that meets the aims and objectives of the research. The researcher must therefore settle on an appropriate research approach to deal with the research question in accordance with the research philosophy. According to Saunders et al. (2004), the research approach can be divided into two categories (refer figure 3.1),

- **Deductive** In this approach, the researcher first develops a theory and hypothesis and then designs a research strategy to test the hypothesis. This approach is based on positivism;
• **Inductive:** Here, the researcher first collects the data and develops a theory based on the results of the data analysis. This approach is based on interpretivism.

The present study requires the researcher to identify the severe risk factors and how they are handled by the parties to the contract in the construction life-cycle. The deductive approach is therefore selected for the purposes of this study.

According to Kagioglou et al. (2000), the following are the most popular and widely used research approaches in the world:

- Experiments – laboratory, quasi-experiments
- Surveys
- Case study research
- Ethnography
- Action research
- Grounded theory

The present study adopts the survey method as the most appropriate approach since it was necessary to elicit the perceptions and opinions of building construction practitioners.

**Survey research approach**

Survey research is one of the most common research approaches. The main characteristics of survey research, according to Pinsonneault and Kraemer (2002) are:

- Obtaining information from a sample,
- Asking questions from the respondents,

**3.2.3 Choice of survey approach**

After developing a feasible research question, it is necessary to design the research from a macro to a micro perspective. For the purposes of this research, the survey
approach is selected over the case-study approach because it offers a bird’s eye view of the whole industry and thus a broader perspective rather than an in-depth analysis. Moreover, in identifying risk factors and how they are managed, the survey approach provides better access to information through a concise and precisely designed questionnaire (N.A.Katam & Katam, 2001). Since, according to Akintoye and MacLeod (1997), the analysis and management of construction risk depend mainly on intuition, judgment and experience, it is clear that the research can be implemented through a questionnaire survey for the purpose of obtaining the relevant data under the research topic.

It is also a fact that there is a need to generalize the result to some extent. Hence, by resorting to a survey, the research obtains the following advantages (Saunders et al., 2004):

- Surveys are relatively inexpensive (especially self-administered surveys);
- Surveys are useful in describing the characteristics of a large population. No other method of observation can provide this generalizing capability;
- Surveys make very large samples feasible, thus making the results statistically significant even when analyzing multiple variables;
- Many questions can be asked of a given topic which gives considerable flexibility to the analysis;
- There is flexibility at the creation phase in deciding how the questions will be administered: as face-to-face interviews, via telephone, as a group-administered written or oral survey, or via electronic mail;
- Standardized questions make measurement more precise by enforcing uniform definitions upon the participants;
- Standardization ensures that similar data can be collected from groups and then interpreted comparatively (i.e. between-group study).

3.2.4 Research technique
Taking into consideration the circumstances of this particular research, especially the need to elicit and identify perceptions of construction industry practitioners about risk and the strategies for risk handling among contracting parties, the Delphi
technique was used in the survey which is a systemic interactive forecasting method for obtaining forecasts from a panel of independent experts. Furthermore, in order to fill gaps in results obtained from the questionnaire survey, a semi-structured interview was used where a concerted effort was made to determine the actual situation.

Kerzner (2001) describes the Delphi method as an expert judgment technique, which offers one of the most comprehensive surveying techniques for the purpose of identifying risk factors. According to Dey (2001), the Delphi method is one of the most effective techniques to identify the various risk factors and an analysis tool often used by researchers and practitioners. Therefore, given the nature of the study and the techniques in use in similar researches on risk management, the present study was conducted via a questionnaire survey, using the Delphi technique, on the basis of guidelines proposed by Linstone and Turoff (1975) and Turoff and Hiltz (2006) for conducting a Delphi study and other useful reviews of the technique are offered by researchers such as Fischer (1978), Gupta and Clarke (1996), Schmidt (1997), Rowe and Wright (1999), Okoli and Pawlowski (2004) and Keeney, Hasson and McKenna (2006), in order to attain the aim and objectives for the research.

3.3 The Delphi Technique

3.3.1 An overview
The Delphi technique has been used since the 1950s, with the use of Delphi as a forecasting method at RAND, Santa Monica, California. But the Delphi technique later came to be used in a number of other areas such as business, education, and the social sciences for a number of applications, including management decision-making, policy evaluation, program planning, and prioritization of issues or actions (Delbecq, Van, & Gustafson, 1975; Dunham, 1998; Gunaydin, 2004).

According to Chapman (1998), “the Delphi technique is a method for the systematic collection of judgments from isolated anonymous respondents on a particular topic, through a set of carefully designed sequential questionnaires interspersed with
summarized information and feedback of opinions, derived from earlier responses” (p.340). Fischer (1978) defines Delphi as a method for collecting and refining expert opinions for the purpose of arriving at a consensus. For Linstone and Turoff (1975), Delphi is a method for structuring a group communication process so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem. Sackman (1975) defines Delphi as an attempt to elicit expert opinions in a systematic manner to produce useful results. According to Dalkey and Helmer (1963), the Delphi technique is capable, through a series of questionnaires, of producing a reliable consensus among an expert group while Scapola and Miles (2006) identify Delphi as facilitating the formation of group judgments.

The objective of the Delphi method is to obtain a reliable response to a problem or question from a group of experts. This is done by giving individuals in the group a series of questionnaires (or interviews) that reiterate the same questions while providing group feedback from previous rounds (Helmer 1983, p.135). Delphi experiments tend to produce a convergence of opinion, not just toward the mean but toward the true value (Helmer 1983, p. 133). The Delphi technique is based on the qualities of ‘anonymity, statistical analysis, and feedback’ (Armstrong, as cited in Gunaydin, 2004). Further, in a Delphi study, the participants do not interact with one another, their responses being anonymous, while the group results are given in terms of means, medians, or standard deviations. However, participants are given the opportunity to reconsider their response after receiving group feedback.

Fowles (1978) describes the following ten steps for the Delphi method:

1. Formation of a team to undertake and monitor a Delphi on a given subject;
2. Selection of one or more panels to participate in the exercise. Customarily, the panellists are experts in the area to be investigated;
3. Development of the first round Delphi questionnaire;
4. Testing the questionnaire for proper wording (e.g., ambiguities, vagueness, etc.);
5. Transmission of the first questionnaires to the panellists;
6. Analysis of the first-round responses;
7. Preparation of the second-round questionnaires (and possible testing);
8. Transmission of the second-round questionnaires to the panellists;
9. Analysis of the second-round responses (Steps 7 to 9 are reiterated as long as desired or necessary to achieve stability in the results);
10. Preparation of a report by the analysis team to present the conclusions of the exercise.

3.3.2 Delphi method design considerations
While the Delphi method is flexible and superficially simple, many design considerations need to be taken into account in order to successfully use the method because if it is poorly applied, like any other research method, the Delphi can yield suspect results. The number of rounds again is variable and dependent upon the purpose of the research. Delbecq et al. (1975) suggests that a two or three iteration Delphi is sufficient for most research. In this research, it was limited to three rounds of the questionnaire survey. The questionnaires are designed to focus on problems, opportunities, solutions, or forecasts (Skulmoski, Hartmen, & Krahn, 2007).

Strengths of the Delphi Method
Gordon, Helmer, & Dalkey (2008) have identified the strengths of the Delphi method as follows:
1. Rapid consensus;
2. The ability to survey participants resident in different locations;
3. Coverage of a wide range of expertise;
4. Avoidance of Groupthink;
5. Forecasting of a specific, single-dimension question

The advantages of conventional Delphi, at least in this reviewer’s estimation, are its primarily low cost, versatile application to virtually any area where “experts” can be found, and the ease of administration, the minimal time and effort on the part of the director and panellists, and the simplicity, popularity, and directness of the method (Sackman, 1975).
Weaknesses of the Delphi Method

Even though the Delphi method possesses several advantages, it has certain weaknesses (Gordon et al., 2008):

1. Neglect of cross impact in the original form;
2. Inability to cope well with paradigm shifts;
3. The need to watch out for:
   - Imposing preconceptions or Monitor’s own view;
   - Ignoring and not sufficiently investigating disagreements;
   - Underestimating the demanding nature of the Delphi method.

Delphi is a powerful method for deriving objective opinions in areas given to a high-level of subjectivity (A.P.C. Chan, Wong, Chan, & Ho, 2000) via controlled opinion feedback (Alder & Ziglio, 1996). Even though the Delphi method has some limitations, by considering its advantages and the subjective nature of risk identification and handling, and the need of coverage of wide range of expertise in road construction for this research, the Delphi method was considered to be appropriate to achieve the objectives of this study.

3.3.3 Research sample

Selecting research participants is a critical component of Delphi research since it is their expert opinions upon which the output of the Delphi is based (Ashton, as cited in Skulmoski et al., 2007). Goldstein (1975) supports this view by demonstrating how the success of the Delphi method depends principally on the careful selection of a panel of experts.

According to Adler & Ziglio (1996), there are four requirements for “expertise”:

1. Knowledge and experience with the issues under investigation;
2. Capacity and willingness to participate;
3. Sufficient time to participate in the Delphi;
4. Effective communication skills.
Since expert opinion is sought, a purposive sample is necessary where people are selected not on the basis of their representativeness of the general population but on their expert ability to answer the research questions (Fink & Kosecoff, as cited in Skulmoski et al., 2007). The judgemental sampling design is used where the collection of specialised insights on the area researched is vital and where the use of any other sampling designs would not offer opportunities to obtain the specialised information (Sekaran, 2003). Therefore, for the purpose of this research, judgmental sampling was selected as the most appropriate method out of the available sampling techniques.

Although a panel of seven experts was selected for the original Delphi experiment in 1953, Helmer (1983) and Turoff (1975) have suggested a panel size of anywhere from ten to 50 participants. Wicklein (2000), on the other hand, used a panel of 25 experts in his study. According to Dalkey (1969), the error decreased rapidly as the group size increased from one to about thirteen. Further, the small decreases in error continued to a size of about 25 people, at which point, the error rate stabilized. Since Gordon (1994) has stated that most studies use panels of 15 to 35 people, with the length of the list anticipating an acceptance rate between 35 and 75 percent, in this research, a Delphi expert panel comprising 33 professional members was selected from among clients, consultants, project managers and contractors who are involved in road construction projects. This panel represents a wide distribution of professionals from several disciplines working in public and private sector organizations with more than 15 years of experience. Table 3.1 captures the variety and mix among the panel of experts and their participation in the Delphi study.
Table 3.1: Variety and mix of experts

<table>
<thead>
<tr>
<th>Designation</th>
<th>Number of Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Round one</td>
</tr>
<tr>
<td>Civil Engineer</td>
<td>03</td>
</tr>
<tr>
<td>Design Engineer</td>
<td>02</td>
</tr>
<tr>
<td>Manager Contracts</td>
<td>02</td>
</tr>
<tr>
<td>Project Accountant</td>
<td>04</td>
</tr>
<tr>
<td>Project Director</td>
<td>02</td>
</tr>
<tr>
<td>Project Manager</td>
<td>05</td>
</tr>
<tr>
<td>Quantity Surveyor</td>
<td>02</td>
</tr>
<tr>
<td>Senior Engineer</td>
<td>02</td>
</tr>
<tr>
<td>Senior Manager Roads and Bridges</td>
<td>01</td>
</tr>
<tr>
<td>Senior Quantity Surveyor</td>
<td>07</td>
</tr>
<tr>
<td>Site Manager</td>
<td>03</td>
</tr>
<tr>
<td><strong>Total Responses</strong></td>
<td><strong>33</strong></td>
</tr>
<tr>
<td><strong>Percentage of Response</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

The survey was carried out in three rounds, which focused on fulfilling one objective in each round as mentioned below.

### 3.4 Research Process

The aim of this study is to identify and evaluate the risk management practices of road construction projects in Sri Lanka taking into consideration the project life cycle. This research adopted the following steps in order to achieve the aims and objectives of the research.
Figure 3.3: Research process
3.5 Data Collection

Qualitative and Quantitative data were required to establish risk identification and handling and a Delphi method was used to collect the empirical data from the experts. The following section briefly explains the activities involved in the three rounds of the Delphi survey.

3.5.1 Delphi round one design

Identification of risk factors prevailing in each phase of the project life cycle

The first round Delphi questionnaire, accompanied by an invitation letter, explained the purpose of the research and the respondents were informed that there would be three rounds of questionnaires. In the first round of the questionnaire survey, a list of 21 risk factors (refer section 2.9) were provided as identified by B.A.K.S. Perera and Rameezdeen (2008) and with the use of preliminary interviews. The experts were asked to identify the potential risk factor that prevailed in each phase of the project life cycle and provision was also made to mention other risk factors which were not included in the pre-identified list. In the second part of the questionnaire, a list of Risk Response Measures sourced from literature on road projects was provided and the experts were asked to review the list and to add new response methods. Round one questionnaire is given in Appendix 2.

3.5.2 Delphi round one survey and analysis

The survey duration was four weeks and the survey involved 33 respondents in all. The total marking of each risk factor against each phase was counted and taken as a percentage of the total number of respondents. The first round of the survey was screened on the basis of each factor obtaining twenty five percentage frequency or more. Twenty five percent was considered as the cutoff point as Dey (2002) in a similar study has used the same cutoff point for screening. The risk factors obtaining more than twenty-five percentage frequency were selected for further analysis in the second round.

In the second part of the questionnaire, the collected data on risk response measures were analysed based on the expert’s responses on the different types of risk response
measures that have a common basis or is the same, summarised under one heading. Then all the risk response measures were arranged in descending order with respect to their importance and listed for further analysis.

3.5.3 Delphi round two design

Identification of severe risk factors at each phase of project life cycle and risk response measures by contracting parties

This questionnaire consisted of feedback report of the round one questionnaire which had been identified and analysed from the round one Delphi survey. Risk factors were grouped according to the phases which had been chosen by the experts. Experts were required to review the factors that had been indicated in the round one Delphi survey.

In part one of the round two questionnaire (Appendix 3), the respondents were asked to indicate the levels of frequency of risk occurrence during each phase of the project life cycle, and the significance of risk impact on the project objectives, in order to estimate the severe risk factors. The level of frequency of risk occurrence (α) and significance of risk impact (β) were presented for each risk factor according to a scale of 1-5 denoting 1=Very Low, 2=Low, 3=Medium, 4=High, 5=Very High.

In part two of the questionnaire and experts were asked to identify the risk response measures adopted by contractors and client/consultants at each phase against each risk factor. In part three, the respondents were asked to identify whether the above mentioned risk factors were borne by the client/consultant or contractor at each stage of the project life cycle.

In the part four of the questionnaire, a list of barriers to risk response measures and solutions to those barriers when managing risk factors was provided. Experts were asked to review the list and add new barriers and the solutions to the given list.
3.5.4 Delphi round two survey and analysis

Survey
The survey duration was seven weeks and the survey involved 33 respondents but there were 29 questionnaires returned. The techniques used to analyze the data derived from each round include the following:

1. Cronbach's Alpha
2. Mean Weighted Rating (MWR)
3. Severity Index

In addition to the above techniques, Special Package for Standard Statistical (SPSS) and MS Excel software packages were used as tools in data analysis. SPSS facilitates statistical data analysis including descriptive statistics as plots, frequencies, charts, and lists. Being user friendly, MS Excel assisted in plotting charts.

The following section briefly defines each technique and justifies the selection of each technique for this study.

Cronbach's alpha
Reliability testing is also important for a questionnaire survey. Cronbach's alpha is a test for a model or survey's internal consistency. In addition, it is identified as the 'scale reliability coefficient' sometimes. Cronbach's Alpha is a measure of how well each individual item in a scale correlates with the sum of the remaining items. It measures consistency among individual items in a scale (Nully, 1978; Streiner & Norman, 1989).

The standardized Cronbach's $\alpha$ can also be defined as:

$$\alpha = \frac{N \cdot \bar{c}}{(\overline{\sigma} + (N - 1) \cdot \bar{c})}$$

Where $N$ is the number of components, $\overline{\sigma}$ equals the average variance and $\bar{c}$ is the average of all co-variances between the components (Cronbach, 1951). According to
Nully (1978), in a reliable data set the alpha should be above 0.7. Cronbach’s alpha was calculated with the use of SPSS and the calculation of Cronbach’s alpha is shown in Appendix 4.

**Severity index**

Since the method had been used in similar studies previously of Fang et al. (2004), Zou et al. (2007) and Sun, Fang, Wang, Dai, & Ly (2008), it was implemented to extract the severe risk factors in this round. The following formulas (1) and (2) show the calculation of the Severity Index for risk factors:

\[
S_j' = \alpha_j \beta_j
\]  

(1)

\[
RS' = \frac{\sum_{i=1}^{n} S_j'}{n}
\]  

(2)

Where \( n \) = number of responses, \( S_j \) = evaluation of risk severity by \( j^{th} \) respondent, \( \alpha \) = evaluation of frequency level of risk occurrence by \( j^{th} \) respondent, \( \beta \) = evaluation of significance of risk occurrence from the \( i^{th} \) factor by \( j^{th} \) respondent, and \( RS' \) = Risk Severity Index for the \( i^{th} \) risk factor. The Severity Index calculation was used to rank the risk factors according to their criticality to the road project.

**Mean weighted rating**

Mean Weighted Rating = \( \frac{\sum Vi * Fi}{n} \)

Where,

- \( Vi \) - Rating of each factor
- \( Fi \) - Frequency of responses
- \( n \) - Total number of responses

Since ratings range between 1 and 5, point 3 is considered as the neutral point.

A mean weighted rating for each factor was computed for the significance of risk impact and frequency of risk occurrence to get an indication of the importance of each factor for the Delphi round two.
In the second part of Delphi round two, the total marking of each risk response measure against each risk factor was counted and taken as a percentage of the total number of respondents. The risk response methods obtaining 25 percentage frequency or moderately against each risk factor were considered as the relevant risk response method for that risk factor. In part III, the same method was used for risk allocation among contractors and owner/consultants. Factors which scored more than 25% in significance on each party were considered to be borne by that party at each phase where 25% was considered as the cutoff point by following a previous similar study of Dey (2002).

The collected data on barriers and solutions were analysed based on the expert’s responses to the different types of barriers and solutions that had a common basis or were the same, summarised under one heading. Then all the barriers and solutions were ordered in descending order with respect to their importance, from the most significant barriers and solutions to the least significant. The list of barriers to risk response measures and the solutions to barriers when managing risk factors were listed for further analysis.

### 3.5.5 Delphi round three design

**Identification of risk allocation to stakeholders and barriers and solutions to overcome barrier to risk response measures**

This questionnaire consisted of feedback reports of the round-two questionnaire, which gives the severe risk factors at each project phase, response measures by contracting parties, allocation of these severe risk factors among contracting parties and a list of barriers and solutions. Experts were required to review the factors that had been indicated in the round two Delphi survey.

In part one of the Delphi round three, experts were requested to identify the percentage of the risk borne by the contractor and client/consultant at each phase of the project life cycle. Experts were asked to identify what percentage of a particular risk lies with the contractor (say x from 0 to 100), thereby implying that (100-x) percentage of that risk lies with the client/consultant (Appendix 9).
Part two of the third round of the questionnaire was designed to identify the barriers to response methods, and solutions to barriers when managing each risk factor at the different stages of the project life cycle (Appendix 5). Experts were asked to identify the barriers to handling against the risk factors. Furthermore, the experts were allowed to mention solutions to overcome these barriers.

### 3.5.6 Delphi round three survey and analysis

The survey duration was seven weeks. The questionnaire was distributed among 29 experts but 26 responses were received only. During this phase, the average (arithmetic mean) values of the percentage of all 26 responses allocated to the contracting parties was calculated for each factor at each stage of the project life cycle. Part two of Delphi round three mainly dealt with identifying barriers for implementing risk response measures and the solutions for those barriers against each risk factor. The barriers and solutions obtaining 25 percentage frequency or more against each risk factor were considered as the relevant barriers and solutions for response measures for that risk factor. The 25% was considered as the cutoff point by following a previous similar study of Dey (2002).

### 3.5.7 Case studies

Ten road rehabilitation projects were selected as case studies. Unstructured interviews with selected two persons out of contractors and clients /consultants from selected road rehabilitation projects were conducted to test the practical use of the model to evaluate the applicability of the model.

### 3.6 Summary

This chapter has described and justified the research process and the methodology adopted for the purpose of the research. The questionnaire survey method was used for the survey and the Delphi technique with three rounds was adopted for the questionnaire survey. Further, a Severity Index was used to identify the severity of the risk factors in each stage of the project life cycle. The next chapter will analyse and discuss the results obtained from the three-round questionnaire surveys in detail.