RISK IDENTIFICATION AND RISK HANDLING IN CONSTRUCTION: A CONSIDERATION OF THE PROJECT LIFE CYCLE IN SRI LANKAN ROAD PROJECTS

Balasuriya Arachchige Kanchana Shiromi Perera

(07/9901)

University of Moratuwa, Sri Lanka. Electronic Theses & Dissertations www.lib.mrt.ac.lk
Degree of Master of Philosophy

Department of Building Economics

University of Moratuwa
Sri Lanka

March 2012
RISK IDENTIFICATION AND RISK HANDLING IN CONSTRUCTION: A CONSIDERATION OF THE PROJECT LIFE CYCLE IN SRI LANKAN ROAD PROJECTS

Balasuriya Arachchige Kanchana Shiromi Perera

(07/9901)

Thesis submitted in partial fulfillment of the requirements for the degree of Master of Philosophy

Department of Building Economics

University of Moratuwa
Sri Lanka

March 2012
DECLARATION

I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Also, I hereby grant to University of Moratuwa the non-exclusive right to reproduce and distribute my thesis/dissertation, in whole or in part in print, electronic or other medium. I retain the right to use this content in whole or part in future works (such as articles or books).

Signature: ………………………… Date: ………………………

University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

The above candidate has carried out research for the MPhil Dissertation under my supervision.

Signature of the supervisor: …………………………….. Date ………………………

i
ABSTRACT

Risk is an inescapable dimension of construction projects, particularly in road construction, which makes effective risk management crucial in the achievement of project goals with risk identification, analysis and handling as important steps in this process. The present study aims to identify the severe risk factors and the strategies for handling them at each stage of the project life cycle in road construction projects via a three-round comprehensive Delphi survey. It also introduces alternatives to the present risk response measures adopted in road construction projects in Sri Lanka, while attempting to develop a risk management model for road construction.

The findings of the study reveal that although risks are spread throughout the whole project life cycle, the construction phase is the most risky phase followed by the design phase. Delays in payment by the client were found to be the most critical risk factor in the construction stage while errors in estimated cost and construction period were the most critical risk factor in the design stage. The study revealed that the most commonly used risk response measures by the owner/consultant and contractor were the allocation of contingency plans and claims for damages. It was also found that the lack of joint risk management mechanisms by parties and shortage of knowledge on risk management were the most common barriers to risk management. A consideration of the life cycle of a project makes it clear that critical risks at the conceptual and design stages are mostly apportioned to the owner or consultant while at the construction stage a high percentage of critical risk is allocated to contractors. Shared responsibility is more the norm in the operational stage although, at all stages, some portion of risk is shared by the other party. Based on data from three rounds of the Delphi survey, the study finally proposes a risk management model which has the potential to enhance the identification, allocation and handling of severe risks throughout the project life cycle. The study concludes that risk management should be a shared responsibility among parties to the contract, and education on risk management is needed to ensure quality construction activities at all phases of the project life cycle.

Keywords: Risk management; Severe risk factors; Risk handling; Road projects.
DEDICATION

To my mother and late father ......
ACKNOWLEDGEMENT

It is my utmost duty to acknowledge the individuals and organisations who rendered unstinting cooperation to make this dissertation a success.

First and foremost, I pay gratitude to my supervisors, Prof. R. Rameezdeen, and Prof. M. Lalith De Silva, for all the guidance, assistance and encouragement, provided to me. The insights and constructing criticisms they provided were invaluable for the success of this research. Also I owe a special thanks to Dr. Sepani Senarathne (Director, Postgraduate Studies, Faculty of Architecture), and Dr. Yasangika Sandanayake (Research Coordinator, Department of Building Economics) for their guidance and support towards the success of this research.

My very special thanks go to all leading professionals of the construction industry, for their kind corporation and valuable interviews towards the achievement of a victorious Delphi and Expert opinion survey. Also I would like to express my sincere gratitude to External Examiner, Mr. H.D. Chandrasena for his valuable comments and support.

I would also like to thank all academic and non-academic staff members of the Department of Building Economics for their unfailing assistance rendered towards this research.
TABLE OF CONTENTS

Declaration ............................................................................................................. i
Abstract ............................................................................................................... ii
Dedication .......................................................................................................... iii
Acknowledgement ............................................................................................. iv
Table of Contents ............................................................................................... v
List of Figures ...................................................................................................... x
List of Tables ...................................................................................................... xi
List of Abbreviations .......................................................................................... xiii

1.0 INTRODUCTION TO RESEARCH ........................................................ 01
1.1 Background ............................................................................................... 01
1.2 Research Problem ................................................................................... 03
1.3 Research Questions ............................................................................... 03
1.4 Aim and Objectives .............................................................................. 03
1.4.1 Aim ............................................................................................... 03
1.4.2 Objectives ............................................................................... 04
1.5 Scope and Limitations .......................................................................... 04
1.6 Methodology ......................................................................................... 04
1.7 Research Output/ Dissemination ......................................................... 05
1.8 Structure of the Thesis ....................................................................... 05

2.0 LITERATURE REVIEW ON RISK MANAGEMENT ........................... 07
2.1 Introduction ........................................................................................... 07
2.2 Concept of Risk and Uncertainty ....................................................... 07
2.2.1 Risk ........................................................................................... 09
2.2.2 Construction project risks .......................................................... 10
2.3 Risk Management .................................................................................. 13
2.4 Risk Management Process ................................................................. 15
2.4.1 Risk identification ...................................................................... 17
2.4.2 Risk analysis ........................................................................... 23
2.4.3 Risk response/ Risk handling .................................................. 26
2.5 Involvement of Stakeholders in Risk Management .......................... 30
  2.5.1 Involvement of client in risk management ............................. 32
  2.5.2 Involvement of consultant in risk management .................... 32
  2.5.3 Involvement of contractor in risk management .................. 33
  2.6 Project Life Cycle ............................................................................ 34
  2.7 Risk Management and Project Life Cycle ................................. 35
  2.8 Trend on Road Construction Projects in Sri Lanka ................. 36
    2.8.1 Risk management in road construction projects
               in Sri Lanka ......................................................................... 38
  2.9 Approaches to the Research Problem ........................................ 39
  2.10 Summary ......................................................................................... 43

3.0 RESEARCH METHODOLOGY .............................................................. 44
  3.1 Introduction ...................................................................................... 44
  3.2 Research Design ............................................................................... 44
    3.2.1 Research philosophy............................................................. 46
    3.2.2 Research approach ................................................................ 46
    3.2.3 Choice of survey approach ................................................... 47
    3.2.4 Research technique ............................................................... 48
  3.3 The Delphi Technique ...................................................................... 49
    3.3.1 An overview ........................................................................ 49
    3.3.2 Delphi method design considerations.................................... 51
    3.3.3 Research sample ................................................................... 52
  3.4 Research Process .............................................................................. 54
  3.5 Data Collection ................................................................................. 56
    3.5.1 Delphi round one design ...................................................... 56
    3.5.2 Delphi round one survey and analysis ................................. 56
    3.5.3 Delphi round two design ...................................................... 57
    3.5.4 Delphi round two survey and analysis ................................. 58
    3.5.5 Delphi round three design .................................................... 60
    3.5.6 Delphi round three survey and analysis ............................... 61
    3.5.7 Case studies ......................................................................... 61
  3.6 Summary ........................................................................................... 61
4.0 RESULTS AND DATA ANALYSIS ................................................................. 62
4.1 Introduction .................................................................................................. 62
4.2 Result and Analysis of Delphi Round One .................................................. 62
  4.2.1 Round one; Part I – Risk factors prevalent in the different phases of the project life cycle ............................................... 62
  4.2.2 Round one; Part II – Risk response measures ................................. 64
  4.2.3 Summary; round one ............................................................... 65
4.3 Results and Analysis of Delphi Round Two ............................................. 65
  4.3.1 Round two; Part I – Calculation of severity of risk at each stage........................................................... 65
    4.3.1.1 Severe risk factors at the conceptual stage ............. 68
    4.3.1.2 Severe risk factors at the design stage ................. 70
    4.3.1.3 Severe Risk Factors at the Construction Stage ....... 71
    4.3.1.4 Severe Risk Factors at the Operation Stage ......... 76
  4.3.2 Round 2; Part II- Risk response measures at each phase by contracting parties ........................................................... 78
    4.3.2.1 Response measures at the conceptual stage .......... 78
    4.3.2.2 Response measures at the design stage ............... 79
    4.3.2.3 Response measures at the construction stage ...... 80
    4.3.2.4 Response measures at the operation stage.............. 83
  4.3.3 Round 2; Part III - Risk allocation among contracting parties ........................................................... 83
  4.3.4 Round 2; Part IV- Identification of barriers to implementing risk response measures and solutions .............. 85
  4.3.5 Summary: Round two ............................................................... 87
4.4 Results and Analysis of Delphi Round 3 .................................................. 87
  4.4.1 Round 3; Part I- Risk allocation to client/ consultants and contractors........................................................... 87
  4.4.2 Round 3; Part II- Barriers and upgraded solutions to current risk management practice ...................................................... 91
    4.4.2.1 Barriers and upgraded solutions at the conceptual stage ........................................................... 91
    4.4.2.2 Barriers at the design stage ........................................................... 92
Appendix 7 : Circulation of Severity Index and Weighted Mean Rating (Wmr) ................................................................. 170
Appendix 8 : Risk Allocation among Contracting Parties ............... 171
Appendix 9 : Percentage of Risk Allocation among Contracting Parties at each Phase of Project Life Cycle ............... 173
Appendix 10 : Details of Projects Used as Case Studies .................. 174
Appendix 11 : Review of Case Studies ......................................... 176
Appendix 12 : Publications of Researcher ...................................... 177
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Decision making spectrum</td>
<td>08</td>
</tr>
<tr>
<td>2.2</td>
<td>Risk management process</td>
<td>17</td>
</tr>
<tr>
<td>2.3</td>
<td>Risk identification process framework</td>
<td>19</td>
</tr>
<tr>
<td>2.4</td>
<td>Risk analysis</td>
<td>24</td>
</tr>
<tr>
<td>2.5</td>
<td>Spectrum of risks in construction</td>
<td>31</td>
</tr>
<tr>
<td>3.1</td>
<td>Research methodology illustration</td>
<td>45</td>
</tr>
<tr>
<td>3.2</td>
<td>Nested research methodology</td>
<td>45</td>
</tr>
<tr>
<td>3.3</td>
<td>Research process</td>
<td>55</td>
</tr>
<tr>
<td>4.1</td>
<td>Risk factors vs occurrence and impact at the conceptual stage</td>
<td>68</td>
</tr>
<tr>
<td>4.2</td>
<td>Severity of risk at the conceptual stage</td>
<td>69</td>
</tr>
<tr>
<td>4.3</td>
<td>Risk factors vs occurrence and impact at the design stage</td>
<td>70</td>
</tr>
<tr>
<td>4.4</td>
<td>Severity of risk at design stage</td>
<td>70</td>
</tr>
<tr>
<td>4.5</td>
<td>Risk factors vs occurrence and impact at the construction stage</td>
<td>72</td>
</tr>
<tr>
<td>4.6</td>
<td>Severity of risk at the construction stage</td>
<td>72</td>
</tr>
<tr>
<td>4.7</td>
<td>Risk factors vs occurrence and impact at the operation stage</td>
<td>76</td>
</tr>
<tr>
<td>4.8</td>
<td>Severity of the risk at the operation stage</td>
<td>77</td>
</tr>
<tr>
<td>4.9</td>
<td>Risk Management Model for Road Construction- Part I</td>
<td>103</td>
</tr>
<tr>
<td>4.10</td>
<td>Risk Management Model for Road Construction- Part II</td>
<td>104</td>
</tr>
<tr>
<td>4.11</td>
<td>Risk Management Model for Road Construction- Part III</td>
<td>105</td>
</tr>
</tbody>
</table>
LIST OF TABLES

Table 2.1 : The risk-uncertainty continuum ................................................. 09
Table 2.2 : Government investment on infrastructure ................................. 37
Table 2.3 : Ten-year development framework of the government:
                2006-2016 ................................................................................... 37
Table 3.1 : Variety and mix of experts ......................................................... 54
Table 4.1 : Risk factors prevalent in each phase of the project
                lifecycle ...................................................................................... 63
Table 4.2 : Risk response measures .............................................................. 64
Table 4.3 : Severe risk factors at each phase of the project life cycle ......... 66
Table 4.4 : Response measures at the conceptual stage by contracting
                parties ......................................................................................... 78
Table 4.5 : Response measures at the design stage by contracting
                parties ......................................................................................... 79
Table 4.6 : Response measures at the construction stage by contracting
                parties ......................................................................................... 81
Table 4.7 : Response measures at the operation stage by contracting
                parties ......................................................................................... 83
Table 4.8 : Risk allocation at each phase of the project life cycle
                among contracting parties ........................................................... 84
Table 4.9 : Barriers to risk response measures ........................................... 86
Table 4.10 : Solutions to overcome barriers to risk response measures ....... 86
Table 4.11 : Percentage of risk allocation among contracting parties at
                each phase of the project lifecycle .................................................. 88
Table 4.12 : Barriers and solutions at the conceptual stage ......................... 91
Table 4.13 : Barriers and solutions at the design stage ............................... 92
Table 4.14 : Barriers and solutions at the construction stage ...................... 94
Table 4.15 : Barriers and solutions at the operation stage ........................... 97
Table 4.16 : Model on risk factors ............................................................... 100
Table 4.17 : Model on response measures .................................................. 101
Table 4.18: Model on barriers to risk management .............................. 101
Table 4.19: Model on solutions to risk management .............................. 102
Table 4.20: Review of case-studies: Matching the results of case-studies with model ............................................................... 107
LIST OF ABBREVIATIONS

BOQ  -  Bills of Quantities
CEB  -  Ceylon Electricity Board
km   -  kilo meter
MWR  -  Mean Weighted Rating
NWSDB - National Water Supply and Drainage Board
RDA  -  Road Development Authority
SLT  -  Sri Lanka Telecom
PMI  -  Project Management Institute
ICE  -  Institute of Civil Engineers
CIDA - Construction Industry Development Agency

University of Moratuwa, Sri Lanka. Electronic Theses & Dissertations
www.lib.mrt.ac.lk