

**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)



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

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

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



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

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.



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

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




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

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



4.4.2.3	Barriers and upgraded solutions at the construction stage	93
4.4.2.4	Barriers and upgraded solutions at the operation stage	97
4.4.3	Summary; Round three	97
4.5	Risk Management Model for Road Construction Projects.....	97
4.5.1	Objectives of the model.....	98
4.5.2	Development of the model	98
4.5.3	Use of the model.....	106
4.5.4	Model Evaluation	106
4.6	Summary	108
5.0	CONCLUSIONS, RECOMMENDATIONS, LIMITATIONS AND PATHWAYS TO FURTHER DEVELOPMENT	109
5.1	Conclusions	109
5.2	Recommendations	112
5.3	Limitations	113
	 Difficulties in conducting three rounds of the Delphi Survey	113
	5.3.2 Difficulties in conducting case studies.....	114
	5.3.3 Limitations to model development.....	114
5.4	Further Research	115
Reference	116
Appendix 1	: Research Paper	136
Appendix 2	: Delphi Round One Questionnaire	150
Appendix 3	: Delphi Round Two Questionnaire	153
Appendix 4	: Calculation of Cronbach's Alpha	161
Appendix 5	: Delphi Round Three Questionnaire	162
Appendix 6	: Risk Factors Prevailing at Phases of the Project Life Cycle	169

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



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

LIST OF FIGURES

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

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



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

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