IDENTIFICATION AND MODELLING OF RISK FACTORS, MITIGATION MEASURES, AND ENTRY STRATEGIES FOR INDIAN CONSTRUCTION FIRMS IN INTERNATIONAL MARKET

SATISH KUMAR V

DEPARTMENT OF CIVIL ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY DELHI
OCTOBER 2019

IDENTIFICATION AND MODELLING OF RISK FACTORS, MITIGATION MEASURES, AND ENTRY STRATEGIES FOR INDIAN CONSTRUCTION FIRMS IN INTERNATIONAL MARKET

by

SATISH KUMAR V
Department of Civil Engineering

Submitted
In fulfilment of the requirements of the degree of Doctor of Philosophy

to the

INDIAN INSTITUTE OF TECHNOLOGY DELHI
OCTOBER 2019

Dedicated to Malai Murugar, Teachers,

Family and Friends...

CERTIFICATE

This is to certify that the thesis entitled "**Identification and Modelling of Risk Factors, Mitigation Measures, and Entry Strategies for Indian Construction Firms in International Market"**, being submitted by **Mr. Satish Kumar V** to the Indian Institute of Technology Delhi for the award of the degree of **Doctor of Philosophy** is a bonafide record of the research work carried out by him under my supervision and guidance. The thesis work, in my opinion, has reached the requisite standard, fulfilling the requirements for the degree of Doctor of Philosophy.

The contents of this thesis, in full or in parts, have not been submitted to any other University or Institute for the award of any degree or diploma.

Prof. Kumar Neeraj Jha
Department of Civil Engineering
Indian Institute of Technology Delhi
New Delhi 110016
India

ACKNOWLEDGEMENTS

Firstly and foremost, I would like to thank God for guiding and helping me to complete this thesis at its best.

I would like to extend my sincere gratitude to my guide Prof. K. N. Jha, Department of Civil Engineering, IIT Delhi, for his constant support, encouragement, consistent, inspiring guidance and utmost cooperation at every stage throughout the duration of the study. It was a highly educative and memorable experience working under his supervision.

I am thankful to my student research committee members, Prof. Geetam Tewari and Dr. Uma Maheswari of Department of Civil Engineering, IIT Delhi, and Prof. Ravi Shankar, Department of Management Studies, IIT Delhi, for providing me with their valuable inputs throughout my study.

I wish to take this opportunity to extend my sincere thanks to Prof A. K. Jain and Prof R. Ayothiraman, and other faculty and staff members of the Department of Civil Engineering, IIT Delhi, for all possible help and guidance rendered by them in my work.

As is the case with any empirical research, the respondents and interviewees played a major role in providing me with significant inputs. I am grateful to all the respondents and interviewees who contributed by filling in the questionnaire, sparing their valuable time and giving insight into my research problem.

I am very much indebted to Shri. Pradeep Aggarwal, former Chief Engineer, DCSEM, Department of Atomic Energy, Government of India, without whom my

doctoral research would have never seen the light of the day. My sincere thanks to all other office colleagues, especially Shri. Anshuman Shukla, Shri. Sunil Kumar, and Shri. Alock Saxena.

I have earned many good souls as friends during these years in IIT Delhi In particular, I cherish the moments spent with Sathiyaseelan, Sathish (Kuttan), Dr. Karthikeyan, Dr. Praveen, Dr. MuthuKumar, Dr. Barani, Sathish (Officer), Durai, Dr. Ramamoorthy, Rajkumar, Lingesh, Thirumalai, Jayamoorthy, Jose, Dr. Premnath and Dr. Arun. I sincerely acknowledge my lovely brothers Sathiyaseelan and Sathish, as they have always considered me as one in their family. Special thanks to Mrs. Kanimozhi Sathiyaseelan for her unconditional care during my thesis writing phase.

I thank my research group colleagues and friends Dr. Dilip Patel, Dr. Amit Chandra, Dr. Gayatri Vyas, Dr. K.K. Tripati, Dr. Prachi K Sohoni, Harsh Raghuvanshi, Ajit K. Sinha, Dr. Abhilasha Panwar, Sparsh Johari, Santu Kar, Rouzbeh and Fekreyesus with whom I have spent a lot of time in technical discussions at various stages of my research. A special thanks to Mr. Randeer Jha for his co-operation extended during my entire IITD tenure.

I would like to extend my deepest gratitude to my parents, brother and his family, and in-laws for their constant support and encouragement throughout the course of study. I wholeheartedly thank my loving wife Dr. Smitha, daughter Akshayaa and son Avneesh for their unconditional love and cooperation, without which this study would not have been possible at all.

SATISH KUMAR V

ABSTRACT

International construction projects comprise many risks, and it is essential to evaluate and manage them effectively for achieving project success. As the approach towards addressing risks in international market varies from country to country, this study has focused on identifying critical risk factors, risk mitigation measures and their influence on project performance criteria in international construction projects based on Indian experiences. To achieve this, 26 risk variables and nine risk mitigation measures were identified through a literature review. After verifying the risk variables and mitigation measures with a preliminary study, a questionnaire survey was conducted to draw the views of 105 experts who possess international project experience. The collected data were analysed using univariate and multivariate techniques. Through ANOVA, significant risk variables influencing the different project performance criteria were identified for international construction projects. Subsequently, these risk variables were grouped based on their underlying relation called (called "risk factors") factors using factor analysis. Further, a stepwise regression analysis was carried out to recognise the critical risk factors that influence different project performance criteria. In order to examine the risk mitigation measures and their influence on project performance criteria and the identified risk factors, hypothesised models were generated and examined using structural equation modelling (SEM) and the conclusions were drawn.

In addition to effective risk management, a suitable market strategy is a key element in the internationalisation of firms. Though studies on international market strategy have been widely carried out in the past for manufacturing, banking, and other sectors, there has been little attention towards the construction industry, particularly for

firms from developing countries like India. Two prime aspects of the international market strategy are market selection and entry modes. In this study, an attempt was made to identify the important factors that influence the international market selection by examining the market entry choices of 29 international construction firms of Indian origin across 106 countries. To achieve this, a total of six hypotheses were developed and tested on the basis of the predictive capacity of the logistic regression analysis.

Similar to market selection, entry mode selection is one of the critical decisions in construction firms' international market entry strategies. In the course of internationalization, rather than focusing on a single entry mode, it is essential for entrants to syndicate or sequence various entry modes to ensure their sustainable growth. In this study, after verifying the nine most commonly adopted international entry modes in the construction sector, an entry mode sequencing model is developed by drawing on experts' opinions and using the interpretative structural modelling (ISM) method. In addition, an impact matrix cross-reference multiplication applied to a classification (MICMAC) analysis is performed to identify the interrelationships of the entry modes by examining the dependency and driving power of these modes. Lastly, a framework for the firms to select a potential developing infrastructure market is presented based on the host country's factors, which can be valuable information for the practitioners and international market aspirants.

सार

अंतर्राष्ट्रीय निर्माण परियोजनाओं में कई जोखिम शामिल हैं, और परियोजनाओं की सफलता प्राप्त करने के लिए उनका प्रभावी ढंग से मूल्यांकन और प्रबंधन करना आवश्यक है। अंतर्राष्ट्रीय बाजार में जोखिमों को संबोधित करने का दृष्टिकोण एक देश से दूसरे देश में भिन्न होता है, इस अध्ययन ने भारतीय अनुभवों के आधार पर अंतर्राष्ट्रीय निर्माण परियोजनाओं में महत्वपूर्ण जोखिम कारकों, जोखिम शमन उपायों और परियोजना प्रदर्शन मानदंडों पर उनके प्रभाव की पहचान करने पर ध्यान केंद्रित किया है। इसे प्राप्त करने के लिए, एक साहित्य समीक्षा के माध्यम से 26 जोखिम कारक और नौ जोखिम शमन उपायों की पहचान की गई थी। प्रारंभिक अध्ययन से जोखिम कारक और शमन उपायों की पुष्टि करने के बाद, अंतर्राष्ट्रीय परियोजना अनुभव रखने वाले 105 विशेषज्ञों के विचारों को व्यक्त करने के लिए एक प्रश्नावली सर्वेक्षण किया गया था। एकत्रित आंकड़ों का विश्लेषण यूनीवेरेट और मल्टीवेरेट तकनीकों का उपयोग करके किया गया था। एनोवा के माध्यम से, अंतर्राष्ट्रीय निर्माण परियोजनाओं के लिए विभिन्न परियोजना प्रदर्शन मानदंडों को प्रभावित करने वाले महत्वपूर्ण जोखिम कारकों की पहचान की गई थी। इसके बाद, इन जोखिम कारकों को कारक-विश्लेषण का उपयोग करके उनके अंतर्निहित संबंध ("जोखिम कारक") कारकों के आधार पर समूहीकृत किया गया। इसके अलावा, विभिन्न जोखिम कारकों को पहचानने के लिए एक स्टेपवाइज-रिग्रेशन-विश्लेषण किया गया, जो विभिन्न परियोजना प्रदर्शन मानदंडों को प्रभावित करता है। जोखिम शमन उपायों और परियोजना के प्रदर्शन मानदंड और पहचाने गए जोखिम कारकों पर उनके प्रभाव की जांच करने के लिए, संरचनात्मक समीकरण मॉडलिंग (एसईएम) का उपयोग करके परिकल्पित मॉडल उत्पन्न और जांच किए गए थे और निष्कर्ष निकाले गए थे।

प्रभावी जोखिम प्रबंधन के अलावा, फर्मों के अंतर्राष्ट्रीयकरण में एक उपयुक्त बाजार रणनीति एक प्रमुख तत्व है। हालांकि विनिर्माण, बैंकिंग और अन्य क्षेत्रों के लिए अंतर्राष्ट्रीय बाजार की रणनीति पर अध्ययन व्यापक रूप से किया गया है, विशेष रूप से भारत जैसे विकासशील देशों की फर्मों के लिए, निर्माण उद्योग की ओर बहुत कम ध्यान दिया गया है। अंतरराष्ट्रीय बाजार की रणनीति के दो प्रमुख पहलू बाजार चयन और प्रवेश विकल्प हैं। इस अध्ययन में, 106 देशों में भारतीय मूल के 29 अंतर्राष्ट्रीय निर्माण

फर्मों के बाजार प्रवेश विकल्पों की जांच करके अंतर्राष्ट्रीय बाजार चयन को प्रभावित करने वाले महत्वपूर्ण कारकों की पहचान करने का प्रयास किया गया था। इसे प्राप्त करने के लिए, लॉजिस्टिक-रिग्रेशन-विश्लेषण की भविष्यवाणी क्षमता के आधार पर कुल छह परिकल्पनाओं का विकास और परीक्षण किया गया।

बाजार चयन के समान, प्रवेश विकल्प का चयन निर्माण फर्मों के अंतर्राष्ट्रीय बाजार में प्रवेश की रणनीतियों में महत्वपूर्ण निर्णयों में से एक है। अंतर्राष्ट्रीयकरण के दौरान, एकल प्रविष्टि विकल्प पर ध्यान केंद्रित करने के बजाय, उनके स्थायी विकास को सुनिश्चित करने के लिए प्रवेशकों को सिंडिकेट या विभिन्न प्रवेश विकल्पों को अनुक्रमित करना आवश्यक है। इस अध्ययन में, निर्माण क्षेत्र के नौ सबसे सामान्य रूप से अपनाए गए अंतर्राष्ट्रीय प्रवेश विकल्पों की पुष्टि करने के बाद, विशेषज्ञों की राय पर ड्राइंग और व्याख्यात्मक संरचनात्मक मॉडलिंग (आईएसएम) विधि का उपयोग करके एक प्रवेश-विकल्प अनुक्रमण मॉडल विकसित किया है। इसके अलावा, एक प्रभाव मैट्रिक्स क्रॉस-रेफरेंस गुणा एक वर्गीकरण (मिकमैक) विश्लेषण के लिए लागू किया जाता है, इन्हे विकल्पों की निर्भरता और ड्राइविंग शक्ति की जांच करके प्रवेश विकल्पों के अंतर्संबंधों की पहचान करने के लिए किया जाता है। अंत में, फर्मों के लिए देश के कारकों के आधार पर एक संभावित विकासशील बुनियादी मेजबान बाजार का चयन करने के लिए एक फ्रेमवर्क प्रस्तुत किया जाता है, जो सलाहकार और अंतर्राष्ट्रीय बाजार के उम्मीदवारों के लिए बहुमूल्य जानकारी हो सकती है।

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

AAA	Adaptation, Aggregation, and Arbitrage
ARCOM	Association of Researchers in Construction Management
AVOVA	An Analysis of Variance
BHEL	Bharat Heavy Electricals Limited
BIM	Building Information Modelling
BO	Branch Office
BOT	Built, Operate and Transfer
BSPD	Barrel per Stream Day
CEPII	Centre d'Études Prospectives et d'Informations Internationales
CFI	Comparative Fit Index
EIL	Engineers India Limited
ENR	Engineering News-Record
EPC	Engineering, Procurement and Construction
EPCM	Engineering, Procurement, Construction Management
EPI	Engineers Projects (India) Limited
EXIM	Export-Import Bank of India
FY	Financial Year
GAIL	Gas Authority of India Limited
GDP	Gross Domestic Product
GOF	Goodness of Fit
HCC	Hindustan Construction Company
IFI	Incremental Fit Index
IMS	International Market Selection
IRCON	Indian Railway Construction Company

ISM	Interpretive Structural Modelling
JV	Joint Venture
JVC	Joint Venture Company
JVP	Joint Venture Project
KMO	Kaiser–Meyer–Olkin
L&T	Larsen and Toubro
LA	Local Agent
LISREL	Linear Structural Relations
LLC	Limited Liability Company
MENA	Middle East and North Africa
MICMAC	Impact Matrix Cross-Reference Multiplication Applied to a Classification
MLE	Maximum Likelihood Estimation
MMTPA	Million Metric Tonne Per Annum
MW	Megawatt
NBCC	National Building Construction Company
NHPC	National Hydroelectric Power Corporation
NPP	Nuclear Power Plant
PEPC	Project Exports Promotion Council of India
PMC	Project Management Consultant
RITES	Rail India Technical and Economic Service
RMSEA	Root Mean Square Error of Approximation
RO	Representative Office
S&P	Standard and Poor's
SA	Strategic Alliance
SE	Standard Error

SEM	Structural Equation Modelling
SPINT	Shapoorji Pallonji International
SPSS	Statistical Package for the Social Sciences
SSIM	Structural Self-Interaction Matrix
SV	Sole Venture
SVC	Sole Venture Company
SVP	Sole Venture Project
SWOT	Strength, Weakness, Opportunity, and Threat
TLI	Tucker–Lewis index
TPA	Tonne Per Annum
VIF	Variance Inflation Factor
WLL	With Limited Liability