MEGAPROJECT RISK ANALYSIS AND SIMULATION: A DYNAMIC SYSTEMS APPROACH

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Abbreviations

ANP	Analytical Network Process
AHP	Analytic Hierarchical Process
BBS	Bilfinger Berger Civil (UK) and Siemens plc
CEC	City of Edinburgh Council
CDR	Cost of Dispute Resolution
CDUD	Cost of Delay in Utility Diversion
CI	Consistency Index
CLA	Cost of Legal Action
CLD	Causal Loop Diagram
COD	Cost of Delays
COR	Cost of Rework
CR	Consistency Ratio
DEG	De-Escalation to Grievances
Disp.	Disputes
DOAF	Delay of All Forms
DOC	Delay in Obtaining Consent
EC	Economic Certainties
E*c*RM	Economic Risks Model
ETN	Edinburgh Tram Network (Project)
EG	Escalation to Grievances
EnC	Environmental Certainties
EnR	Environmental Risks
EnRE	Environmental Regulation Enforcement
EnRM	Environmental Risks Model
EnU	Environmental Uncertainties
EP	Energy Price
EPC	Engineering, Procurement and Construction
EPCO	Escalation to Project Cost Overrun
EPTO	Escalation to Project Time Overrun

ER	Economic Risks
ERM	Environmental Resource Management
ErG	Error Generation
EU	Economic Uncertainties
FE	Foreign Exchange
GCP	Ground Conditions Problem at a Given Site
GFP	Government Funding Policy
IPV	Ideal Priority Value
LA	Legal Actions
LD	Liquidated Damages
LIR	Local Inflation Rate
LRC	Legislative & Regulation Changes
IRPI	Ideal Synthesized Risk Priority Indexes
IRPV	Ideal Risk Priority Index
MCDM	Multi-Criterion Decision Making
MLDMBI	Multi-Level Decision-Making Bodies Involvement
MP	Material Price
MPDS	Modification to Project Design & Specification
MPH	Material Price Hike
MUDFA	Multi-Utilities Framework Agreement
NPV	Normal Priority Value
O&M	Operations and Maintenance
PA	Social Acceptability
PC	Political Certainties
PDP	Political Debates on the Project
PH	Political Harmony
PI	Political Indecision
PIP	Political Interferences in the Project
PMPS	Pressure to Modify Project Scope
P*o*RM	Political Risks Model
PQD	Project Quality Deficiency
PR	Political Risks
Proj.C	Project Complexity
PS	Political Support

Proj.S	Project Scope
PT	Project Termination
PU	Political Uncertainties
RMSI	Respondent's Mean Scores of Importance
RPCO	Risks of Project Cost Overrun
RPI	Risk Prioritization Index
RPIG	Global Risks Priority Index
RPIL	Local Risk Priority Index
RPTO	Risks of Project Time Overrun
SC	Social Certainties
SD	System dynamics
SFM	Stock and Flow Model
SG	Social Grievances
SI	Social Issues
S*o*RM	Social Risks Model
SPV	Special Purpose Vehicle
SR	Social Risks
SU	Social Uncertainties
TC	Technical Certainties
TDUU	Time to Divert Underground Utilities
T*e*RM	Technical Risks Model
TIE	Transport Initiatives Edinburgh Ltd.
TPAS	Threat to Personal & Asset Security
TPV	Total Priority Value
TR	Technical Risks
TRO	Traffic Regulation Order
TRPI	Total Risk Priority Index
TU	Technical Uncertainties
WCP	Worksite Coordination Problems
WQS	Weighted Quantitative Score
WI	Wage Inflation

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Preface

This book provides technical details on a dynamic systems approach to megaproject risk analysis and simulation, and it is based on the authors' long-term research into megaproject management, multi-criteria decision making, and system dynamics. For the first time, the authors have attempted to find a technical solution to tackle overruns on cost and time in megaprojects, and this is based on a comprehensive set of risks associated with social, technical, economic, environmental and political (STEEP) issues in megaproject environment and a dynamic systems approach called SDANP. The approach is an integrated use of tools including analytic network process (ANP) and system dynamics (SD) for risks prioritization and simulation.

The new SDANP model is described in this book with a case study on the Edinburgh Tram Network (ETN) project, which was a live case project during the time of the authors' research into a dynamic systems approach to megaproject risk analysis and simulation. Through this experimental research, the SDANP model has provided interesting results on cost and time overruns with accuracy rates above 80%, respectively, for the ETN project over the time period between 2007 and 2013. The authors expect that this dynamic systems approach to megaproject risk analysis and simulation can be widely tested for the benefits of stakeholders in dealing with cost and time overruns in megaproject development.

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Foreword

As our journey into the uncertainties of the twenty-first century continues, of one thing we can be sure: megaprojects are viewed as increasingly important in creating solutions to societal problems. Megaprojects will provide the new power plants that will give us with green energy, they will deliver transport systems that work for all without increasing carbon emissions, they will provide us with the integrated hospitals and healthcare that we need and they will even delight us with cultural and sporting events! We remain optimistic that the huge complexities of megaprojects in people, capital and technology can be tamed and we can look forward to feeling the benefits of their successful implementations.

However, at their heart, megaprojects pose a conundrum. Time after time (and despite their apparent benefits) we do not seem to be able to deliver them on time, to budget and actually producing the output functionality that we need. We only have vague ideas why some succeed and, where they fail, we discover worryingly psychological failings in their planning and design. Given their importance in facing twenty-first century challenges, we desperately need to undertake more research to help us deliver megaprojects more effectively and to insure that the results of that research are available to the widest possible population of stakeholders.

It is precisely this gap that Boateng, Chen and Ogunlana have aimed at with the work that they report upon in this book. They take one of the most clearly identified complexities in delivering megaproject, namely risk, and explore new ways of conceptualizing it and dealing with it. They employ a wide range of novel systems dynamics and frameworks to develop an understanding of risk in megaprojects. They provide interesting applications of techniques used elsewhere in simulation to megaprojects. They illustrate their work with an insightful case of the Edinburgh Tram Project, a megaproject which embodies both the huge benefits that megaprojects can bring and the significant issues that inhibit their delivery. Boateng, Chen and Ogunlana are to be congratulated for the zeal with which they have pursued their research objectives and their fervour to share the results of their endeavours with others.

This book provides a valuable addition to the work currently being undertaken by academics and practitioners alike in understanding megaproject design and delivery. It is through such committed work that we

really will be able to tame megaprojects and insure that they can reliably deliver the outcomes that society so desperately needs.

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