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A Simulation-Optimisation-Based Decision Support System for Optimising Project Risk Treatment Decisions Considering Risk Interdependencies

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Abstract

The growing complexity of contemporary projects increases the chance that project risks with different natures are interrelated through complex cause-effect relationships. However, the effects of risk interdependencies and dynamic risk propagations are often ignored in previous project risk management studies, leading to inconsistent risk assessment results with engineering practice and reduced efficacy of risk treatment actions. This research proposes an intelligent decision support system (DSS) to determine an effective portfolio of risk treatment actions by considering complex risk interdependencies and project resource constraints. First, a hierarchical project risk interdependency network (RIN) is developed systematically based on the interpretive structural modelling process, where all possible cause-effect interdependencies among project risks are presented. Then, a Monte Carlo simulation (MCS)-based RIN model is devised to prioritise project risks and evaluate the overall project risk level, where the stochastic behaviour of risk occurrence and risk propagation effects within a project RIN are captured. Subsequently, a bi-objective risk treatment optimisation model is proposed considering limited project resources, aiming to minimise not only the project loss due to risk but also the risk treatment cost. To obtain a set of Pareto-optimal risk treatment solutions, the non-dominated sorting genetic algorithm II is tailored by integrating with the MCS-based RIN model. A case study is provided to demonstrate the feasibility of the proposed DSS for project risk treatment decision-making. The findings from this work help project decision-makers allocate risk treatment budgets more appropriately and determine the most effective risk treatment solution corresponding to their risk attitudes.

Keywords

Risk interdependency, Risk treatment, Interpretive structural modelling, Monte Carlo simulation, and Non-dominated sorting genetic algorithm II.

Biographies

Li Guan is currently Postdoctoral Research Fellow at the School of Computer Science, Faculty of Engineering and Information Technology, University of Technology Sydney (UTS), Australia. Before joining UTS, she was Research Associate with 'The Decision Support and Analytics Research Group' at the School of Systems and Computing, University of New South Wales (UNSW), Canberra, Australia. She obtained her Ph.D. degree in Project Management from UNSW Sydney in 2022. She has several publications in international top-tier journals in the decision-making domain, such as *Decision Support Systems*, *Journal of Cleaner Production*, and *Journal of Civil Engineering and Management*. Her current research interests include risk management, computational intelligence, decision-making,

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Ripon K. Chakrabortty is Lecturer in Systems Engineering & Decision Analytics at the School of Systems and Computing, University of New South Wales (UNSW), Canberra, Australia. He is experienced in "Artificial Intelligence in Decision-Making for Complex Systems". His research interest covers a wide range of topics in decision analytics, applied artificial intelligence, and applied optimisation in the "Project Scheduling and Supply Chain Management" domains. He is the team leader and founder of 'The Decision Support and Analytics Research Group' at the School of Systems and Computing, UNSW Canberra, Australia. He has written three authored books, two book chapters, and over 160 technical journal and conference papers in prestigious venues. He coordinates three master's programs simultaneously, i.e., Master of Decision Analytics, Master of Engineering Science, and Master of Project Management at UNSW Canberra. Many organisations, such as the Department of Defence and the Commonwealth Government of Australia, have funded his research programs.

Alireza Abbasi is Senior Lecturer and Coordinator of Project Management programs at the School of Systems and Computing, University of New South Wales (UNSW), Canberra, Australia. He obtained his Ph.D. degree in Project Management from the University of Sydney in 2012 before joining UNSW Canberra. He also holds a graduate certificate in University Learning and Teaching from UNSW Sydney. His research and teaching interests include project management, management science, information systems management and network science. He has written a book, three book chapters and over 120 technical journal and conference papers. He has had several appointments and been involved in different projects in IT/Software, Oil, Education and R&D sectors. He is an active member of several professional bodies including Australian Institute of Project Management (AIPM), Project Management Institute (PMI), and Australian and New Zealand Academy of Management (ANZAM).