Robust Intelligent Scenario Planning for Industrial Systems

This Thesis is presented for the degree of
Doctor of Philosophy in Engineering

By

Sorousha Moayer

B.E. (Industrial Engineering), 2002
M.Sc. (Information Technology Management), 2005

School of Engineering and Energy
Murdoch University, Perth, Western Australia

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Declaration

I declare that this thesis is my own account of my research and contains, as its main content, work which has not previously been submitted for a degree at any tertiary education institution.

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Sorousha Moayer

Abstract

Uncertainty about the future significantly impacts on the planning capacities of organisations. Scenario planning provides such organisations with an opportunity to be aware of the consequences of their future plans. By developing plausible scenarios, scenario planning methodologies assist decision-makers to make systematic and effective decisions for the future. This research aims to review existing scenario planning methodologies and develop a new framework to overcome the shortcomings of previous methodologies. The new framework has two major phases: a 'scenario generation phase' and an 'intelligent robust optimisation phase'. The scenario generation phase creates future scenarios by applying fuzzy logic and Artificial Neural Network (ANN) concepts. With these concepts, it is possible to deal with qualitative data and also learn from expert data. The intelligent robust optimisation phase identifies the best strategic option which is suitable for working with the most probable scenarios. This second phase includes fuzzy programming and robust optimisation methods to deal with uncertain and qualitative data which usually exists in generated scenarios. The case study for this thesis focuses on Western Australia's power capacity expansion needs and demonstrates the application of this new methodology in managing the uncertainties associated with future electricity demand. Scenarios which are generated based on different future population trends and industrial growth are used as the basis of determining the best strategic option for the expansion in WA's electricity industry. Furthermore, transition to renewable energy and technological constraints for WA's electricity industry are considered in the proposed framework. The result of this case study is an investment plan that satisfies WA's electricity demand growth and responds to technological and environmental constraints. The new intelligent robust scenario planning framework has the potential to deal with uncertainties in business environments and provides a strategic option that has the ability to work with plausible scenarios for the future.

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Publications[1]

Journal Publications

- Moayer, S., & Bahri, A., P. (2009). Hybrid Intelligent Scenario Generator for Business Strategic Planning by Using ANFIS. *Expert Systems with Applications Journal*, 36, 4.

- Moayer, S., & Bahri, A., P. (x). Intelligent Robust Scenario Planning framework for Power Capacity Expansion in South-West Interconnected System (SWIS), Western Australia (WA). *European Journal of Operation Research.* Under review.

- Moayer, S., & Bahri, A., P. (x). Fuzzy Robust Optimisation for Capacity Expansion Planning under Uncertainty. *Operation Research Letter.* Under review.

- Moayer, S., & Bahri, A., P. (x). A Methodology for Robust Intelligent Scenario Planning: Power System Capacity Expansion Case Study. *Computers and Operation Research Journal.* Under review.

- Moayer, S., & Bahri, A., P. (x). A Comparative Study between Qualitative and Quantitative Methodologies in Business Strategic Scenario Planning. *Futures*. Under review.

Conference Publications

- Moayer, S., & Bahri, A., P. (2008). Intelligent Robust Scenario Planning Framework for Power Capacity Expansion in South-West Interconnected System (SWIS), Western Australia (WA). *Informs Annual Meeting*. Washington D.C., USA, October, 2008.

- Moayer, S., & Bahri, A., P. (2008). A Hybrid Optimisation Method for Managing Uncertainty in Capacity Expansion Planni*ng. International Conference on Principles and Practice of Constraint Programming*. Sydney, Australia, September, 2008.

- Moayer, S., Bahri, A., P., & Nooraii, A. (2007). Adaptive Neuro-Fuzzy Inference System for Generating Scenarios in Business Strategic Planning: *IEEE International Conference on Systems, Men, and Cybernetics*. Montreal, Canada, October, 2007.

[1] Published papers are available on the attached CD.