Editorial: qualitative and quantitative methods aimed at technology management

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Abstract: A new methodology may lead to new substantive theory (or explanations), new data and new theory. This special issue focuses on 'Qualitative and quantitative methods aimed at technology management' and 12 papers reporting recent research results are preceded by a review of literature on the main topics of technology management. These 12 papers summary of insights are provided for the readers of International Journal of Technology Management.

Keywords: qualitative methodology; quantitative methodology.

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1 Introduction

As persons with professional experience in both business and academia, we have become interested in the use of management science and have participated in some of its research developments and applications in technology management and other areas. The leapfrog model of scientific progress reflects the unbalanced growth of science that can result from an advance in any one of the four components of scientific progress-theory, data, problems or methodology. A new methodology may lead to new substantive theory (or explanations) as did Newton's calculus reformulation of Galileo's 'odd integer law'

of falling bodies, which, in turn, enabled Newton to progress from pure prediction of astronomical bodies, as Kepler had previously done, to 'controlled predictions', as in his calculations of the trajectories and escape velocities needed to achieve Earth orbit. New methodology can also lead to both new data and new theory, as witness, for instance, the germ theory of disease, which could not emerge until the microscope (a methodological advance) revealed a new body of previously unobservable data (Learner and Phillips, 1993).

This special issue focuses on 'Qualitative and quantitative methods aimed at technology management' and 12 papers reporting recent research results are preceded by a review of literature on the main topics of technology management. This review is intended as an introduction to the issue. According to the topic of interest, we marshal the 12 papers and listed in Table 1. The scope of these papers is Management of technology for operations, Supplier/customer relationship management, Healthcare management, Performance measurement and management, Technology assessment, Technology and policy, Knowledge management and decision-making. The methodologies of these papers are Statistical analysis, Analytical Hierarchical Process, Logical Framework Analysis (LFA), Fuzzy Multiattribute Analysis, Case study, Bayesian Decision Analysis and Data Envelopment Analysis (DEA).

Table 1 Scope and methodology among the 12 papers

Methodology	*Scope*	*Papers*
Statistical analysis	Management of technology for operations	The Impact of Innovation Management Implementation on Enterprise Competitiveness among Taiwan's High-Tech Manufacturers
LFA	Healthcare management	Managing Healthcare Technology in Quality Management Framework
Analytical Hierarchical process	Supplier/customer relationship management	A Strategic Decision Model for the Justification of Supply Chain as a Means to Improve National Development Index
Statistical analysis	Performance measurement and management	Predicting Citations to Biotechnology Patents based on the Information from the Patent Documents
Statistical analysis	Technology assessment	The Contingency Value of Knowledge in New Product Creativities
Fuzzy Multiattribute Analysis	Technology and policy	Fuzzy Multiattribute Analysis for Evaluating Firm Technological Innovation Capability
Case study	Supplier/customer relationship management	Achieving Supply Chain Environmental Management: An Exploratory Study
Case study	Knowledge management and decision-making	Technology Management and Broadband Internet Regulation: the Case of Thailand
Bayesian Decision Analysis	Management of technology for operations	A Bayesian Decision Analysis with Fuzzy Interpretability for Aging Chronic Disease

Table 1 Scope and methodology among the 12 papers (continued)

Methodology	*Scope*	*Papers*
Statistical analysis	Management of technology for operations	Quantitative Evaluation of Building Technology
DEA	Management of technology for operations	An Application of DEA to Measure the Managerial Performance of Electronics Industry in Taiwan
Statistical analysis	Technology and policy	The Role of Directors' and Officers' Insurance in Corporate Governance–Evidence from the High-Tech Industry in Taiwan

2 Classification of the methodology

Multiple Criteria Decision Making (MCDM) aims at using a set of criteria for a decision problem. Since these criteria may vary in the degree of importance, the Analytical Hierarchial Process (AHP) methodology is employed to prioritise the selection criteria (Saaty, 1980). Conceptually, AHP is only applicable to a hierarchy that assumes a unidirectional relation between decision levels. The top level of the hierarchy (apex) is the overall goal for the decision model, which decomposes to a more specific level of elements until a level of manageable decision criteria is met (Meade and Sarkis, 1999). Yet, the strict hierarchical structure may need to be relaxed when modelling a more complicated decision problem that involves interdependencies between elements of the same cluster or different clusters. This, requires the generic analytical method 'Analytical Network Process (ANP)' that can evaluate multidirectional relationship among decision elements (Saaty, 1996). Fuzzy Multiple Attribute Decision-Making (FMADM) methods have been developed owing to the imprecision in assessing the relative importance of attributes and the performance ratings of alternatives with respect to attributes. Imprecision may arise from a variety of reasons: unquantifiable information, incomplete information, unobtainable information and partial ignorance. Conventional Multiple Attribute Decision Making (MADM) methods cannot effectively handle problems with such imprecise information. To resolve this difficulty, fuzzy set theory, first introduced by Zadeh (1965), has been used and is adopted herein. Fuzzy set theory attempts to select, prioritise or rank a finite number of courses of action by evaluating a group of predetermined criteria. Solving this problem thus requires constructing an evaluation procedure to rate and rank, in order of preference, the set of alternatives.

DEA is commonly used to evaluate the efficiency of a number of producers. A typical statistical approach is characterised as a central tendency approach and it evaluates producers relatively to an average producer. In contrast, DEA is an extreme point method and compares each producer with only the 'best' producers. By the way, in the DEA literature, a producer is usually referred to as a Decision Making Unit (DMU). Extreme point methods are not always the right tool for a problem but are appropriate in certain cases (Charnes et al., 1978). Assumption may be reasonable for only one part, while the latter assumption seems more plausible for complex human physiological systems consisting of many organs, each of which has its own failure mode.

3 Summary of the papers

In the first paper, 'The Impact of Innovation Management Implementation on Enterprise Competitiveness among Taiwan's High-Tech Manufacturers', Tien and his co-authors studied the degree of innovation implementation among domestic high-tech manufacturers and the impact of innovation management implementation on competitiveness. Results of innovation management implementation have a significant impact on competitiveness. The degree of innovation management implementation has an essential impact on the two competitiveness dimensions including technological innovation and differentiation. In the Second paper, 'Managing healthcare technology in quality management framework', Dey and his co-authors used the LFA to improve the performance of healthcare service processes and develop an integrated quality management model that integrates technology with other functional management through identifying problems, suggesting solutions, developing a framework for implementation and helping to evaluate performance dynamically.

In the third paper, 'A Strategic Decision Model for the Justification of Supply Chain as a Means to Improve National Development Index', Balan and his co-authors Modified Brown-Gibson (MBG) model is proposed by considering objective (Internal factors affecting supply chain), subjective (External factors affecting supply chain) and risk factors (Risk associated with supply chain). The subjective factor measure is performed using the rating approach of the AHP. A detailed sensitivity analysis is carried out by changing the objective factor decision weight, the priority weight of subjective factors and also by changing the gain factors. In the following paper, 'Predicting citations to biotechnology patents based on the information from the patent documents', Lin and his co-authors study is to develop a simple and robust model for predicting citations to a patent based on the information from the front page of the patent documents. This paper provides a simple regression model to predict citations to biotechnology patents from the front pages of patent documents. The model can be used as a supplementary evaluation tool in mergers and acquisitions, strategic technology planning, valuation of high-tech firms and R&D performance evaluation.

In the fifth paper, 'The Contingency value of knowledge in new product creativities', Yang uses hierarchical moderated regression to examine the impact of knowledge innovation on new product creativities in Chinese High Technology industry. The results show that the knowledge innovation – new product creativities connection is contingent on reward system, top management support, technical skills adequacy and marketing fit. The findings suggest that top management support, technical skills adequacy and marketing fit moderate the relationship between knowledge innovation and new product creativities.

In the sixth paper, 'Fuzzy Multi-Attribute Analysis for Evaluating Firm Technological Innovation Capability', Lu and his co-authors study utilise an AHP method to determine the weighting of all aspects and criteria of innovation performance. The fuzzy set theory, then is applied to make evaluators' subjective judgments and the fuzzy Multiple Attribute Decision Making (MADM) method is applied to evaluate the firm innovation performance. Finally, the aggregated fuzzy evaluation of various hi-tech. firms are ranked to determine the well-performed firm innovation.

In the seventh paper, 'Achieving supply chain environmental management: an exploratory study', Yang and Sheu use case research that involved direct observation and systematic interviews with five manufacturers, this study examines how manufacturing

firms involve various supply chain partners (e.g. suppliers, customers, peer organisations, government and community) in their environmental supply chain. The results indicate that a firm's environmental partnership should be aligned with its EM strategy. A SCEM framework is proposed for planning and monitoring the development of environmental partnership. In the eighth paper, 'Technology management and broadband internet regulation: the case of Thailand', Ayuth and David build up the proposed model and show that governments are able to manage the trade-off and create a level playing field by separately regulating internet service, broadband network and telecommunications facility. They apply the proposed model to help the National Telecommunications Commission (NTC), the telecommunications regulator of Thailand, assess Thailand's broadband internet market and develop Thailand's broadband internet licensing.

In the ninth paper, 'A Bayesian Decision Analysis with Fuzzy Interpretability for Aging Chronic Disease', Chang and Chang present ideas on the applications of fuzzy concept to decision making for aging chronic disease. A Non-Homogeneous Poisson Process (NHPP) with a power-law intensity function is used in this study. In general, classical Bayesian decision methods presume that future states of nature can be characterised as probability events. In the tenth paper, 'Quantitative evaluation of building technology', Romualdas and his co-authors describe in the literature not taking into consideration the specific character of construction industry. Some methods are intended for a wide variety of industries and therefore, can hardly be used for precise evaluation. The quantitative methods suggested in the present investigation are aimed at evaluating quantitative and qualitative aspects of enterprise production programs, depending on the applied technology.

In the 11th paper, 'An application of DEA to measure the managerial performance of electronics industry in Taiwan', Hwang uses the effectiveness model to measure the relative managerial performance and performance change of 50 listed corporations of the electronics industry under multiple financial ratio criteria. Based on the measurement of managerial performance, the entire industry can be partitioned into six clusters. Effective management strategies are developed specifically to each of six clusters of electronics industry.

In the 12th paper, 'The Role of Directors' and Officers' Insurance in Corporate Governance-Evidence from the High-Tech Industry in Taiwan', Lu and Horng use coefficient, descriptive statistics and means difference to examine the role of Directors' and Officers' insurance in corporate governance of 292 publicly-listed high-tech companies in Taiwan.

Acknowledgement

The author thank the reviewers for their candid and strict but friendly comments to improve the quality of the contributions. Most of all, we appreciate all the authors' efforts in making this special issue a precious publication. Finally, we would like to thank Dr. Dorgham and the Publisher, for inviting me to guest-edit this special issue and for creating the opportunity to publish a journal.

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