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A network hierarchical feedback system for Taiwanese universities based on the integration of total quality management and innovation

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ABSTRACT

An increasing number of Taiwanese universities are improving operational performance through innovation and total quality management (TQM). In addition, the National Quality Award (NQA), which is based on TQM, is now used to evaluate quality performance in various industries in Taiwan. Thus, several models for performance measurement have been proposed in recent years. However, these models do not take into account several features germane to performance within the Taiwanese university system, such as characteristics unique to the integration of TQM and innovation, comprehensive focuses in operational performance improvement across different types of universities, and interrelations among the different variables used to measure performance. Thus, precisely measuring and improving operation performance has proven to be a difficult task. The aim of this paper is to construct a network hierarchical feedback system (NHFS) based on the integration of TQM and innovation to overcome these problems. To that end, we adopted a decision-making trial and evaluation laboratory (DEMATEL) method to address the complex, interdependent relationships among the variables and thereby construct a relation structure among the measurement criteria for evaluation purposes. A fuzzy analytic network process (FANP) is employed to overcome the problem of dependence and feedback among each of the TQM measurement criteria. A fuzzy analytic hierarchical process (FAHP) is used to evaluate the measurement criteria for innovation performance. Lastly, a gray relational analysis (GRA) is utilized to find optimal alternatives. The value of this study comes from providing all types of universities in Taiwan the most complete evaluation system of operational performance, as well as opportunities to realize improved competitive advantages and enhanced prospects for survival.

1. Introduction

A country's higher education system fosters high-tech talent, which is the key contributor to rising national quality and one of the main ways to upgrade national competitiveness [21,39]. Based on records from the Taiwanese Ministry of Education in Taiwan, the number of universities in Taiwan has increased to 157 and continues to rise [40]. These universities' levels of quality and operational performance, however, have not increased equally across the board [47]. In addition, with birth rates continuously dropping, the number of universities increasing, and Taiwan joining the World Trade Organization (WTO), the competitive advantages of a strong university system have decreased drastically [10]. Thus, these problems are serious issues for both governments and universities [17].

The main method of improving and measuring the operational performance of universities involves measuring innovation performance [8] and total quality management (TQM) performance. These two factors have gained significant attention in recent years in Taiwan. A growing number of studies have started to develop separate models for measuring innovation and TQM. However, we argue that a model that addresses both TQM and innovation is necessary for Taiwanese universities to gain competitive advantages and thereby ensure their future survival. In this paper, we propose a measurement system for Taiwanese universities based on the integration of TQM and innovation.

Although the criteria used for the measurement of TQM [34,43] and innovation [8] are numerous, these criteria seem to ignore the characteristics unique to the integration of TQM and innovation. In addition, Taiwanese universities can be categorized into three main types: the research-intensive university (RU), the teaching-intensive university (TU), and the professional-intensive university (PU). Another university type, the education-in-practice-intensive

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university (EIPU), has recently emerged. It focuses on operations performance improvement while conducting TQM and innovation independently from one another [9]. In addition, the measurement criteria proposed in the literature are assumed to be independent of each other, even though this separation does not reflect real world circumstances [38]. To maximize the evaluation and improvement of operational performance in Taiwanese universities, measurement criteria must consider characteristics related to the integration of TQM and innovation, the comprehensive focuses across the four types of universities in terms of operational performance, and the interrelationships among the criteria.

To overcome these problems and construct a useful model, a decision-making trial and evaluation laboratory (DEMATEL) method is used to address the complex interdependent relationships of TQM and to construct a relation structure that includes the measurement criteria for evaluation purposes. A fuzzy analytic network process (FANP) is employed to overcome the problems of dependence between and feedback among TQM measurement criteria. A fuzzy analytic hierarchical process (FAHP) is used to evaluate the measurement criteria for innovation performance based on the effects of TQM criteria. The FANP and FAHP methods are widely used for multiple-criteria decision making, and the practical applications reported in the literature have demonstrated related advantages with regard to handling unquantifiable/qualitative criteria and obtaining reliable results [6–8]. Finally, gray relational analysis (GRA) is utilized to find optimal alternatives based on weights of innovation criteria. Unlike the overly subjective nature of the simple average weighted method (SAW), the GRA method has been adopted largely due to its proficiency in uncertainty information management and its simple calculations [53]. Hence, we combine the DEMATEL, the fuzzy ANP, the fuzzy AHP and the GRA approaches to construct a network hierarchical feedback system (NHFS) based on the integration of TQM and innovation.

The remainder of this paper is organized as follows. An overview of total quality management and innovation is discussed in Section 2. Research methods are proposed in Section 3. Our empirical study is detailed in Section 4. Conclusions are discussed in the last section.

2. An overview of total quality management and innovation

Because the aim of this paper is to construct a network hierarchical feedback system (NHFS) based on the integration of TQM and innovation for higher education, the mechanisms and evaluation criteria for both TQM and innovation proposed by past research are introduced in this section.

2.1. Total quality management (TQM)

There are various criteria for measuring TQM [43]. Based on previous research, the criteria for TQM are summarized in Table 1 [7]. In addition, many quality awards exist for rewarding TQM performance, such as the European Quality Award, the Malcolm Baldrige National Quality Award, the Asia-Pacific Business Excellence Standard, the Vietnam Quality Award, the QS 9000, and the IS 9000 [18]. These awards include various quality measurement criteria and play a (sometimes limited) role in standardizing the measurement of the overall quality of an organization [7]. In Taiwan, the National Quality Award (NQA) has been widely utilized to formally measure operational performance across different industries. The NQA takes into account leadership and operations ideals, strategy

Table 1
Criteria for TQM.

Authors	TQM factors
Brah et al. (2000)	Top management support, customer focus, employee involvement, employee training, employee empowerment, supplier quality management, process improvement, service design, quality improvement rewards, benchmarking, cleanliness and organization, and customer satisfaction.
Antony et al. (2002)	Management commitment, role of the quality department, training and education, employee involvement, continuous improvement, supplier partnership, product/service design, quality policies, quality data and reporting, communication to improve quality, and customer satisfaction orientation.
Sila and Ebrahimpour (2002)	Top management commitment, employee involvement, employee empowerment, education and training, teamwork, customer focus, process management, information and analysis systems, strategic planning, open organization, a service culture, and especially process management.
Shieh and Wu (2002)	Leadership, human resource management, process management, supply chain management and information management.
Sureshchandar et al. (2002)	Top management commitment and visionary leadership, human resource management, technical systems, information and analysis systems, benchmarking, continuous improvement, customer focus, employee satisfaction, union intervention, social responsibility, services capes, and service culture.
Besterfield (2003)	Quality culture, the quality chain, quality assurance, commitment to continuous improvement, and the support of top management.
Prajogo and Sohal (2003b)	Product innovation impacts the performance of total quality management.
Jacqueline et al. (2003)	Statistical process control, the commitment of top management, empowerment, and appropriate culture.
Wagner and Schaltegger (2004)	Leadership.
Kenneth and Cynthia (2004), Escrig-Tena (2004)	Financial performance.
Ozden and Birsen (2006)	Customer focus, continuous improvement, and teamwork.
Nusrah et al. (2006)	Employee empowerment, information and communication, customer focus, and continuous improvement.
Ismail (2006)	Leadership, strategic planning, customer focus, information and analysis, human resource management, process management, supplier management, human resource results, customer results, and organizational effectiveness.
Dinh and Triros (2006)	Strategic planning.
Keng et al. (2007)	Teamwork, reward and recognition, customer focus, organizational trust, extensive training, high level of communication, management commitment at all levels, employee involvement, empowerment and organizational culture.
Han et al. (2007)	Supplier relationship, customer involvement, training, top management commitment, and product design.
Chen and Chen (2008)	Market focus (customer relationship management), organization focus (unique competitive ability development), process focus (information utilization), and result focus (R&D and innovation productivity evaluation and development and financial evaluation and improvement).

Source: Chen & Chen [7].