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Developing a strategy map for forensic accounting with fraud risk management: An integrated balanced scorecard-based decision model

Chih-Hao Yang[a,*], Kuen-Chang Lee[b]

[a] Department of Financial Management, National Defense University, Beitou, Taipei, 11258, Taiwan
[b] Department of Accounting, Soochow University, Shihlin, Taipei, 11102, Taiwan

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ABSTRACT

Corporate fraud risk management strategy has increasingly become a sustainable business development goal. Recent reforms in forensic accounting technology for corporate fraud risk management globally have opened up new avenues for corporate governance and internal control mechanism implementation. This study thus presents an integrated methodology for forensic accounting implementation to improve the identification of the strategy map relationship between the Balanced Scorecard (BSC)-based perspective and criteria, by combining multiple-criteria decision making (MCDM) with the Decision Making Trial and Evaluation Laboratory (DEMATEL) and the Analytic Network Process (ANP) techniques. The results have implications for corporate decision-makers to effectively fulfil corporate governance quality assurance and anti-fraud through a forensic accounting strategy map illustration. From the evaluation and planning perspective, the in-depth analysis of strategy map is useful to obtain an interrelationship that takes as its starting point the practice professions of the decision maker to improve existing strategy alternatives and focus on the valuable strategy paths. In the evaluation planning application, a strategy map of forensic accounting presents the knowledge regarding key indicators' priorities to achieve satisfactory strategy planning and to practice forensic accounting development linked to fraud risk management in Taiwan.

1. Introduction

The goal of corporate governance is to protect stakeholders from managerial misconduct and potential financial risk. Poor corporate governance has a strong relationship with poor performance, including fraud, misappropriation of assets and dissatisfied shareholders (Bhasin, 2013). Companies often face challenges when seeking to improve their fraud risk management related to its internal operation processes and business transactions. Effective internal control system planning and implementation are of crucial importance to management. Therefore, the integrity of the internal control system and the degree of top management support can further reduce expectations of intentional misstatements (Wang & Fargher, 2017). As the technology development and business model transformation advance, the types of fraud increasingly change. The variety of fraud behaviors not only cause financial loss and damage goodwill, but also lower employee morale. Hence, the development of forensic accounting techniques benefits the detection of financial fraud and the promotion of audit effectiveness (Shah, 2018).

Deloitte (2014) proposed that research and development (R&D) activities have come to the attention of regulators in recent years. In Taiwan, high-technology industry development contributes to domestic industries' technological diffusion and promotes self-reliant R&D capacity. Especially in high-technology industry, in addition to the impact financial fraud on company revenues, business secrets are important information, including core manufacturing technology, procurement transactions between business partners, significant assets, etc. Therefore, the implementation of forensic accounting techniques and fraud risk management are necessary for planning fraud management strategy. The strategy map, a tool used by a company to present its strategic goals and evaluate company characteristics, is associated with the Balanced Scorecard (BSC). Valmohammadi and Sofiyabadi (2015) indicated that the strategy map is a well-known problem solver regarding the logic of cause-and-effect relationships. More importantly, decision makers can understand the cause-and-effect grouping in the strategy map to plan accurate and clear goals. Simultaneously, integrating forensic accounting technique with the internal control system provides an effective instrument for developing fraud risk management strategy.

Modern decision-makers use integrated (or hybrid) multiple-criteria

* Corresponding author.
E-mail addresses: chyang@ndu.edu.tw (C.-H. Yang), kc@scu.edu.tw (K.-C. Lee).

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decision-making (MCDM) methods when solving strategically important economic and engineering issues (Zavadskas, Turskis, & Kildienė, 2014; Zavadskas, Antucheviciene, Turskis, & Adeli, 2016), which include the challenges of sustainable development (Zavadskas, Govindan, Antucheviciene, & Turskis, 2016; Zolfani, Zavadskas, & Turskis, 2013). Intensive research into the MCDM field started in the 1970s, with scientists proposing classical MCDM methods, such as Elimination and Choice Expressing Reality (ELECTRE) (Benayoun, Roy, & Sussman, 1966; Govindan & Jepsen, 2016; Roy, 1968, 1978; Roy, 1988, 1990; Roy, 1991, 1996), Preference Ranking Organization Method for Enrichment Evaluations (PROMETHEE) (Brans & Mareschal, 1992, 2005; Brans, Mareschal, & Vincke, 1984; Brans, Vincke, & Mareschal, 1986), Simple Additive Weighting (SAW) (MacCrimmon, 1968), REMBRANDT (Olson, Fliedner, & Currie, 1995), Simple Multi-Attribute Rating Technique (SMART) (Edwards, 1977), SMARTER (Barron & Barrett, 1996; Edwards & Barron, 1994), the qualitative flexible multiple criteria method (QUALIFLEX) (Paelinck, 1978), and others (Zavadskas & Turskis, 2011).

Starting around 2004–2005, the above methods were expanded to solve complicated problems. Scientists proposed such methods as COmplex PRoportional Assessment (COPRAS) (Zavadskas & Kaklauskas, 1996; Zavadskas, Kaklauskas, Turskis, & Tamošaitienė, 2009; Zavadskas, Kaklauskas, Turskis, & Tamošaitiene, 2008), Evaluation based on Distance from Average Solution (EDAS) (Aouadni, Rebai, & Turskis, 2017; Keshavarz Ghorabaee, Zavadskas, Olfat, & Turskis, 2015; Keshavarz Ghorabaee, Zavadskas, Amiri, Turskis, 2016; Keshavarz Ghorabaee, Amiri, Zavadskas, Turskis, & Antucheviciene, 2017; Keshavarz Ghorabaee, Amiri, Zavadskas, Turskis, & Antucheviciene, 2018), Combined Compromise Solution (CoCoSo) (Yazdani, Zarate, Kazimieras Zavadskas, & Turskis, 2019), Additive Ratio Assessment (ARAS) (Turskis & Zavadskas, 2010a; Turskis & Zavadskas, 2010a; Turskis, Lazauskas, & Zavadskas, 2012; Zavadskas & Turskis, 2010, 2010b), COmbinative Distance-based Assessment (CODAS) (Keshavarz Ghorabaee, Zavadskas, Turskis, & Antucheviciene, 2016), and Weighted Aggregated Sum Product Assessment (WASPAS) (Mardani et al., 2017; Turskis, Zavadskas, Antucheviciene, & Kosareva, 2015; Zavadskas, Turskis, Antucheviciene, & Zakarevicius, 2012; Zavadskas, Turskis, & Antucheviciene, 2015; Zavadskas, Antucheviciene, & Saparauskas, 2013).

One of the greatest challenges to decision-makers is to determine the importance of different criteria in the multi-attribute utility function. Different methods are available to solve this issue. Generally, the methods of determining the weights of attributes can be grouped into two categories: subjective and objective. The subjective methods determine the weights of characteristics in terms of the subjective preference or judgment of the decision-makers, including the direct rating method (Roberts & Goodwin, 2002), Analytic Hierarchy Process (AHP) (Ergu, Kou, Peng, Shi, & Shi, 2013; Kou, Ergu, & Shi, 2014; Kou, Peng, & Wang, 2014; Peng, Kou, Wang, Wu, & Shi, 2011; Saaty, 1977, 1980), and others. The objective and subjective categories both have their advantages and disadvantages. For example, subjective methods can take full advantage of the subjective opinions of experts, but it is difficult for them to eliminate any preconception caused by a lack of knowledge or experience from the decision makers. Objective methods have strong mathematical and theoretical basis, and their evaluation results do not depend on human factors, but they do not reflect the subjective preferences of decision makers and ignore the accumulation of knowledge and experience of experts. To make accurate and scientific decisions, decision makers are usually required to give qualitative or quantitative assessments for determining performance and the relative importance of the evaluation criteria.

There are many different subjective approaches to determine the relative importance of criteria. They include AHP (Saaty, 1977), Analytic Network Process (ANP) (Saaty, 1996), Step-wise Weight Assessment ratio Analysis (SWArA) (Keršuliene, Zavadskas, & Turskis, 2010; Ruzgys, Volvačiovas, Ignatavičius, & Turskis, 2014), FActor RElationship (FARE) (Ginevičius, 2011), and others. Eckenrode (1965) compared six methods' (Ranking, Rating, two types of Partial Paired Comparisons, Complete Paired Comparisons, and Successive Comparisons) efficiency in collecting judgment data and found that the values calculated by all of the methods correlate to one another. Turskis, Dzitac, Stankiuviene, and Šukys (2019) extended Eckenrode's rating technique and presented fuzzy its extension. The AHP method is the most widely used one among all MCDM methods (Zavadskas, Mardani, Turskis, Jusoh, & Nor, 2016). Therefore, the AHP method is verified in many studies and is one of the soundest mathematical techniques to determine criteria weights. Through its extension, the ANP method takes into account the interrelationships among criteria. Differing from the AHP approach, Saaty (1996) indicated that the ANP method considers both inter-dependent and complex factors within the hierarchical structure model.

Developing the strategy map for forensic accounting and fraud risk management entails decision problems; decision-makers should incorporate multi-dimension consideration by BSC concept into the decision process of strategic planning, including the financial, customer, internal process, and learning and growth perspectives. Extant studies have confirmed the feasibility of applying the MCDM model based on the Decision Making Trial and Evaluation Laboratory (DEMATEL) and ANP for solving accounting or auditing problems (Sardasht & Rashedi, 2018). The integrated MCDM method has been applied to many research subject, such as financial performance in life insurance industry (Shen, Hu, & Tzeng, 2017), improving airline operational performance (Pineda, Liou, Hsu, & Chuang, 2018), and composing strategy maps for manufacturing firms (Quezada, López-Ospina, Palominos, & Oddershede, 2018). However, little research to date has applied the MCDM to measure forensic accounting and fraud risk management implementation in high-technology industry. In order to develop the strategy map of forensic accounting and fraud risk management, it is necessary to evaluate the interrelationships among the BSC perspective and criteria (key indicators).

In order to realize the performances and benefits of fraud risk management, a strategy map evaluation is of absolute necessity in order to manage potential risks associated with forensic accounting technology implementation. The purpose of this study is to identify the cause-effect relationship of a BSC-based strategy map for forensic accounting implementation and to examine a forensic accounting decision-making optimal strategy map by applying a combined MCDM methodology. It is important to rank the priority of key indicators associated with BSC in order to simultaneously achieve the sustainable development of the fraud risk management infrastructure.

2. Literature review

2.1. Forensic accounting with fraud risk management in the high-tech industry

Kranacher and Riley (2019) indicated that forensic accounting concerns the application of financial principles and theories to facts at issue in a legal dispute and simultaneously provides litigation advisory and investigative services that utilize forensic accounting professional skills. For the recent development toward digital transformation, it is important that big data analytics and forensic accounting should be integrated into the business curriculum and education (Kokina, Mancha, & Pachamanova, 2017; Rezaee & Wang, 2019). For an emerging industry's vision planning, fraud risk management engagement contributes to offsetting the weakness of operation processes and promotes internal control effectiveness. In Taiwan, high-tech industry plays an important role in industrial development and economic growth. The proactive government policy provides an innovative development environment in which to promote core technology integration platforms. Along with accelerated growth of high-tech industry, corporate fraud risk management has become one of the operational

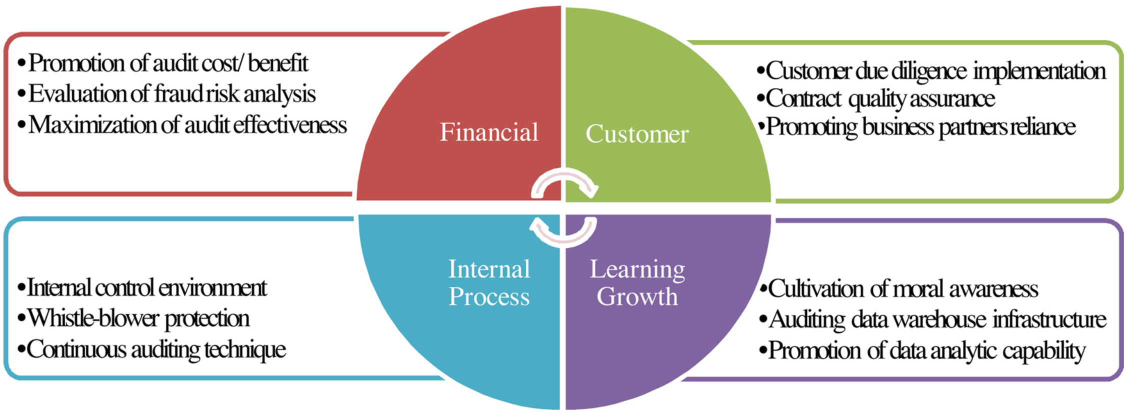

Fig. 1. The BSC-based strategy map for fraud risk management.

management strategies.

Due to the rise of cloud computing and intelligent technology, combining forensic accounting technology with fraud detection is a significant accounting and management issue. Knowledge and applications of analytic technology are increasingly essential in effective forensic accounting, anti-fraud programs, and fraud investigations (Bhasin, 2016a, 2016b). Pamungkas, Ghozali, and Achmad (2018) indicated that accounting fraud is the result of inadequate supervision systems, and that a company has the obligation to implement a good monitoring mechanism and pursue the standardization of operating procedures. The kinds of fraud of high-tech industry are similar to those of general companies, including financial report fraud, misappropriation of assets, etc. Importantly, intellectual property theft in high-tech industry not only harms a company financially, but also the enterprise value and competitive advantages. Fortunately, forensic accounting technology strengthens the advantages of audit evidence collection, processing, and analytics to produce decision information reports that evaluate fraud risk and promote correct fraud detection.

2.2. The evaluation criteria of BSC strategy maps

Kaplan and Norton introduced the BSC in 1992; it includes financial and non-financial measures for the estimation of the state of an organization. The four constructs of the BSC are financial, customer, internal business process, and learning and growth (Kaplan & Norton, 2001). The purpose of this study is to establish the BSC strategy map for forensic accounting with fraud risk management. The evaluation criteria under the four perspectives are discussed, as follows:

Implementing forensic accounting promotes effectiveness maximization for auditing and fraud risk evaluation. Bhasin (2016a, 2016b) suggested that implementing forensic accounting needs state-of-the-art facilities technology to uncover and analyze fraud in the modern sophisticated technology environment. Therefore, a cost/benefit analysis and assessment of the advanced forensic accounting technology is necessary. Moreover, Asare and Wright (2017) indicated that forensic accounting expertise has a close relationship with the professional auditor's specific task experience because it can result in labor efficiency and cost savings. High-technology industry decision makers must pay attention to the measurement of the financial dimension to enhance audit benefits while achieving the goals of fraud risk management.

For any implemented project, its management techniques (Zavadskas, Kaklauskas, Turskis, & Kalibatas, 2009) and technologies used (Zavadskas, Turskis, Volvačiovas, & Kildienė, 2013) have impacts on the project's risks and environment and are reasons that could change a risk management strategy. Anti-Money Laundering (AML) has drawn the attention of the financial sector, but high-tech industry efforts to review its management instruments, especially in Customer Due Diligence (CDD) implementation, while avoiding the threats and damage of business secrets theft, counterfeiting, etc. De Koker (2006) indicated that enhanced customer due diligence is necessary; it provides an audit detection assessment to lower fraud risks. Contract fraud for high-tech industry usually has different dimensions: inclusive false reporting of expenses, violation of conflicts of interest, receipt of rebates, etc. Trinkūnienė et al. (2017) proposed that contractors should be responsible rights and duties, and evaluated the contract risk to protect the interests of customers and contractors. Hence, contract quality assurance presents corporations successfully completing contracts and promoting their business partner's reliance.

The internal process perspective of forensic accounting with fraud risk management, which includes an internal control environment, whistle-blower protection and continuous auditing, is an important key indicator of forensic accounting with fraud risk management development. Generally, top management support and a strong internal control environment benefit fraud prevention (Schaubroeck et al., 2012). Van Akkeren and Buckby (2017) proposed that a weak internal control environment is a significant enabler of fraud. Effective fraud risk management needs the implementation of whistle-blower protection mechanisms. Cordis and Lambert (2017) indicated that whistle-blower laws have a deterrent effect on corporate fraud, and serve as a core policy instrument to support the fraud risk management. Furthermore, continuous auditing techniques possess early notification and fraud-detection capabilities, and provide the internal process for improving information for corporate decisions (Gonzalez & Hoffman, 2018).

Learning and growth perspectives aim to measure the cultivation of moral awareness, audit data warehouse infrastructure, and promote data analytic capacity. In the digital operation environment, the cultivation of moral awareness among employees has an anti-corruption education basis. Rodgers, Söderbom, and Guiral (2015) emphasized that the relationships among ethics, internal control, and fraud are important in seeking to understand corporate social responsibility (CSR). Thus, strengthening the moral awareness of employees helps to prevent the fraud opportunities. Simultaneously, developing an auditing data warehouse and data analytic professionals can support a continuous monitoring process (Alles, Brennan, Kogan, & Vasarhelyi, 2006). Based on the review of the relevant literature, an analytic framework was established, as shown in Fig. 1.

2.3. Literature review of DEMATEL & ANP methodology applications

Liu, Chen, Duan, and Wang (2019) indicated MCDM is a popular research method for dealing with a variety of complex problems that encompass ranking and prioritization, high uncertainty, and multiple evaluation factors. When facing complex decision problems, many factors or elements influence each other directly or indirectly. To deal with the interrelationships of evaluation factors' identification, integrated DEMATEL and ANP can be used and provide decision

Table 1
Summarize research scopes for the hybrid DEMATEL and ANP method.

Authors and Year	Research scopes	Applied hybrid techniques
Chen, Ming, Zhang, Yin, and Sun (2019)	Evaluating sustainable value requirement of product service system	DEMATEL & ANP
Gholami and Seyyed-Esfahani (2019)	Competitive market strategy selection	DEMATEL & ANP
Eslamkhah and Hosseini Seno (2019)	Identifying and ranking knowledge management tools	DEMATEL & ANP & VIKOR
Hatefi and Tamošaitienė (2019)	Construction projects risk factors evaluation	DEMATEL & ANP
Lan, Yang, and Tseng (2019)	Causal financial efficiency model	DEMATEL & ANP
Quezada et al. (2018)	Manufacturing company strategy maps	DEMATEL & ANP
Ghassemi and Darvishpour (2018)	Geothermal drilling project risk response planning	DEMATEL & ANP
Tarei, Thakkar, and Nag (2018)	Quantifying supply chain risk and prioritizing the risk drivers	DEMATEL & ANP
Deng et al. (2018)	Sustainability performance evaluation	DEMATEL & ANP & VIKOR
Fazli, Mavi, and Vosooghidizaji (2015).	Crude oil supply chain risk management	DEMATEL & ANP
Liu et al. (2014)	Material selection with target-based criteria	DEMATEL & ANP & VIKOR
Zhou, Bai, and Sun (2014)	Safety assessment in high-risk hydropower-construction-project work systems	DEMATEL & ANP
Hu, Chen, Tzeng, and Lee (2014)	Corporate governance effects on an enterprise crisis	DEMATEL & ANP & VIKOR
Yang, Shieh, and Tzeng (2013)	Information security risk control assessment	DEMATEL & ANP & VIKOR
Tsai, Chou, Lee, Lin, and Hwang (2013)	Information technology auditing and risk control	DEMATEL & ANP
Hung (2011)	Supply chain planning for competitive advantage in the risky global environment	DEMATEL & ANP & Fuzzy Goal Programming
Tsai and Chou (2009)	Management systems selection	DEMATEL & ANP & Zero-One Goal Programming

information that clarifies the interrelationships among the criteria for the evaluation goal. The hybrid DEMATEL and the ANP technique are frequently used in academic research and policy evaluation for solving complex MCDM problems. In particular, there are many studies that apply DEMATEL and ANP to provide decision information for accounting and risk management issues (Si, You, Liu, & Zhang, 2018).

Table 1 summarizes the literature on the research scopes for accounting information and risk management that emphasize at solve decision-making problems with different degrees of effects among criteria. Hatefi and Tamošaitienė (2019) integrated the fuzzy DEMATEL-fuzzy ANP model to evaluate the overall risks of construction projects and the relationships among risk factors. Liu, You, Zhen, and Fan (2014) revealed that combining DEMATEL-based ANP (DANP) and modified VIKOR can help solve the material selection problems of multiple dimensions and criteria that are interdependent and may reduce the risk of wrong evaluation. However, for forensic accounting and risk management, such applications are very limited. This study fills the gap in this literature with the high-tech industry implementing a BSC strategy map for forensic accounting technology that targets fraud risk management.

3. Methodology of MDCM approach

The overview of steps of the integrated DEMATEL and ANP approaches is given in Fig. 2. Before the methodology application, it is important to structure a BSC-based evaluation network according to research purposes. This study uses a two-phase methodology process. In Phase 1, the DEMATEL was employed to examine the relationships of BSC perspective and criteria. In Phase 2, the ANP was adopted to rank the priority of key indicators and identify the cause-effect relationship of a BSC-based strategy map for forensic accounting implementation.

3.1. Decision-making trial and evaluation laboratory (DEMATEL)

The Science and Human Affairs Program of the Battelle Memorial Institute of Geneva developed an approach to the DEMATEL (Fontela & Gabus, 1976). The DEMATEL technique has been applied to accounting-related decision issues, including risk assessment capability analysis (Liu, You, Shan, & Su, 2019), identifying critical success factors in emergency management (Ding & Liu, 2018), auditing risk model measurement (Sardasht & Rashedi, 2018), exploring critical factors of green business failure (Cui, Chan, Zhou, Dai, & Lim, 2019), sustainability performance evaluation for Taiwanese Certified Public Accountant firms (Deng, Wen, Chen, & Lin, 2018), etc. The major advantages of the DEMATEL method are to identify the interrelationships of evaluation infrastructure variables.

The steps of the DEMATEL method are summarized as follows.

Step1: Calculation of the direction-relationship matrix

The first step is to design the five levels that measure the relationships among problematic factors. Here, the scores 0, 1, 2, 3, and 4 represent levels of influence ranging from no influence at all to a high influence. Pairwise comparisons are determined so as to model a mathematical matrix. Assuming the factors considered contain several criteria $A = \{A_1, A_2 \dots A_N\}$, the respondents propose the level of direct influence of each criterion and derive an average matrix X, where e_{ij} denotes the level that criterion A_i exerts on criterion Aj. The average matrix X is shown as Eq. (1):

$$X = \begin{array}{c} \\ A_1 \\ A_2 \\ \vdots \\ A_N \end{array} \begin{array}{c} \begin{array}{cccc} A_1 & A_2 & \cdots & A_N \end{array} \\ \begin{bmatrix} 0 & e_{12} & \cdots & e_{1N} \\ e_{21} & 0 & \cdots & e_{2N} \\ \vdots & \vdots & \ddots & \vdots \\ e_{N1} & e_{N2} & \cdots & 0 \end{bmatrix} \end{array}. \quad (1)$$

Step2*: *Normalization and analysis of the direct-relation matrix and total-relationship matrix

According to matrix X, a normalized direct-relationship matrix Z can be acquired through Eqs. (2) and (3), in which all major diagonal criteria are equal to zero:

$$Z = r \cdot X \quad (2)$$

$$r = Min\left(1/\max_{1\le i\le n}\sum_{j=1}^{n}|a_{ij}|,\ 1/\max_{1\le j\le n}\sum_{i=1}^{n}|a_{ij}|\right),\ ij \in \{1, 2, 3, \cdots, n\} \quad (3)$$

A total-relationship matrix **W** can then be derived through Eq. (4), in which **I** denotes the identity matrix (Tsai & Chou, 2009):

$$W = Z + Z^2 + Z^3 + \cdots = \sum_{i=1}^{\infty} Z^i = Z(I - Z)^{-1} \quad (4)$$

Step3: Find the dispatcher and receiver groups and set the threshold values to obtain the impact-digraph-map

The values of D-R and D + R are derived from Matrix W, where D is the sum of the rows and presents the influences dispatched from criterion *i* to the other criteria. Here, R is the sum of columns presenting the influences that criterion *i* receives from the other criteria; the equations are shown in (5)–(7) (Tsai & Chou, 2009). Some criteria have a positive value of D-R, indicating criterion *i* affects the other criteria. This is called the dispatcher group. Conversely, if the value of D-R is negative, then criterion *i* is influenced by the other criteria and is called the receiver group. Moreover, the value of D + R indicates an index of the intensity of the influences delivered and received and presents the relationships for each criterion:

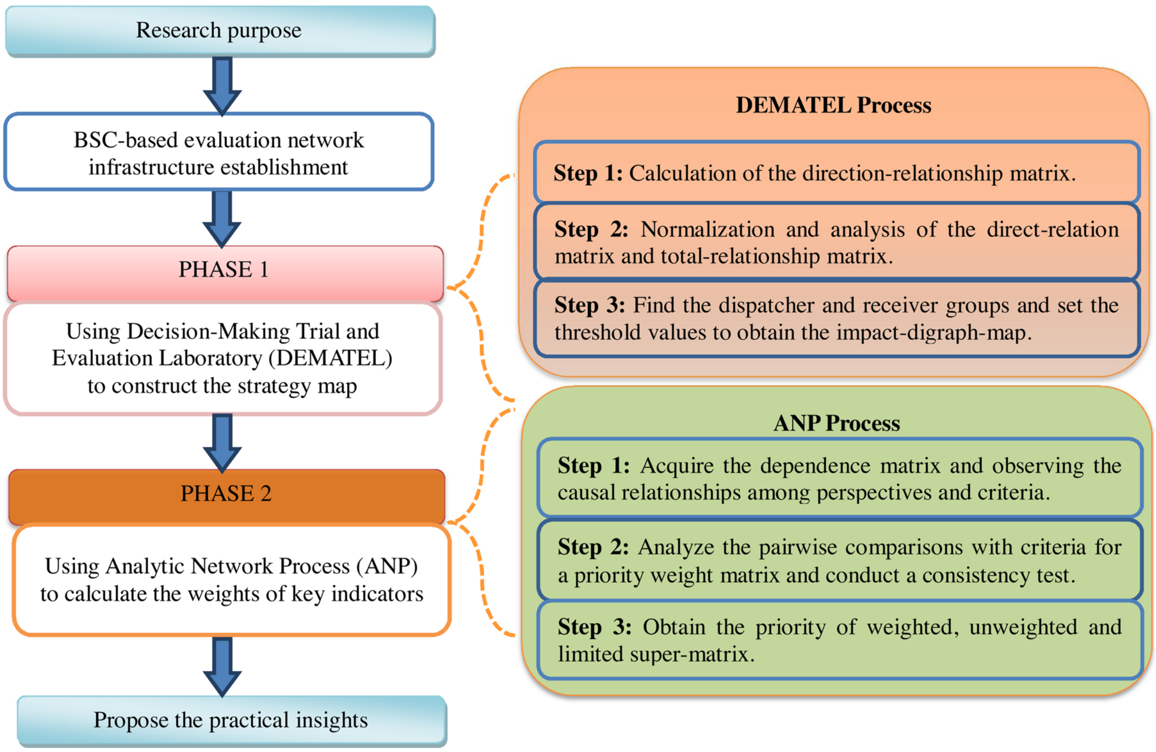

Fig. 2. A flow chart of combined DEMATEL-ANP process to identify the cause-effect relations among perspectives/criteria.

$$W = [W_{ij}]_{n\times n} \quad i, j \in \{1, 2, 3, \cdots\cdots, n\} \tag{5}$$

$$D = \sum_{j=1}^{n} W_{ij} \tag{6}$$

$$R = \sum_{i=1}^{n} W_{ij} \tag{7}$$

Finally, it is necessary to set a threshold value q to clarify the influence level and to filter out smaller effects. The threshold value is determined through discussions with the decision makers and the expert group. When the threshold value has been decided, an impact-digraph-map can be drawn accordingly. The map is obtained by drawing the values of (D + R, D-R), where the horizontal axis is D + R, and D-R is set as the vertical axis.

3.2. ANP procedure

Once the interrelationships of the BSC perspective and key indicators were identified, the ANP method could be applied. The ANP technique is derived from the AHP (. Differing from the AHP approach, the ANP method considers both the inter-dependent and complex factors within the hierarchical structure model (Saaty, 2001). The ANP method has been widely applied in several accounting academic fields, such as renewable energy investment project evaluation (Hamal, Senvar, & Vayvay, 2018), organizational outsourcing decision (Modak, Ghosh, & Pathak, 2019), etc. The following steps describe the ANP method:

Step 1: Acquire the dependence matrix and observing the causal relationships among perspectives and criteria.

Step 2: Analyze the pairwise comparisons with criteria for a priority weight matrix and conduct a consistency test.

The matrix can be accomplished by the pair-wise comparisons resulting from the experts input. The general form of the matrix FA can be described as Eq. (8):

$$\mathrm{FA} = \begin{array}{c} \\ KI_1 \\ KI_2 \\ \vdots \\ KI_N \end{array} \begin{array}{c} \begin{array}{cccc} KI_1 & KI_2 & \cdots & KI_N \end{array} \\ \begin{bmatrix} 1 & m_{12} & \cdots & m_{1n} \\ 1/m_{12} & 1 & \cdots & m_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ 1/m_{1n} & 1/m_{2n} & \cdots & 1 \end{bmatrix} \end{array}. \tag{8}$$

In matrix FA, the problem becomes one of assigning$KI_1KI_2KI_3\ldots KI_n$ to the n criteria. A set of numerical weights$m_1m_2m_3\ldots m_n$ represents expert judgments. Saaty (1996) suggested that the largest eigenvalue would be expressed as Eq. (9):

$$\lambda_{\max} = \sum_{j=1}^{n} m_{ij} w_j / w_i \tag{9}$$

In order to identify and verify the consistency of judgments by decision makers, CI and CR are employed through the value of a consistency index, as shown in Eq. (10):

$$CI = (\lambda_{\max} - n)/(n-1)$$
$$CR = CI/RI \tag{10}$$

Above, related to the random index (RI), the value indicates the average consistency index of numerous random entries of the reciprocal matrices. If CR is less than 0.1, the outcome of the pairwise comparison is acceptable; if CR is greater than 0.1, the result presents the pairwise criteria for comparison again.

Step 3: Obtain the priority of weighted, unweighted, and limited super-matrix.

Ultimately, the comparison results will be illustrated as a super-matrix, and the higher priority weighting evaluation objects indicate that the evaluation object with the greatest priority will be selected. Collectively, this study integrates the DEMATEL and ANP method advantages in establishing the strategy map of forensic accounting with fraud risk management. The decision information is provided in regard to examining the interrelationships of the BSC perspective and key indicators, and to enhance the corporate management strategy decision efficiency.

Table 2
The total-relationships matrix of BSC perspectives (p ≥ 3.985).

	Financial	Customer	Internal Process	Learning Growth	D	D + R	D − R
Financial	**4.306**	**4.243**	**3.985**	**4.087**	16.620	34.540	**(1.300)**
Customer	**4.289**	3.755	3.741	3.824	15.609	32.247	**(1.029)**
Internal Process	**4.735**	**4.416**	3.902	**4.224**	17.278	32.900	1.656
Learning Growth	**4.590**	**4.224**	**3.994**	3.851	16.658	32.644	0.672
R	17.920	16.638	15.622	15.986			

Note: The bold values present the relationship between perspectives that are over the threshold value.

4. Application of the proposed framework

In this section, the strategy map for forensic accounting with fraud risk management of high-tech industry in Taiwan was evaluated to measure the effectiveness and robustness of the proposed MCDM method. For this study, six experts with more than 10 years of experiences in the industry, including a high-tech industry auditor manager and financial officer, a professor of accounting, and a certified public accountant, were invited to fill out the expert questionnaires.

Step 1*: *Evaluating Relationships among the BSC Perspectives with DEMATEL

Prior to analyzing the rank priorities of key indicators for forensic accounting with fraud risk management of the ANP decision model, the potential relationships of the complicated criteria should be measured, and the influence directions among the effected criteria groups should be determined. Based on the DEMATEL, the criteria scale and pairwise comparisons from the expert panel will determine the intensity of the influence direction for each criterion in seeking to acquire the total-relationship matrix.

Table 2 shows the BSC perspective relationships of expert decision results, where the threshold value of 3.985 for the perspective was determined, and the greater-than value was then presented so that the column criterion strongly affected the row criterion. According to Table 2, the financial perspective with the (D + R) score of 34.540 has the highest degree of importance. On the other hand, considering the value of their respective (D–R) scores, the evaluation perspective of the Internal Process Perspective and Learning Growth Perspective are classified into the cause group factors, while the Financial Perspective and Customer Perspective belonged to the effect-related groups. The interrelationships within the strategy map for forensic accounting with fraud risk management are shown in Fig. 3.

Fig. 3 shows the results when the corporate strategy is focused on the enhancement of the internal process and learning growth through the improvement of the internal control environment, fulfilling the Whistle-blower protection, and strengthen the cultivation of the moral awareness among employees.

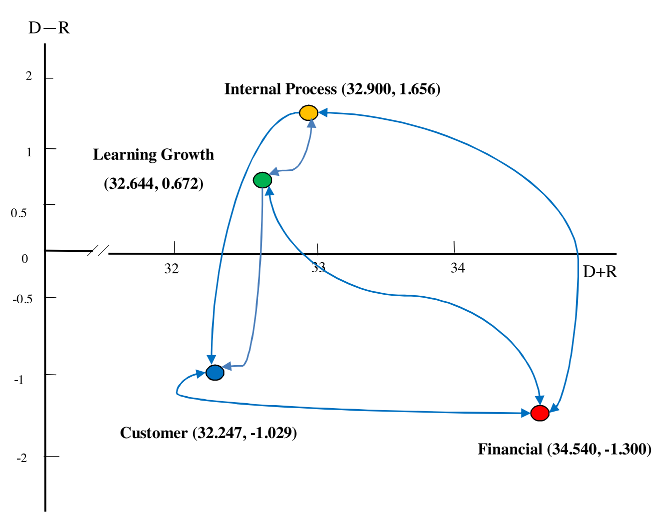

Fig. 3. Interrelationships within the strategy map for forensic accounting with fraud risk management.

Table 3 shows the BSC key indicators relationships of expert decision results, where the threshold value of 0.350 for the criteria was determined. According to Table 2, Evaluations of fraud risk analysis (FI-2), Whistle-blower protection (IP-2), Cultivation of moral awareness (LG-1), Auditing data warehouse infrastructure (LG-2), and Promotion of data analytic capacity (LG-3) with the (D + R) score higher than 5.00, have high degrees of importance. Moreover, the (D-R) scores presented that Evaluation of fraud risk analysis (FI-2), Customer due diligence implementation (CU-1), Whistle-blower protection (IP-2), Cultivation of moral awareness (LG-1), Auditing data warehouse infrastructure (LG-2), and Promotion of data analytic capacity (LG-3) are classified into cause group indicators. The effect-related group indicators include Promotion of audit cost/ benefit (FI-1), Maximization of audit effectiveness (FI-3), Contract quality assurance (CU-2), Promoting business partner's reliance (CU-3), Internal control environment (IP-1), and Continuous auditing technique (IP-3).

The interrelationships within the strategy map of key indicators for forensic accounting with fraud risk management were composed as shown in Fig. 4. The key indicators of the learning growth perspective have significant influences on the other key indicators that present the moral awareness of employees as a basis for fraud risk management. In order to respond to the big data and cloud computing business environment, computer auditing and auditing data warehouses are important auditing instrument innovations for forensic accounting and fraud risk management.

Step 2*: *Priority weights of evaluation key indicators by ANP

As shown in Table 4 and Fig. 5, according to step 1 of the research results, the interrelationships of the BSC perspective and key indicators were obtained; the priority weights of key indicators computing process were analyzed through the Super Decision software. The corresponding priorities of the key indicators formed the unweighted and weighted super-matrix and limiting powers until the weights converged to stabilize the limited super-matrix

The ANP results indicated that the higher priority of evaluation key indicators was Evaluation of fraud risk analysis (FI-2) followed by Maximization of audit effectiveness (FI-3) ≻ Promotion of audit cost/ benefit (FI-1) ≻ Continuous auditing technique (IP-3) ≻ Whistle-blower protection (IP-2) ≻ Cultivation of moral awareness (LG-1) ≻ Auditing data warehouse infrastructure (LG -2) ≻ Promotion of data analytic capacity (LG-3) ≻ Internal control environment (IP-1) ≻ Customer due diligence implementation (CU-1) ≻ Contract quality assurance (CU -2) ≻ Promoting business partners reliance (CU -3). As a result and according to the decision model provided by this study, the integrated expert opinions indicate that Evaluation of fraud risk analysis (FI-2) is a high priority key indicator for forensic accounting implementation in fraud risk management.

5. Discussion

The main results clearly reveal the cause-effect relationship of the BSC-based strategy map of forensic accounting implementation. The

Table 3
The total-relationships matrix of BSC Criteria (p ≥ 0.350).

	FI-1	FI-2	F1-3	CU-1	CU-2	CU-3	IP-1	IP-2	IP-3	LG-1	LG-2	LG-3	D	D + R	D − R
FI-1	0.329	**0.365**	**0.362**	0.279	0.286	0.251	0.329	0.288	0.320	0.323	0.343	0.308	3.783	9.454	**(1.889)**
FI-2	**0.573**	**0.422**	**0.541**	**0.398**	**0.409**	**0.395**	**0.471**	**0.413**	**0.459**	**0.419**	**0.472**	**0.440**	5.412	10.540	0.283
FI-3	**0.447**	**0.388**	0.341	0.275	0.283	0.273	**0.386**	0.340	**0.376**	0.339	**0.387**	**0.361**	4.196	9.477	**(1.086)**
CU-1	**0.427**	**0.386**	**0.402**	0.258	0.329	0.318	0.361	0.310	0.351	0.347	0.344	0.333	4.167	8.023	0.310
CU-2	**0.371**	0.340	0.349	0.270	0.222	0.268	0.318	0.278	0.310	0.300	0.319	0.298	3.643	7.634	**(0.348)**
CU-3	**0.357**	0.327	0.336	0.261	0.288	0.204	0.300	0.243	0.292	0.290	0.308	0.288	3.493	7.318	**(0.331)**
IP-1	**0.433**	**0.423**	**0.435**	0.295	0.303	0.291	0.294	0.307	0.340	0.326	0.324	0.302	4.072	8.797	**(0.653)**
IP-2	**0.535**	**0.516**	**0.504**	**0.363**	**0.373**	**0.360**	**0.483**	0.321	**0.471**	**0.429**	**0.459**	**0.404**	5.218	9.227	1.210
IP-3	**0.503**	**0.439**	**0.450**	0.323	0.332	0.320	**0.386**	**0.362**	0.321	0.339	**0.413**	**0.385**	4.573	9.148	**(0.002)**
LG-1	**0.579**	**0.508**	**0.521**	**0.403**	**0.414**	**0.400**	**0.475**	**0.389**	**0.436**	**0.370**	**0.502**	**0.470**	5.467	9.871	1.062
LG-2	**0.540**	**0.483**	**0.521**	**0.358**	**0.368**	**0.374**	**0.452**	**0.371**	**0.440**	**0.451**	**0.374**	**0.413**	5.147	9.893	0.400
LG-3	**0.577**	**0.530**	**0.519**	**0.374**	**0.385**	**0.371**	**0.471**	**0.387**	**0.458**	**0.471**	**0.500**	**0.362**	5.406	9.769	1.042
R	5.671	5.128	5.281	3.856	3.991	3.825	4.725	4.009	4.575	4.405	4.746	4.364			

Note: The bold values present the relationship between perspectives that are over the threshold value.

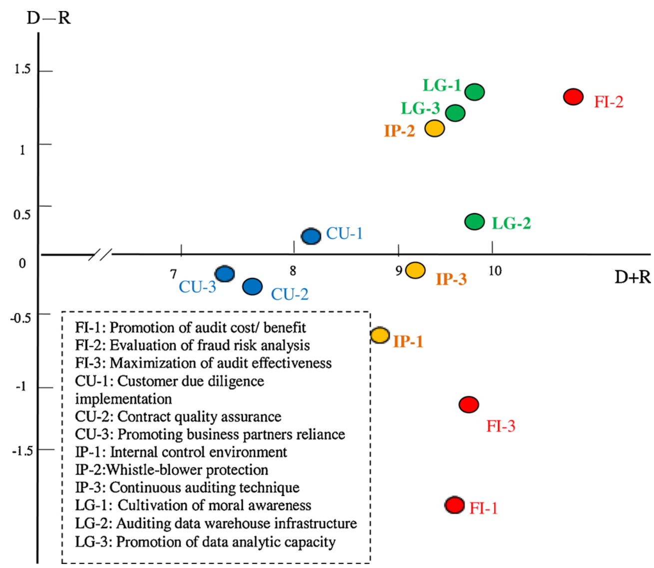

Fig. 4. Interrelationships within the strategy map of key indicators for forensic accounting with fraud risk management.

Table 4
The ranking of key indicators for forensic accounting with fraud risk management.

Key indicators	Weights	Rank
FI-1: Promotion of audit cost/ benefit	0.05	3
FI-2: Evaluation of fraud risk analysis	0.06	1
FI-3: Maximization of audit effectiveness	0.07	2
CU-1: Customer due diligence implementation	0.11	10
CU-2: Contract quality assurance	0.10	11
CU-3: Promoting business partners reliance	0.05	12
IP-1: Internal control environment	0.01	9
IP-2: Whistle-blower protection	0.01	5
IP-3: Continuous auditing technique	0.02	4
LG-1: Cultivation of moral awareness	0.16	6
LG-2: Auditing data warehouse infrastructure	0.21	7
LG-3: Promotion of data analytic capacity	0.14	8

DEMATEL process results help establish the strategy map for forensic accounting with fraud risk management (shown in Fig. 3). By using DEMATEL, the key indicators of forensic accounting technology implementation are proven to have interrelations and self-feedback relationships. From the BSC perspectives, “Internal Process” and “Learning Growth” are classified as part of a cause group. On the other hand, the perspectives of “Financial” and “Customer” make up the effect group. Managers should concentrate most of the input resources on the cause group, the majority of which are concentrated on the perspectives of the internal process and learning growth for achieving the fraud risk management development goals. In addition, the Whistle-blower protection (IP-2) is the most influential criterion and should be improved first, followed by Cultivation of moral awareness (LG-1) and Promotion of data analytic capacity (LG-3). The process also determines that the Evaluation of fraud risk analysis (FI-2) has a value of (D + R = 10.540) and is regarded as the most important key indicator to pay attention to. From the managerial viewpoint, it is important to state that the DEMATEL analysis process serves as a systematic method that allow managers to build a strategy map for the high-tech industry in Taiwan. In addressing the research purpose of this study, the strategy map of forensic accounting technology implementation implies that learning growth may play a critical success dimension to achieve the objective of fraud risk reduction.

Moreover, ANP is utilized to calculate each influential weight of the key indicators, and the results show that Evaluation of fraud risk analysis (FI-2), Maximization of audit effectiveness (FI-3), and Promotion of audit cost/ benefit (FI-1) are the three most important criteria. To avoid any potential risk of forensic accounting technology implementation, decision-makers should not only pay attention to the cause-effect relationship among forensic accounting evaluation criteria, but also consider the priority and significance of the key indicators. Contract quality assurance (CU-2) and Promoting business partners reliance (CU-3) are the least important criteria, with influence weights of 0.10 and 0.05, respectively. Managers and internal auditors should analyze the fraud risk dimensions and consider the audit cost-benefit importance, which can help the industry to successfully implement forensic accounting technology and maximize audit effectiveness. It is interesting to remark that the rankings of the criteria for the customer perspectives are last. The criterion of promoting a business partner’s reliance is significantly behind other key indicators. This relationship with the business partner reliance is maintained, because fraud risk management can be achieved through the best strategy map of a forensic accounting design. It can be observed that the interrelationships of key indicators imply that the decision makers should focus attention on the financial perspectives. Forensic accounting is a technological innovation of the digital transaction process; prior to achieving the goal of fraud risk management, the cultivation of moral awareness among employees, whistle-blower protection, and internal control environment assurance are also important parts of management strategy.

The traditional AHP for the strategy map development of forensic accounting does not reflect interdependencies among perspectives and criteria. However, considering their interdependencies may more accurately promote the decision information. Hence, the integrated DEMATEL and ANP approaches help to identify the cause-effect

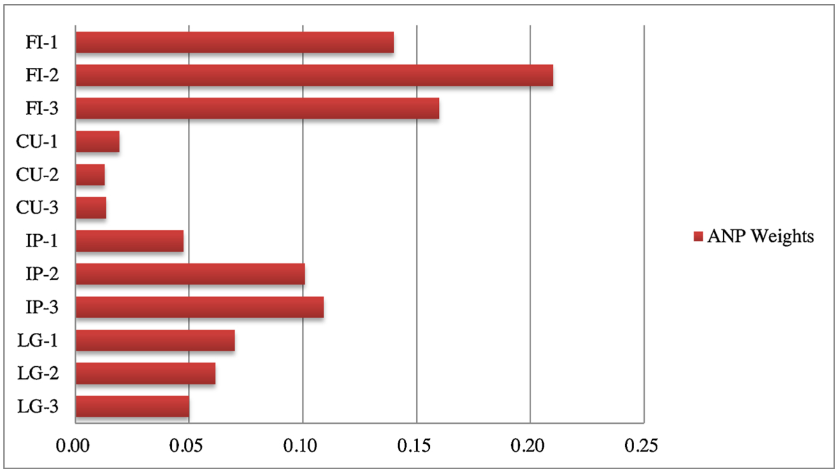

Fig. 5. The ANP weights of key indicators for forensic accounting with fraud risk management.

relationship of the BSC-based strategy map for forensic accounting implementation in order to establish the fraud risk management mechanism.

6. Conclusion and management implications

In order to maximize the benefit of a corporate governance mechanism and protect the interest of stakeholders, Taiwan has proactively promoted fraud risk management and policy regulations to lower financial loss and corporate brand damage. The cloud computing business model and forensic accounting techniques have increased in importance. As a result, decision makers should pay attention to implementing auditing innovation technology and handling organization operation process challenges. This study examined the interrelationships in the forensic accounting decision-making optimal strategy map by applying a combined MCDM methodology. Furthermore, the ranking priority of key indicators associated with the BSC perspective was obtained in order to extract the criteria importance.

The integrated DEMATEL and ANP approaches have been employed in this study to solve the research problem concerning the cause-effect relationship of the BSC-based strategy map for forensic accounting implementation and to examine a forensic accounting decision-making optimal strategy map. While the integrated DEMATEL and ANP approaches provide a solution to the complexity problem, the shorter and more straightforward SWOT analysis contributes to understanding the improvement in the methodology that can be applied in future research. We note the SWOT analysis as follows.

- ***Strengths***: The integrated approach has comprehensible logic and can be widely used to analyze policy evaluation or project selection. Moreover, the cause-effect interrelationships are important among the evaluating perspectives and criteria in the decision process.
- ***Weaknesses***: The integrated approach provides the weights and ranking, but the empirical results need to be verified through further analysis, such as sensitivity analysis or other methods of comparison.
- ***Opportunities***: The integrated approach can incorporate the resource constraints into the decision model and combine goal programming to obtain optimal and reasonable alternative portfolios.
- ***Threats:*** The research hierarchies of the evaluating criteria may present the origin of subjective identification from a literature review or expert interviews.

This study has contributed to providing decision-makers with a quantitative method to create a strategy map of forensic accounting implementation among key indicators for forensic accounting along with fraud risk management. From the evaluation and planning perspective, the in-depth analysis of strategy map is useful to obtain an interrelationship that takes as its starting point the practice professions of the decision maker to improve existing strategy alternatives and focus on the valuable strategy paths. In the evaluation planning application, a strategy map of forensic accounting presents the knowledge regarding key indicators' priorities to achieve satisfactory strategy planning and to practice forensic accounting development linked to fraud risk management in Taiwan.

Some limitations of this study should be mentioned. First, this study mainly is constrained to the high-tech industry's strategy map examination. Second, the BSC-based criteria (key indicators) were not fully considered during the planning process. Future research can consider combining expert practice experiments into analyses of the hierarchy phases. Further research should be undertaken to develop evaluation alternatives for forensic accounting technology, to consider resource constraints (such as budget amount, labour hours, etc.), and to apply goal programming model in order to evaluate optimal alternative portfolio in support of fraud risk management effectiveness.

CRediT authorship contribution statement

Chih-Hao Yang: Conceptualization, Methodology, Software, Validation, Formal analysis, Writing - original draft, Writing - review & editing, Project administration. **Kuen-Chang Lee:** Validation, Formal analysis, Data curation, Writing - review & editing, Project administration.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.evalprogplan.2020.101780.

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Chih-Hao Yang is an associate professor in the Department of Financial Management, National Defense University, Taiwan. He received his PhD degree in Business Administration from the National Central University. He received his MBA degree and his MS degree in Accounting from the National Defense University. He is also a certified SAP Application Consultant on TERP, ACL certified data analyst, International Certified CAATs Practitioner (ICCP), and Certified ERP Audit Professional (CEAP). His research interests include Cost and Management Accounting, Multi-Criteria Decision Making, Accounting Information System, ERP and Computer Auditing. He has published several papers in European Journal of Operational Research, Computers & Operations Research, Journal of Cleaner Production, Journal of Environmental Planning and Management, Group Decision and Negotiation, etc.

Kuen-Chang Lee is a professor and department chairman in the Department of Accounting, Soochow University, Taiwan. He received his PhD degree in Business Administration from the National Central University. He received his MBA degree and his MS degree in Accounting from the Soochow University. His research interests include Financial Accounting, Cost and Management Accounting, Audit Quality and Earnings Management, Accounting Information Systems. He has published several papers in Decision Support Systems, Journal of Air Transport Management, Journal of Cleaner Production, Enterprise Information Systems, Systems Research and Behavioral Science, etc.