



Corporate strategies, environmental forces, and performance measures: a weighting decision support system using the k -nearest neighbor technique

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Abstract

The choice of performance measures is critical to formulating strategies. This paper investigates the relationship among corporate strategies, environmental forces, and the Balanced Scorecard (BSC) performance measures. Corporate strategies are explored within the framework of Miles and Snow's taxonomy, where they are categorized into prospectors, defenders, analyzers, and reactors. The relative weights for each performance measure are calculated by the use of the Analytic Hierarchy Process. A sample of 219 companies can confirm the link between corporate strategies, environmental forces, and the weights of the BSC performance measures. These weights shift depending on the nature of challenges companies face. In the light of this empirical evidence, a decision support system is proposed to help retrieve the BSC weights of the companies with similar characteristics. In order to measure the proximity between companies, a k -nearest neighbor technique is employed. This system can help find the weights of the performance measures for particular strategies.

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1. Introduction

Companies are shaped by their performance measure. Performance measures play a critical role in formulating corporate strategies, evaluating accomplishments, and compensating organizational members. Traditional performance measures are financial. They tend to be myopic and short-term oriented. The financial aspect is only a part of the whole system of a firm. Companies need to leverage their hidden assets. In particular, knowledge is becoming more important in the new economy. Knowledge is non-financial and intangible. Therefore, non-financial measures have been employed to measure such knowledge assets (Dekker & de Hoog, 2000; Kitts, Edvinsson, &

Beding, 2001; Lee, Kwak, & Han, 1995; Liebowitz & Wright, 1999; Wilkins, van Wegen, & de Hoog, 1997).

The need for measuring knowledge components has motivated the need for a variety of performance measurement methods. The Balanced Scorecard (BSC) is one of them. The BSC attempts to integrate all the interests of the key stakeholders—shareholders, customers, and employees, on a scoreboard (Kaplan & Norton, 1996). The beauty of the BSC is that it seeks for a balance between financial and non-financial measures. These diverse interests are categorized into financial, customer, internal business process, and innovation and learning measures.

Companies have to determine the relative importance (i.e. weights) of BSC measures so that they can better identify which measures to focus on and which to ignore. These weights can shift depending on the nature of challenges companies face. However, relatively little is known about how to determine the weights. The weights allotted to particular measures are likely to differ according

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to corporate strategies. For example, prospectors may differ from defenders in determining the weights of performance measures. Furthermore, because companies are thriving in different environments, the weights need to accommodate the potential of environmental variables, such as dynamism, heterogeneity, and hostility (Miller & Friesen, 1983). Recently, several articles admit that, to enhance performance, the strategy pursued by the organization needs to fit into the organizational structure and its evaluation systems (Stathakopoulos, 1998). Olson and Slater (2002), in particular, echo that corporate strategies are linked to the relative importance of the BSC performance measures.

This paper addresses the following research issues: (i) What is the effect of corporate strategic choices on the weighting of the BSC performance measures? (ii) What are the important environmental variables in determining these weights? (iii) What is the potential capability of the k -nearest neighbor technique in measuring the weights of performance measures? (iv) How does our proposed weighting decision support system work?

The rest of this paper is organized as follows: The next section reviews the BSC and the related corporate variables such as strategy, dynamism, and heterogeneity. Section 3 describes measurements including the weighting method. Section 4 analyzes empirical results to explore how the weights of the BSC performance measures vary depending on strategy, dynamism, and heterogeneity. Sections 5 and 6 explore a system for finding the weights among the BSC measures. Section 7 concludes the paper and suggests areas for further research.

2. Balanced scorecard, corporate strategies, and environmental variables

2.1. Balanced scorecard

A great deal of research has investigated on how to remedy weaknesses that underlies most traditional financial performance measurement systems (Bontis, 1998; Edvinsson & Malone, 1997; Kaplan & Norton, 1992; Liebowitz & Suen, 2000; Sveiby, 1997). Examples for new measurement systems include human resource accounting (HRA), economic value added (EVA), BSC, and intellectual capital (IC). Kaplan and Norton (1992) originally proposed the BSC as an integrated performance measurement framework that helps firms articulate, communicate, and translate strategy into action.

According to Kaplan and Norton, the BSC enables managers to look at the business from the four perspectives in a balanced fashion: (i) The financial perspective addresses the question, “To succeed financially, how should we appear to our shareholders?” (ii) The customer perspective addresses the question, “To achieve our vision, how should we appear to our

customers?” (iii) The internal process perspective addresses the question, “To satisfy our shareholders and customers, at what business processes must we excel?” (iv) Finally, the learning/growth perspective addresses the question, “To achieve our vision, how will we sustain our ability to change and improve?” The scorecard takes into account key performance measures that go beyond financial matters to consider employees, customers, and internal operations.

2.2. Balanced scorecard and corporate strategies

The usefulness of the BSC can be enhanced by aligning its scorecard with corporate strategies. The taxonomy by Miles and Snow (1978) is widely used for categorizing corporate strategies. This category includes four strategies: defenders, prospectors, analyzers, and reactors.

Defenders tend to maintain a secured niche position in a relatively stable product or service sector. They are likely to provide a relatively more limited product mix than their competitors, while they are seldom pioneers in development and thus less likely to make ambitious efforts at market penetration. They thus emphasize operational efficiency and seldom attempt to make key changes in technology, organizational structure, or operational method. Instead, they invest in a few pivotal technologies.

In contrast, prospectors tend to work in a variety of product and market sectors; they continue to look for market opportunities and carry out regular searches for any new trends. They react quickly to the suggested opportunities and lead to new fields of exploitation. However, they may not be able to maintain their competitive domination in all the fields that they have penetrated; prospectors put their emphasis on flexibility and innovation, but this tendency may cause a lack of control or low efficiency in operation (Mavondo, 2000).

Defenders are likely to put more emphasis on the perspectives of financial and internal process than prospectors (Lukas, 1999; Chan, Burns, & Yung, 2000). Because their businesses are relatively narrow and stable, they are inactive in the exploring of a new market, i.e. their emphasis on the customer and learning/growth perspectives is lower (Ko, Kincade, & Brown, 2000). In contrast, prospectors tend to put more emphasis on the customer and learning/growth perspectives (Woodside, Sullivan, & Trappey, 1999; Conant, Mokwa, & Varadarajan, 1990).

Analyzers are positioned between the two extremes (defenders and prospectors); they tend to employ both strategies, seeking to maximize opportunities for profit and minimize risk. Analyzers observe the first mover cautiously in order to penetrate into the market with high cost efficiency as the second movers. They neither avoid changes as defenders nor lead these changes as prospectors, but they

attempt to keep both strategies in balance (Miles & Snow, 1978; Mavondo, 2000; Sabherwal & Chan, 2001; Slater & Olson, 2001). Analyzers are likely to place higher weights on the perspectives of financial and internal process than prospectors. However, they place lower weights on the perspectives of financial and internal process than defenders (Sabherwal & Chan, 2001).

Reactors fail to show a consistent posture (Ko et al., 2000); they are neither aggressive even in a stable market nor positive in taking risks. They are not capable of responding, either passively or effectively, to market sectors experiencing environmental strains (Miles & Snow, 1978; Mavondo, 2000). Unlike other strategic types, reactors do not appear to have a consistent product-market orientation. They do not stress the perspectives of customer and learning/growth and are unable to carry out a successful activity (Verhallen, Frambach, & Prabhu, 1998). Reactors have no alternative but to highlight the financial perspective in order to sustain their survival. For a summary of these four strategies, refer to Appendix 1.

2.3. Balanced scorecard and environmental variables

Miller and Friesen (1983) investigate the relationship between a firm's strategy-making and environmental variables. Parnell, Lester, and Menefee (2000) note that strategy is formulated as a response to management uncertainties about competitors, customers, and the environment; they suggest that a company's strategy should fit with the business environment. Companies need to design performance measurement systems adequate to cope with environmental changes.

Environmental variables may have a moderating effect on a firm's performance; we attempt to check if the BSC performance weights are influenced by environmental characteristics. Three environmental variables are considered. Dynamism (often called uncertainty) means the rate of change and innovation in the industry as well as the uncertainty or unpredictability of the actions of competitors and customers (Lawrence & Lorsch, 1967). Heterogeneity (or complexity) encompasses variations among the firm's markets that require diversity in production and marketing orientations (Khandwalla, 1972; Porter, 1980). Hostility represents the degree of threat to the firm posed by the multifacetedness, vigor and intensity of the competition, and the fluctuations of the firm's principal industry (Miller & Friesen, 1978).

3. Measurements

3.1. BSC performance measures

The BSC measures were selected through a complete survey of relevant literature. As a result, the measures adopted can be considered as a revision of Kaplan

and Norton's original measures. Table 1 summarizes the BSC performance measures employed for our study. These BSC measures consist of four major measures and twenty sub-measures, five by each major measure. For example, the financial measures include revenue growth, investment, profitability, asset utilization, and unit cost. In particular, a measure called "knowledge sharing" is included for the learning/growth perspective (Liebowitz & Suen, 2000; Sohn, Park, & Lee, 2001; Sohn Park, Yoon, & Lee, 2001).

3.2. Calculation of weights for BSC measures

The relative weights for each performance measure can be calculated using the Analytic Hierarchy Process (AHP) (Saaty, 1980, 1982, 1990). The AHP can compute the weights of performance measures on the basis of two stepwise questions. First, six questions are asked for comparing (pairwise) the major BSC measures (financial, customer, internal process, and learning/growth). Subsequently, ten questions are asked to compare (pairwise) the five sub-performance measures under each major measure (Saaty & Vargas, 1994).

The AHP converts the pairwise comparisons into the weights. The computational procedure can be supported by a tool like Expert Choice 2000 (Expert Choice, Inc., 2000). The AHP constructs a set of pairwise comparisons as a square matrix A as follows:

$$A = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \cdot & \cdot & \dots & \cdot \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{bmatrix}$$

where a_{ij} is a relative value with respect to factor j of i , $a_{ij} = 1/a_{ji}$ and $a_{ii} = 1$.

To verify the level of logical inconsistency of matrix A , the consistency index (CI) is calculated. λ_{\max} is the largest eigenvalue of matrix A . Saaty (1980) defines the consistent index as $CI = (\lambda_{\max} - n)/(n - 1)$ and uses the consistency ratio (CR), which is the CI divided by the average random index from the empirical data. If the value of CR is less than 0.1, it is typically considered acceptable; larger values require the decision-maker to reduce the inconsistencies by revising judgments.

4. Empirical exploration

4.1. Variables

Our study investigates two types of variables: One is the corporate strategy which includes prospectors, defenders, analyzers, and reactors, and the other is the environmental variable which includes dynamism, heterogeneity, and hostility. Corporate strategic types are determined by

Table 1
Proposed BSC Measures

Perspective	Measure	Reference
Financial	Revenue growth	Chow, Haddad, & Williamson, 1997; Lipe & Salterio, 2000; Mendoza & Zrihen, 2001; Najmi & Kehoe, 2001; Norreklit, 2000; Stewart, 2001
	Investment	Bach, Calais, & Calais, 2001; Denton & White, 2000; Edvinsson & Malone, 1997
	Profitability	Drew, 1997; Edvinsson & Malone, 1997; Hoffecker & Goldenberg, 1994; Johnson, 1998; Norreklit, 2000
	Asset utilization	Alan, Letza, & Neale, 1997; Denton & White, 2000; Edvinsson & Malone, 1997
	Unit cost	Epstein & Manzoni, 1998; Johnson, 1998; Norreklit, 2000; Tsang, 1999; Ziegenfuss, 2000
Customer	Customer profitability	Johnson, 1998; Saint-onge, 1996; Wachtel, Hartford, & Hughes, 1999; Ziegenfuss, 2000
	Customer Acquisition	Deshpande, Farley, & Webster, 1993; Guthrie, 2001; Mendoza & Zrihen, 2001; Norreklit, 2000; Saint-onge, 1996; Tsang, 1999
	Customer retention	Edvinsson & Malone, 1997; Guthrie, 2001; Petty & Guthrie, 2000; Roos & Roos, 1997
	Customer satisfaction	Mendoza & Zrihen, 2001; Payne, Holt, & Frow, 2000; Saint-Onge, 1996; Stewart, 2001; Sveiby, 1997; Tsang, 1999; Ziegenfuss, 2000
	Market share	Najmi & Kehoe, 2001; Norreklit, 2000; Stewart, 2001; Sveiby, 1997
Internal process	Product/service development	Guthrie, 2001; Hall, 1992; Harvey & Lusch, 1999; Liebowitz & Suen, 2000; Martinsons et al., 1999; Tsang, 1999; Ziegenfuss, 2000
	Market identification	Denton & White, 2000; Kaplan & Norton, 1996
	Customer management	Edvinsson & Malone, 1997; Guthrie, 2001; Lipe & Salterio, 2000; Norreklit, 2000
	Operation process	Hall, 1992; Johnson, 1998; Norreklit, 2000; Roos & Roos, 1997; Tsang, 1999; Walker, 1996; Ziegenfuss, 2000
	Environment	Johnson, 1998; Kaplan & Norton, 2001; Stewart, 2001; Walker, 1996
Learning and growth	Skill	Harvey & Lusch, 1999; Johnson, 1998; Kaplan & Norton, 1996; Lipe & Salterio, 2000; Martinsons et al., 1999; Rahman, 2001
	Knowledge sharing	Liebowitz & Suen, 2000; Martinsons et al., 1999; Mayo, 2000; Norreklit, 2000; Payne et al., 2000; Petty & Guthrie, 2000
	IT infrastructure	Edvinsson & Malone, 1997; Kaplan & Norton, 1996; Roos & Roos, 1997; Sveiby, 1997
	IT applications	Alan et al, 1997; Kaplan & Norton, 1996; Lipe & Salterio, 2000; Martinsons et al., 1999; Norreklit, 2000
	Organizational culture	Deshpande et al., 1993; Lipe & Salterio, 2000; Rubenstein-Montano, Buchwalter, & Liebowitz, 2001; Saint-onge, 1996; Stewart, 2001; Tsang, 1999

the use of the paragraph method (Snow & Hambrick, 1980). This method has been widely used for strategy related research (Snow & Hambrick, 1980; Harrigan, 1983; Huber & Power, 1985).

We employ the methods of Miller (1987) and Teo and King (1997) to measure the three environmental variables. A multiple-item method is adopted to construct the questionnaires for corporate performance and environmental variables. Each item is based on a five point Likert scale from 'very low' to 'very high'. Likert scales as generally used tend to underestimate the extreme positions (Albaum, 1997).

4.2. Sample

In order to find the effects of the above variables on the weighting of performance measures, data was collected in

the form of a field survey. A survey was made for a sample of randomly selected Korean companies (with 30 regular employees or more, as of May, 2001) listed in the Annual Corporation Reports (Jang, 2001). The company is a unit of analysis because a single company can provide a set of questionnaires (for the details of the questionnaires, see Appendix 2). The survey was conducted during the period of Sep. 1 through Dec. 31, 2001. Assistant researchers distributed questionnaires with postage-paid and self-addressed envelopes to high-level managers (including directors and CEOs) of six hundred firms. These managers in charge of corporate strategy have a good understanding of the internal/external environment of the business. Prior notice by phone or e-mail was made before survey form was delivered. In cases of delayed responses, respondents were asked to participate in the survey via repeated or prearranged contacts

(Total Design Method; Frankfort-Nachmias & Nachmias, 2000). Questionnaires were collected directly by our researchers or mailed to us at the respondents' own option.

Of the 600 companies contacted, 278 responded; the response rate is 46.3%. Of these 278 respondents, 266 of the respondents completed questionnaires. The CR was computed to verify respondents' degree of consistency. Two hundred and nineteen companies, the CR of which was lower than 0.1, were finally chosen for further analysis (Saaty, 1982; 1990). Consequently, 36.5% of the total sample was used in our analysis. In order to check whether the sample is homogeneous between non-respondents and respondents, we compared firm sizes between the two groups. The number of employees was used as a proxy of firm size. Using the *t*-test, we verified that there is no significant difference between the two groups at a conventional level. The sample characteristics are summarized with respect to industry, number of employees, and respondents' title as shown in Table 2.

4.3. Analysis result

The Cronbach Alpha was used to assess the reliability of the measures. As shown in Appendix 3, reliability coefficients are found to be acceptable for all measures, ranging from 0.707 to 0.906. The multivariate analysis (MANOVA) and the Fisher's LSD (least significant difference) procedure are employed for testing the differences between a pair of corporate strategic types (Hair et al., 1998; Slater and Olson, 2001). The MANOVA procedure is recommended when dependent variables are correlated. The Bartlett's test of sphericity is employed to determine whether dependent variables covary or not. The Bartlett's test procedure checks if the correlation matrix is an identity matrix (Cooley & Lohnes, 1971). We note the sufficient evidence of correlation among dependent variables; i.e. the use of MANOVA procedure is justified.

Table 3 presents a summary of test results on the question of whether or not the mean vectors of the BSC weights are equal among the categories for particular variables.

Table 2
Sample Characteristics

Industry type	Number of firms	Strategy			
		Defender	Prospector	Analyzer	Reactor
< Panel A > Industry type					
Mining/construction/petroleum/agriculture	22	10	2	5	5
Manufacturer	63	9	19	24	11
Public utilities/non-profit organization	14	13	1	0	0
Wholesale/retail/distribution	22	4	6	8	4
Financial and business services	29	7	10	7	5
Computer/communication	68	9	31	21	7
Others	1	1	0	0	0
Total	219	53	69	65	32
< Panel B > Number of employees					
Range	Number of firms	Percent (%)			
Less than 100	89	40.6			
100–500	62	28.4			
500–5000	43	19.6			
5000 and above	25	11.4			
Total	219	100.0			
< Panel C > Years employed					
Years employed	Number				
Less than 5	74				
5–10	76				
10 and above	69				
Total	219				
< Panel D > Title					
Title	Number				
Manager	101				
Director	64				
CEO	54				
Total	219				

Table 3
Overall MANOVA test results

Variable	Value (Wilks' Lambda)	F	Hypothesis degree of freedom	Error degree of freedom	Significance
Strategy	0.840	4.291	9	518.537	0.000***
Dynamic	0.931	2.577	6	428.000	0.018**
Heterogeneity	0.858	5.660	6	428.000	0.000***
Hostility	0.977	0.827	6	428.000	0.687

*** : $p < 0.01$, ** : $p < 0.05$.

The variable 'strategy' is classified into four categories, while environmental variables are classified into three. The MANOVA procedure is adopted for the four variables: strategy, dynamism, heterogeneity, and hostility. These variables are analyzed based on the four major measures. The MANOVA statistic, Wilks' Lambda, states that the mean vectors of the BSC weights are equal with respect to strategy, dynamism, and heterogeneity, but not for hostility. Our study measures hostility through the extent of key competitors' unpredictable and hostile activities. Our result implies that the companies tend not to adjust

the BSC weights in view of key competitors' hostile activities. Therefore, we decided to ignore hostility variable in the further analysis.

A further detailed analysis is performed on the significant variables: strategy, dynamism, and heterogeneity. Panel A of Table 4 shows the results from the test on the null hypothesis that each perspective has the same mean weight across the corporate strategies. This test checks if different strategy types lead to different weights. The pairwise test results can be summarized as follows: First, defenders place higher weights on the perspectives

Table 4
Test on Differences in Mean Weights across Variables

Weight of the BSC measures	Mean of the weight by corporate strategy				F	Significance	Result of LSD test ($p < 0.05$)
	Defender (D)	Prospector (P)	Analyzer (A)	Reactor (R)			
< Panel A > Strategy							
Financial	0.398	0.279	0.337	0.403	6.877	0.000***	D > P; D > A; A > P; R > P
Customer	0.233	0.307	0.241	0.235	3.546	0.015**	P > D; P > A; P > R
Internal process	0.128	0.086	0.092	0.118	3.331	0.020**	D > P; D > A
Learning and growth	0.242	0.327	0.330	0.245	5.233	0.002***	P > D; P > R; A > D; A > R
< Panel B > Dynamism							
Weight of the BSC measures	Mean of the weight by environmental dynamism			F	Significance	Result of LSD test ($p < 0.05$)	
	Low (LD)	Middle (MD)	High (HD)				
Financial	0.387	0.321	0.352	2.229	0.110	LD > MD	
Customer	0.264	0.255	0.262	0.073	0.930	–	
Internal process	0.128	0.103	0.088	2.966	0.054*	LD > HD	
Learning and growth	0.221	0.320	0.298	5.607	0.004***	LD < MD; LD < HD	
< Panel C > Heterogeneity							
Weight of the BSC measures	Mean of the weight by environmental heterogeneity			F	Significance	Result of LSD test ($p < 0.05$)	
	Low (LH)	Middle (MH)	High (HH)				
Financial	0.406	0.347	0.324	2.586	0.078*	LH > HH	
Customer	0.220	0.247	0.278	2.014	0.136	HH > LH*	
Internal process	0.153	0.119	0.078	12.643	0.001***	LH > MH; LH > HH	
Learning and growth	0.221	0.287	0.320	4.443	0.013**	HH > LH; MH > LH*	

* : $p < 0.1$, ** : $p < 0.05$, *** : $p < 0.01$.

of financial and internal process than prospectors. Second, prospectors place higher weights on the perspectives of customer and learning/growth than defenders. Third, reactors place a higher weight on the financial perspective than prospectors and place lower weights on the perspectives of customer and learning/growth than prospectors. Fourth, analyzers do not exhibit any clear pattern.

Environmental variables are measured based on three different levels of strength: low, middle, and high. Appendix 4 reports statistics for environmental variables clustered in three levels. Firms, which are classified into the ‘high’ level of dynamism, are likely to be exposed to the most dynamic environment. Similarly, firms in the ‘low’ level of heterogeneity are operating under the most homogeneous environment. Panel B of Table 4 demonstrates that the BSC weights differ in the level of environmental dynamism. For example, the weight for the internal process is significantly greater in the low level of dynamic environment than the high level. By contrast, the weight for learning/growth is lowest in the low level of dynamic environment. According to Panel C of Table 4, the less heterogeneous the environment is, the higher the weights for financial and internal process perspectives are. By contrast, companies tend to emphasize customer and learning/growth perspectives in the case of more heterogeneous environments.

In sum, the above results turn out to be generally consistent with the core arguments that underlie the relevant theories aforementioned. This consistency implies that companies need to reflect the moderating environmental forces for mobilizing their performance weighting systems. Dynamic and heterogeneous environments have a significant effect on the weighting of the BSC measures. Such a finding is consistent with the prior literature. Li and Ye (1999) note that IT investment has a stronger positive impact on financial performance under greater environmental dynamism. Zahar (1996) reports that the strategy-performance link is related to environmental forces such as dynamism and heterogeneity. Miller and Friesen (1983) also find that there is a relationship between strategy-making and the environment; they report that heterogeneous and dynamic forces are particularly related to innovation. Our study also documents the similar result.

5. Weighting decision support mechanisms

In this paper, we develop the weighting decision support system (hereafter, WDSS) in order to retrieve the weights of a given number of neighbors nearest to a certain company (so called proximate companies). This retrieval can help determine the weights of the BSC performance measures for a particular corporate strategy; i.e. the weights of proximate companies can be useful as a reference. For this

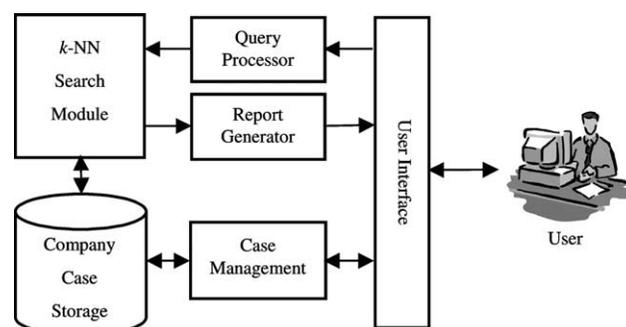


Fig. 1. WDSS Architecture.

determination, WDSS employs 3-dimensional axes: strategy, dynamism, and heterogeneity. The WDSS enables us to identify which companies are the most similar to a particular one in terms of strategy, dynamism, and heterogeneity.

The WDSS can allow users to distinguish between successful and unsuccessful firms not only by providing the weights of the BSC measures, but also by generating the perceived performance. Fig. 1 depicts the architecture of the WDSS. The system provides multiple screens such as the search I/O (Input/Output) and the user interface. The search I/O screens allow users to enter a search condition and get the result. The user interface screens enable users to register their own application onto the database as a new case.

In order to measure the proximity between companies, we employ the k -nearest neighbor (k -NN) technique (Buta, 1994; Kolodner, 1991, 1993; Park & Han, 2002). A company can be represented by a point with respect to given attributes in a multidimensional data space, where each dimension corresponds to an attribute. In the WDSS, the data space consists of three-dimensional axes: strategy, dynamism, and heterogeneity. The dynamism and heterogeneity dimensions of the space are normalized to have the range [0,1], and the strategy dimension has the value of 0 or ∞ . The proximity between companies can be described as a function of the distance between the corresponding points in the space. Thus, the problem of searching companies similar to a given company with respect to certain attributes is transformed to that of finding the points (companies) that are near to a given point in the space. To find the k -nearest points from a given point is known as the k -nearest neighbor technique.

The value range of proximity between two companies is usually [0,1] while the range of the distance is [0, ∞]. The distance is close to zero when two companies are similar, and becomes large if they are quite different. The similarity, however, is the opposite. It is close to one when two companies are similar, while it is close to zero when they are very dissimilar. The distance between companies can be transformed easily into the similarity

measure by an appropriate mapping function. We will propose the WDSS k -NN for corporate performance measures as follows:

Now, let us consider the distance, $\text{dist}(C_i, C_j)$, between two companies, $C_i(c_{i,1}, c_{i,2}, \dots, c_{i,n})$ and $C_j(c_{j,1}, c_{j,2}, \dots, c_{j,n})$ in an n -dimensional space, where $c_{i,d}$ is a d th attribute, say, dimension d of company C_i . Attributes are numeric or categorical. For a numeric attribute, the Euclidean distance measure is commonly used while, for a categorical attribute, a binary dissimilarity measure is used; this measure is zero when two attributes fall in the same category and ∞ when they fall in different categories. Let a set of numeric and categorical attributes be NA and CA , respectively. Then the distance is given as:

$$\text{dist}(C_i, C_j) = \left(\sum_{1 \leq d \leq n} |x_d|^2 \right)^{1/2},$$

$$\text{where } \begin{cases} x_d = c_{i,d} - c_{j,d} & \text{if } c_{i,d}, c_{j,d} \in NA \\ x_d = 0 & \text{if } c_{i,d}, c_{j,d} \in CA \text{ and } c_{i,d} = c_{j,d} \\ x_d = \infty & \text{if } c_{i,d}, c_{j,d} \in CA \text{ and } c_{i,d} \neq c_{j,d} \end{cases}$$

In the WDSS, dynamism and heterogeneity are numeric attributes while strategy is a categorical attribute. Using the above equations, we can compute the distance, $\text{dist}(C_i, C_j)$, between two companies in a three-dimensional space: strategy, dynamism, and heterogeneity.

Suppose we have a set ζ of companies in a database. For a nearest neighbor query, we are given a query company q and the number k of target companies to be retrieved. The goal is to determine the nearest neighbor set $NN(q)$ that has k elements. The set $NN(q)$ is

defined as:

$$NN(q) = \{o \in \zeta \mid \forall c \in \zeta : \text{dist}(q, o) \leq \text{dist}(q, c)\}$$

6. An application

Using the real-life data from D corporation, we illustrate how the WDSS can help determine the weights of performance measures. D corporation started as a trading company in 1967. As of the end of year 2001, it had about 30 branches around the world, 2300 employees, and 3.8 billion dollars in sales. The success of a peer firm, which has enjoyed a huge benefit from the implementation of the knowledge management system focusing on non-financial measures, motivated the company to consider the BSC performance measurement system. First, the company decided to implement the system in the Media and Electronic Division as a pilot test. In order to ensure a strategic and environmental fit, D corporation attempted to use our WDSS.

D corporation's corporate strategy can be determined by the paragraph method. D corporation identified itself as a prospector in terms of corporate strategy. As shown in Fig. 2, by giving a particular strategy of a company and the number of proximate companies, we can obtain the BSC weights of the proximate companies. The user can select "2. Prospector" in the menu.

Fig. 3 illustrates the user screens for determining the scores of environmental dynamism and heterogeneity. When users give answers to each question regarding dynamism, the system calculates the score of dynamism and employs it for similarity search. The same procedure is also applied to environmental heterogeneity. At this stage, environmental variables' scores are

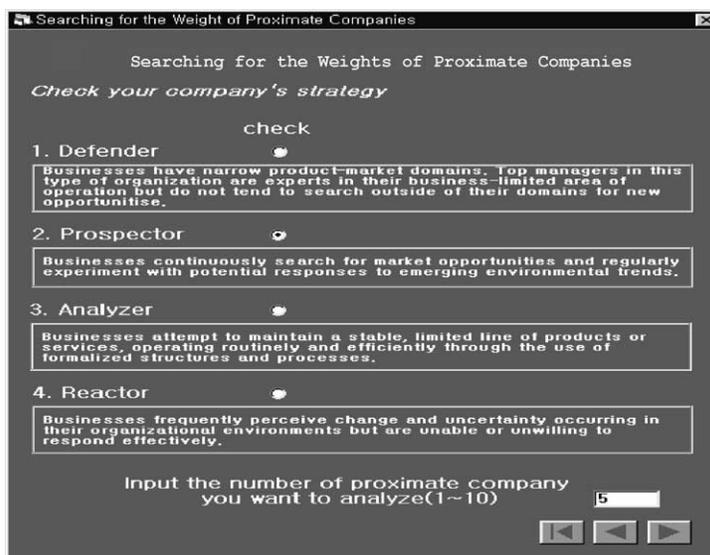


Fig. 2. Strategy Analysis and Selection.

Fig. 3. Measuring the Environmental Dynamism and Heterogeneity.

determined, and the system responds with the weights of companies proximate to D corporation in the given dimensions.

Fig. 4 displays a final output by applying the *k*-nearest neighbor technique. The output can provide a useful reference to the weighting scheme of the neighbor companies. The *k*th nearest company is displayed on the *k*th column under the ‘Range of the Weights.’ More detailed results are obtained by choosing a specific submenu in the upper left corner of the screen. For instance, if you choose ‘20 performance measures’ from the submenus, you can obtain the detailed results based on the 20 sub-measures.

Fig. 5 shows a sample of detailed results based on the 20 sub-measures. The information displayed in the menu contains both the BSC performance weights and performance scores in the proximate companies. D corporation can refer to these weights in deciding the weights of the performance measures. The system also allows users to obtain the graphs of the BSC weights of a specific perspective as well as those of any sub-measures. Fig. 5 contains a graph corresponding to ‘customer perspective.’ In addition, the system provides the perceived performance scores according to each perspective. Accordingly, D corporation was able to obtain information on the weights of proximate companies

	Range of the Weights				
	Entrust.net Kore	Hyundai Mobis	AH Com	Net System	Bio Tech
Financial perspective	0.159	0.395	0.444	0.233	0.096
Customer perspective	0.466	0.163	0.04	0.317	0.371
Internal process perspective	0.046	0.047	0.106	0.04	0.077
Learning and growth perspective	0.329	0.395	0.41	0.41	0.456

Fig. 4. Result for the Weights of Proximate Companies.

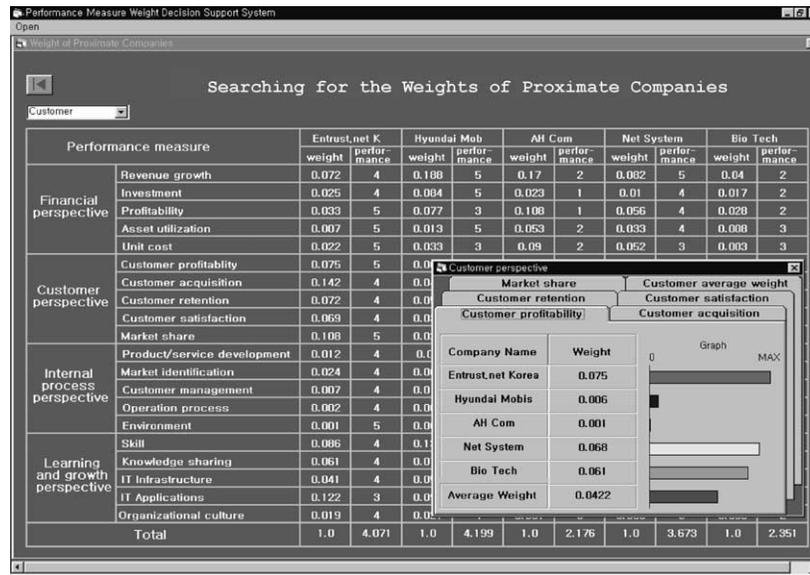


Fig. 5. Detailed Result for the Weights of Proximate Companies.

similar to it in terms of strategies and environments. The information will serve as a good benchmark for its own optimal weights.

The WDSS can have three major advantages over traditional systems. First, the WDSS can ensure a strategic and environmental fit. The system provides good references. Second, the WDSS can ensure a consensus among corporate members. One of the disadvantages of traditional performance systems originates from a lack of understanding among members due to a top-down approach in designing the performance system. However, the WDSS is consensus-oriented because its weighting mechanism is convincingly communicative. Thus, the system can minimize the risk of organizational resistance in implementation. Third, the WDSS strikes a balance between financial and non-financial assets. Therefore, it can contribute to publicizing the importance of intangible assets. As a consequence, all corporate members can be driven to maximize the value of firm.

7. Conclusion

The major objective of this paper is to explore the relationship between corporate strategies, environmental forces, and the weighting of the BSC performance measures. Furthermore, a system is proposed to mobilize this relationship for sharpening the corporate strategies. Corporate strategies are examined under the Miles and Snow’s framework, where strategic types are categorized into prospectors, defenders, analyzers, and reactors. We found the substantial evidence for the relationship. This finding suggests that firms should incorporate this relationship into a viable performance measurement system.

The paper attempted to implement the resulting regularity into a practical system named the WDSS.

The potential contribution of this paper can be summarized as follows: First, we propose a set of corporate performance measures. These measures are developed through an extensive survey of the related literature. They may be useful for any performance measurement system. Second, our study empirically proves that corporate strategies and environmental forces are linked with the performance measures. Thus, we lay grounds on the model of performance measurement systems that can be more suitable under divergent strategies and environments. Third, the proposed weights are useful for pursuing a particular strategy under different degrees of environmental dynamism and heterogeneity. Fourth, the system can help companies establish their own rational measurement systems by benchmarking competitors that operate under similar conditions.

By adding analytic dimensions, our current research can be extended as follows: First, the role of corporate life cycle in determining the weights of the BSC performance measures can be studied more closely. Miller and Friesen (1984) hint on the significance of corporate life cycle. The weight decision mechanism may vary depending on the life cycle stages. The second avenue can be to check if the structure of corporate governance plays a part in the weighting of the BSC performance measures. Emerging financial literature suggests that corporate governance affect its market value significantly. Thus, the governance structure is likely to influence the structure of corporate performance. The third promising avenue would be to see whether organizational characteristics play a role in determining the BSC weights or not. The choice of the BSC weights may rely on the extent of centralization and formalization.

Appendix 1. Definition of corporate strategy

Strategy	Definition
Prospector	Businesses continuously search for market opportunities and regularly experiment with potential responses to emerging environmental trends. Therefore, these businesses often are the creators of change and uncertainty to which their competitors must respond.
Analyzer	Businesses attempt to maintain a stable, limited line of products or services, operating routinely and efficiently through the use of formalized structures and processes. At the same time, these businesses monitor a carefully selected set of promising new product and market developments in different industries.
Defender	Businesses have narrow product-market domains. Top managers in this type of organization are experts in their business-limited area of operation but do not tend to search outside of their domains for new opportunities. As a result of this narrow focus, these businesses seldom need to make major adjustments in their technology, structure, or methods of operation. Instead, they devote primary attention to improving the efficiency of their operations.
Reactor	Businesses frequently perceive change and uncertainty occurring in their organizational environments but are unable or unwilling to respond effectively. Because this type of organization lacks a consistent strategy-structure relationship, it seldom makes adjustments of any sort until it is forced to do so by environmental pressures.

Appendix 2. Questionnaire for corporate performance and environmental variables

Construct	Item						
Corporate performance (CP; 20 items)	Compared with key competitors, our company's achievement level is						
			very low			very high	
	Financial	FCP1: Revenue growth	1	2	3	4	5
		FCP2: Investment	1	2	3	4	5
		FCP3: Profitability	1	2	3	4	5
		FCP4: Asset utilization	1	2	3	4	5
		FCP5: Unit cost	1	2	3	4	5
	Customer	CCP1: Customer profitability	1	2	3	4	5
		CCP2: Customer acquisition	1	2	3	4	5
		CCP3: Customer retention	1	2	3	4	5
		CCP4: Customer satisfaction	1	2	3	4	5
		CCP5: Market share	1	2	3	4	5
	Internal process	ICP1: Product/service development	1	2	3	4	5
		ICP2: Market identification	1	2	3	4	5
		ICP3: Customer management	1	2	3	4	5
		ICP4: Operation process	1	2	3	4	5
		ICP5: Environment	1	2	3	4	5
	Learning and growth	LCP1: Skill	1	2	3	4	5
		LCP2: Knowledge sharing	1	2	3	4	5
		LCP3: IT infrastructure	1	2	3	4	5
LCP4: IT applications		1	2	3	4	5	
LCP5: Organizational culture		1	2	3	4	5	

(continued on next page)

Construct	Item
Environmental dynamism (DYN: 4 items)	DYN1: Products/services in our industry become obsolete very quickly.
	DYN2: The product/service technologies in our industry change very quickly.
	DYN3: We can predict what our competitors are going to do next (R ^a).
	DYN4: We can predict when our product/service demand changes (R ^a).
Environmental heterogeneity (HET: 3 items)	In our industry, there is considerable diversity in:
	HET1: Customers' buying habits.
	HET2: Nature of competition.
	HET3: Product lines.
Environmental hostility (HOS: 3 items)	Market activities of your key competitors:
	HOS1: Have become far more predictable.
	HOS2: Have become far less hostile.
	HOS3: Now affect the firm in far fewer areas.

^a R: indicates that the item is actually measured in a reverse fashion.

Appendix 3. Statistics for reliability test

Measure	Acronym	Number of items	Mean	S.D.	Reliability (Cronbach Alpha)
Corporate performance	CP	4			0.906
Financial	FCP	5	16.069	3.947	0.783
Customer	CCP	5	17.630	3.605	0.758
Internal process	ICP	5	16.890	3.665	0.805
Learning and growth	LCP	5	17.762	3.773	0.799
Environmental variables					
Dynamism	DYN	4	13.537	3.554	0.795
Heterogeneity	HET	3	10.854	2.857	0.830
Hostility	HOST ^a	2	5.781	1.839	0.707
	HOS	3			0.565
	(HOS1)		2.822	1.101	0.417 (alpha if item deleted)
	(HOS2)		2.959	0.988	0.211 (alpha if item deleted)
	(HOS3)		2.397	1.114	0.707 (alpha if item deleted)

^a Hostility is measured by excluding HOS3 because the Cronbach Alpha is increased to 0.707 in that case.

Appendix 4. Statistics for clustering environmental variables

Environmental variable	Number of companies			Total
	Low	Middle	High	
Dynamism	27	96	96	219
Heterogeneity	28	87	104	219
Hostility	57	125	37	219

References

- Alan, B., Letza, S. R., & Neale, B. (1997). Linking the balanced scorecard to strategy. *Long Range Planning*, 30(2), 242–253.
- Albaum, G. (1997). The Likert scale revisited: An alternative version. *Journal of the Market Research Society*, 39(2), 331–348.
- Bach, N., Calais, P., & Calais, M. (2001). Marketing residential grid-connected PV system using a balanced scorecard as a marketing tool. *Renewable Energy*, 22, 211–216.
- Bontis, N. (1998). Intellectual capital: An exploratory study that develops measures and models. *Management Decision*, 36(2), 63–76.
- Buta, P. (1994). Mining for financial knowledge with CBR. *AI Expert*, 9(2), 34–41.
- Chan, J. W. K., Burns, N. D., & Yung, K. L. (2000). Environment-strategy fit: A study of Hong Kong manufacturing logistics. *Logistics Information Management*, 13(5), 286–300.
- Chow, C. W., Haddad, K. M., & Williamson, J. E. (1997). Applying the balanced scorecard to small companies. *Management Accounting*, 79(2), 21–27.
- Conant, J., Mokwa, M., & Varadarajan, P. R. (1990). Strategic types, distinctive marketing competencies, and organizational performance: A multiple measures-based study. *Strategic Management Journal*, 11(5), 365–383.
- Cooley, W. W., & Lohnes, P. R. (1971). *Multivariate data analysis*. New York: Wiley.
- Dekker, R., & de Hoog, R. (2000). The monetary value of knowledge assets: A micro approach. *Expert Systems with Applications*, 18, 111–124.
- Denton, G. A., & White, B. (2000). Implementing a Balanced-scorecard approach to managing hotel operations. *Cornell Hotel and Restaurant and Administration Quarterly*, 41(1), 94–107.
- Deshpande, R., Farley, J. U., & Webster, F. E., Jr (1993). Corporate culture, customer orientation, and innovativeness in Japanese firms: A quadrad analysis. *Journal of Marketing*, 57, 23–37.
- Drew, S. A. W. (1997). From knowledge to action: The impact of benchmarking on organizational performance. *Long Range Planning*, 30(3), 427–441.
- Edvinsson, L., & Malone, M. S. (1997). *Intellectual Capital*. New York: HarperCollins.
- Epstein, M., & Manzoni, J. (1998). Implementing corporate strategy: From Tableaux De Bord to balanced scorecards. *European Management Journal*, 16(2), 190–203.
- Expert Choice, Inc (2000). *Quick start guide and tutorials*. Pittsburgh, PA: Expert Choice, Inc.
- Frankfort-Nachmias, C., & Nachmias, D. (2000). *Research methods in the social sciences*. New York: Worth Publishers.
- Guthrie, J. (2001). The management, measurement and the reporting of intellectual capital. *Journal of Intellectual Capital*, 2(1), 27–41.
- Hair, J. F., Jr, Anderson, R. E., Tatham, R. L., & Black, W. C. (1998). *Multivariate data analysis*. Englewood Cliffs, NJ: Prentice-Hall.
- Hall, R. (1992). The strategic analysis of intangible resources. *Strategic Management Journal*, 13, 135–144.
- Harrigan, K. R. (1983). Research methodologies for contingencies approaches to business strategy. *Academy of Management Review*, 8, 398–405.
- Harvey, M. G., & Lusch, R. F. (1999). Balancing the intellectual capital books: Intangible liabilities. *European Management Journal*, 17(1), 85–92.
- Hoffecker, J., & Goldenberg, C. (1994). Using the balanced scorecard to develop companywide performance measures. *Cost Management*, 8(3), 5–17.
- Huber, G. P., & Power, D. J. (1985). Retrospective reports of strategic level managers: Guidelines for increasing their accuracy. *Strategic Management Journal*, 6, 171–185.
- Jang, D. H. (2001). *Annual Corporation Reports*. Maeil Business Newspaper.
- Johnson, S. D. (1998). Application of the balanced scorecard approach. *Corporate Environmental Strategy*, 5(4), 35–41.
- Kaplan, R. S., & Norton, D. P. (1992). The balanced scorecard: Measures that drive performance. *Harvard Business Review*, 70(1), 71–79.
- Kaplan, R. S., & Norton, D. P. (1996). *The balanced scorecard: Translating strategy into action*. Harvard Business School Press.
- Kaplan, R. S., & Norton, D. P. (2001). *The strategy-focused organization: How balanced scorecard company thrive in the new business environment*. Harvard Business School Press.
- Khandwalla, P. N. (1972). Viable and effective organizational designs of firms. *Academy of Management Journal*, 16, 275–285.
- Kitts, B., Edvinsson, L., & Beding, T. (2001). Intellectual capital: From intangible assets to fitness landscape. *Expert Systems with Applications*, 20, 35–50.
- Ko, E., Kincade, D., & Brown, J. R. (2000). Impact of business type upon the adoption of quick response technologies: The apparel industry experience. *International Journal of Operations and Production Management*, 20(9), 1093–1111.
- Kolodner, J. L. (1991). Improving human decision making through case-based decision aiding. *AI Magazine*, 12(2), 52–68.
- Kolodner, J. L. (1993). *Case-based reasoning*. San Mateo, CA: Morgan-Kaufmann.
- Lawrence, P., & Lorsch, J. (1967). *Organization and environment*. Boston: Harvard University Press.
- Lee, H., Kwak, W., & Han, I. (1995). Developing a business performance evaluation system: An analytic hierarchical model. *The Engineering Economist*, 40(4), 343–357.
- Li, M., & Ye, L. R. (1999). Information technology and firm performance: Linking with environmental, strategic and managerial contexts. *Information and Management*, 35, 43–51.
- Liebowitz, J., & Wright, K. (1999). Does measuring knowledge make cents? *Expert Systems with Applications*, 17, 99–103.
- Liebowitz, J., & Suen, C. Y. (2000). Developing knowledge management metrics for measuring intellectual capital. *Journal of Intellectual Capital*, 1(1), 54–67.
- Lipe, M. G., & Salterio, S. E. (2000). The balanced scorecard: Judgmental effects of common and unique performance measures. *The Accounting Review*, 75(3), 283–298.
- Lukas, B. A. (1999). Strategic type, market orientation, and the balance between adaptability and adaptation. *Journal of Business Research*, 45, 147–156.
- Martinsons, M., Davison, R., & Tse, D. (1999). The balanced scorecard: A foundation for the strategic management of information systems. *Decision Support Systems*, 25, 71–88.
- Mavondo, F. T. (2000). Regulation, deregulation, and free market: The food manufacturing industry in Zimbabwe. *Journal of Business Research*, 50, 305–319.
- Mayo, A. (2000). The role of employee development in the growth of intellectual capital. *Personnel Review*, 29(4), 521–533.
- Mendoza, C., & Zrihen, R. (2001). Measuring up. *Financial Management*, 79(3), 26–29.
- Miles, R. E., & Snow, C. C. (1978). *Organizational strategy, structure and process*. New York: McGraw-Hill.
- Miller, D. (1987). The structural and environmental correlates of business strategy. *Strategic Management Journal*, 8, 55–76.
- Miller, D., & Friesen, P. H. (1978). Archetypes of strategy formulation. *Management Science*, 24, 921–933.
- Miller, D., & Friesen, P. H. (1983). Strategy-making and environment: The third link. *Strategic Management Journal*, 4, 221–235.
- Miller, D., & Friesen, P. H. (1984). A longitudinal study of the corporate life cycle. *Management Science*, 30(10), 1161–1183.
- Najmi, M., & Kehoe, D. F. (2001). The role of performance measurement systems in promoting quality development beyond ISO 9000. *International Journal of Operations and Production Management*, 21(1/2), 159–172.
- Norrekliit, H. (2000). The balance on the balanced scorecard—a critical analysis of some of its assumptions. *Management Accounting Research*, 11, 65–88.

- Olson, E. M., & Slater, S. F. (2002). The balanced scorecard, competitive strategy, and performance. *Business Horizons*, 45(3), 11–16.
- Payne, A., Holt, S., & Frow, P. (2000). Integrating employee, customer and shareholder value through an enterprise performance model: An opportunity for financial services. *International Journal of Bank Marketing*, 18(6), 258–273.
- Park, C. S., & Han, I. (2002). A case-based reasoning with the feature weights derived by analytic hierarchy process for bankruptcy prediction. *Expert Systems with Applications*, 23, 255–264.
- Parnell, J. A., Lester, D. L., & Menefee, M. L. (2000). Strategy as a response to organizational uncertainty: An alternative perspective on the strategy-performance relationship. *Management Decision*, 38(8), 520–530.
- Petty, R., & Guthrie, J. (2000). Intellectual capital literature review: Measurement, reporting, and management. *Journal of Intellectual Capital*, 1(2), 155–176.
- Porter, M. (1980). *Competitive Strategy*. New York: Free Press.
- Rahman, S. (2001). A comparative study of TQM practice and organizational performance of SMEs with and without ISO 9000 certification. *International Journal of Quality and Reliability Management*, 18(1), 35–49.
- Roos, G., & Roos, J. (1997). Measuring your company's intellectual performance. *Long Range Planning*, 30(3), 413–426.
- Rubenstein-Montano, B., Buchwalter, J., & Liebowitz, J. (2001). Knowledge management: A US social security administration case study. *Government Information Quarterly*, 18, 223–253.
- Sabherwal, R., & Chan, Y. E. (2001). Alignment between business and IS strategies: A study of prospectors, analyzers, and defenders. *Information Systems Research*, 12(1), 11–33.
- Saaty, T. L. (1980). *The analytic hierarchy process*. New York: McGraw-Hill.
- Saaty, T. L. (1982). *Decision making for leaders*. Belmont, CA: Lifetime Learning Publications.
- Saaty, T. L. (1990). How to make a decision: The analytic hierarchy process. *European Journal of Operational Research*, 48, 9–26.
- Saaty, T. L., & Vargas, L. G. (1994). *Decision making in economic, political, social and technological environments with the analytical hierarchy process*. Pittsburgh, PA: RWS Publications.
- Saint-Onge, H. (1996). Tacit knowledge: The key to the strategic alignment of intellectual capital. *Strategy and Leadership*, 24(2), 10–15.
- Slater, S., & Olson, E. (2001). Marketing's contribution to the implementation of business strategy: An empirical analysis. *Strategic Management Journal*, 22, 1055–1067.
- Snow, C. C., & Hambrick, D. C. (1980). Measuring organizational strategies: Some theoretical and methodological problems. *Academy of Management Review*, 5, 527–538.
- Sohn, M. H., Park, S. B., & Lee, H. (2001). Integrating balanced scorecard and analytic hierarchy process techniques for evaluating corporate performance. *Proceedings of KORMS Conference on e-Business*, 111–115.
- Sohn, M. H., Park, S. B., Yoon, Y. S., & Lee, H. (2001). A corporate strategy decision supporting system: A balanced scorecard approach. *Proceedings of KMIS International Conference*, 200–207.
- Stathakopoulos, V. (1998). Enhancing the performance of marketing managers: Aligning strategy, structure and evaluation systems. *European Journal of Marketing*, 32(5/6), 536–558.
- Stewart, W. E. (2001). Balanced scorecard for projects. *Project Management Journal*, 32(1), 38–53.
- Sveiby, K. E. (1997). *The new organizational wealth: Managing and measuring knowledge-based assets*. San Francisco: Berrett-Koehler Publishers, Inc.
- Teo, T. S. H., & King, W. R. (1997). Integration between business planning and information systems planning: An evolutionary-contingency perspective. *Journal of Management Information Systems*, 14(1), 185–214.
- Tsang, A. H. C. (1999). Measuring maintenance performance: A holistic approach. *International Journal of Operations and Production Management*, 19(7), 691–715.
- Verhallen, T. M. M., Frambach, R. T., & Prabhu, J. (1998). Strategy-based segmentation of industrial markets. *Industrial Marketing Management*, 27, 305–313.
- Wachtel, T. L., Hartford, C. E., & Hughes, J. A. (1999). Building a balanced scorecard for a burn center. *Burns*, 25, 431–437.
- Walker, K. B. (1996). Corporate performance reporting revised—the balanced scorecard and dynamic management reporting. *Industrial Management and Data Systems*, 96(3), 24–30.
- Wilkins, J., van Wegen, B., & de Hoog, R. (1997). Understanding and valuing knowledge assets: Overview and method. *Expert Systems with Applications*, 13(1), 55–72.
- Woodside, A. G., Sullivan, D. P., & Trappey, R. J. (1999). III Assessing relationships among strategic types distinctive marketing competencies, and organizational performance. *Journal of Business Research*, 45, 135–146.
- Zahar, S. A. (1996). Technology strategy and financial performance: Examining the moderating role of the firm's competitive environment. *Journal of Business Venturing*, 11, 189–219.
- Ziegenfuss, D. E. (2000). Developing an internal auditing department balanced scorecard. *Managerial Auditing Journal*, 15(1/2), 12–19.

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