The BSC Weighting Decision Support System based on Corporate Life Cycle and Environmental Forces

Myung Ho Sohn[a,b], Taewoo You[b], Seok-Lyong Lee[c], Heeseok Lee[a]

[a] *Corporate Information System Laboratory, Graduate School of Management*
Korea Advanced Institute of Science and Technology
207-43, Cheongyangri-dong, Dongdaemoon-gu, Seoul 130-012, Korea
totalsol@kgsm.kaist.ac.kr; hsl@kgsm.kaist.ac.kr

[b] *Business Administration, Myongji College*
356-1, Hongeun3-Dong, Seodaemun-Ku, Seoul 120-776, Korea
taewooyou@mail.mjc.ac.kr

[c] *School of Industrial and Information Systems Engineering*
Hankuk University of Foreign Studies
89, Wangsan-ri Mohyun, Yongin-si,, Kyounggi-do 447-791, Korea
sllee@hufs.ac.kr

ABSTRACT

This paper explores the relationship between corporate life cycle, environmental forces and the weighting of the Balanced Scorecard (BSC) performance measures. Based on the relational evidence, we attempt to develop the weight decision support system. The corporate life cycle is explored within the framework of Miller and Friesen's taxonomy, where they are categorized into birth, growth, maturity, revival, and decline. Environmental forces were examined based on the work by Miller and Friesen, where environmental forces are divided into dynamism, heterogeneity, and hostility. Using a sample of Korean companies, we found substantial evidence for the relationship between corporate life cycle, environmental forces, and the weighting of the BSC performance measures. This finding suggests that firms should consider these factors simultaneously in order to establish a viable performance measurement system. The paper also attempted to incorporate the empirical regularity into a decision support system. One of the distinguishing features underlying our proposed system lies in the application of the similarity technique for sorting out a certain reference group. The proposed system is believed to be of great benefit to firms planning to introduce a performance measurement system based on intangible asset measures.

Keywords: Corporate Life Cycle, Performance Measures

1. Introduction

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. Thus, it is extremely important to know about how to determine the weights. Despite their practical importance, however, relatively little is known about how to determine the weights. Especially, the weights allotted to particular measures are likely to differ according to the corporate life cycle: birth, growth, maturity, revival, and decline (Miller & Friesen, 1984). For example, a firm at birth stage may differ from that at maturity stage 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).

This paper addresses the following research issues: (i) What is the effect of corporate life cycle 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?

2. Balanced Scorecard, Corporate Life Cycle, and Environmental Variables

2.1 Balanced Scorecard

Before delving more deeply into the BSC strategic initiatives, examining why the BSC has emerged is important. A financial perspective alone does not fully account for the corporate performance. Performance measures should identify the factors for creating economic value of a company in the long run as well as the short-term financial outcomes. A conventional performance measurement system makes use of financial measures such as net income, return on investment, or return on equity. Firms, pursuing outward expansion, focus on quantitative financial measures; revenue or expected profit is important. Because these conventional measures are based on historical sales, they are myopic and past-oriented. They fail to reflect the future competitive power of the corporation (Ittner and Larker, 1998).

Since the 1990's, a number of researchers have studied intellectual assets (Bontis, 1998; Edvinsson and Malone, 1997; Sveiby, 1997; Kaplan and Norton, 1992) as a complement to the previous financial performance measurement systems; these efforts result in several measurement methods (for example, strategic managerial accounting, strategic cost control, and non-financial performance measurements). The Balanced Scorecard is one of them. The BSC consists of four different perspectives, as illustrated below. These perspectives are not independent of one another.

• Financial: The financial perspective refers to conventional financial measures (e.g., cash flow, increased sales, operating profit by department, market share by division, ROE, return on investment, economical value added (EVA), and profitability).

• Customer: This perspective includes measures for meeting customers' needs (e.g., market share, customer acquisition, customer profitability, customer retention, and customer satisfaction).

• Internal process: This perspective measures what a company should do in its internal processes. Examples would be the development of new products, the efficiency of processes to penetrate new markets, the process time and quality, the process cost, employee's aptitude, and productivity.

• Learning and growth: This perspective includes measures for long-term value creation. This perspective is important because a company's capacity to innovate is closely related to its value creation. For example, measures include employees' competency and capacities of information systems.

2.2 Balanced Scorecard and Corporate Life Cycle

Prior literature has suggested that the design, development, and behavior of organizations is related to organizational life cycle (Adzies, 1979; Kimberly, 1979; Quinn & Cameron, 1983; Gupta & Chin, 1990; Balkin & Montemayor, 2000; Flamholtz, 1995). Furthermore, using a longitudinal technique, Miller and Friesen (1984) showed that organizational life cycle plays a moderating role in the relationship between environment, strategy, structure and decision making methods.

As a result, the usefulness of the BSC can be enhanced through aligning its scorecard with corporate life cycle. Just as individuals need to adjust to life's change, corporations must recognize life cycle changes and react appropriately in order to survive. The taxonomy by Miller and Friesen (1984) is widely used for categorizing the corporate life cycle. This category includes five phases: birth, growth, maturity, revival, and decline.

The birth stage is the period in which a new firm is becoming a viable entity. The main feature in this stage is that firms are young, owner-managed, and have informal structures. The growth stage occurs once the firm established its distinctive competence and enjoyed some initial product-market success. The emphasis is on achieving rapid sales growth. The stage is characterized by a functional-based structure, some delegation, and formalization. In the maturity stage sales levels stabilize, the level of innovation falls, and a more bureaucratic structure is established. Efficiency becomes a virtue.

The revival stage is typified through diversification and expansion of product-market scope. Firms begin to divisionalize structures in order to cope with the more

complex and heterogeneous markets. There is an emphasis upon more sophistigated control and planning systems. The decline stage reveals encroaching stagnation as markets dry up and firms begin to decline with them. Profitability drops because both of the external challenges and of the lack of innovation Thus, it is likely that companies adjust the weights of their performance measures as they move in a progression of five stages.

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. 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 et al., 2001).

3.2 Calculation of Weights for BSC Measures

The relative weights for each performance measure can be calculated using the Analytic Hierarchy Process (Saaty, 1980; 1982; 1990). The Analytic Hierarchy Process (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:

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

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. Satty (1980) defines the consistent index as $CI = (\lambda_{max} - n) / (n-1)$ and uses the consistency ratio (CR), which is the consistency index 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 life cycle which includes birth, growth, maturity, revival, and decline, and the other is the environmental variable which is represented by dynamism, heterogeneity, and hostility. The corporate life cycle is determined by 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).

Definition of corporate life cycle is described in Table 1.

Table 1. Measurement Variable of Corporate Life Cycle

Operational definition		Related literature	Indicator
Birth	Firm is less than 10 years old, has informal structure, and is dominated by owner-manager.	Miller & Friesen, 1983; Quinn & Cameron, 1983; Miller & Friesen, 1984	nominal scale self-typing (paragraph method)
Growth	Sales growth greater than 15%, functionally organized structure, early formalization of policies.		
Maturity	Sales growth less than 15%, more bureaucratic organization.		
Revival	Sales growth greater than 15%, diversification of product-lines, divisionalization, use of sophisticated controls and planning systems.		
Decline	Demand for products levels off, low rate of product innovation, profitability starts to drop off.		

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).

We employ the methods of Miller (1987) and Teo & 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). Table 2 summarizes the operationalization of the environmental factors.

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Table 2. Measurement Variable of the Environmental Factors

Operational definition		Indicator	Related literature
Dynamism	is manifested by the amount and unpredictability of change in customer tastes, production or service technologies, and modes of competition in the firm's principal industries	4 items 5 Likert scale	Lukas, 1999; Chan and Yung, 2000; Teo and King, 1997; Miller, 1987; Sabherwal and King, 1992
Heterogeneity	is evidenced by differences in competitive tactics, customer tastes, product lines, channels of distribution, etc. across the firm's respective markets. These differences are only significant to the extent that they require different marketing, production, and administrative practices	3 items 5 Likert scale	
Hostility	is evidenced by price, product, technological and distribution competition, severe regulatory restrictions, shortages of labor or raw materials, and unfavorable demographic trends (e.g. decreasing markets)	3 items 5 Likert scale	

4.2 Sample

In order to test 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. 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 consistency ratio (CR) was computed to verify respondents' degree of consistency. Two hundred and eighteen companies, the CR

of which was lower than 0.1, were finally chosen for further analysis (Saaty, 1977; 1982; 1990).

Consequently, 36.3% 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.

4.3 Analysis Result

The Cronbach Alpha was used to assess the reliability of the measures. 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 life cycle (Hair et al., 1998; Slater & 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. The variable "corporate life cycle" is classified into five categories, while environmental variables are classified into three. The MANOVA procedure is adopted for the four variables: corporate life cycle, dynamism, heterogeneity, and hostility. These variables are analyzed based on the four major measures.

The MANOVA statistic, Wilks' Lambda, indicated that the mean vectors of the BSC weights are equal with respect to corporate life cycle, dynamism, and heterogeneity, but not for hostility. In our study, hostility was defined as the extent of key competitors' unpredictable and hostile activities. The insignificance of the variable "hostility" implies that companies tend not to adjust the BSC weights in view of key competitors' hostile activities. Based on this evidence, we decided to ignore hostility variable in the further analysis.

A further detailed analysis is conducted on the significant variables: corporate life cycle, dynamism, and heterogeneity. Panel A of Table 3 shows the results from the test on the null hypothesis that each perspective has the same mean weight across the corporate life cycle. This test checks if different corporate life cycle types lead to different weights. Except the "customer perspective", the stages of corporate life cycle play a significant role in determining the BSC weights.

Table 3. Test on Differences in Mean Weights across Variables

<Panel A> Corporate Life Cycle

Weight of the BSC Measures	Mean of the Weight by Corporate Life Cycle					F	Sig	Result of LSD Test (p<0.05)
	Birth (B)	Growth (G)	Maturity (M)	Revival (R)	Decline (D)			
Financial	0.286	0.304	0.379	0.383	0.412	4.079	0.003	M>B; M>G R>B; R>G D>B; D>G
Customer	0.255	0.277	0.252	0.241	0.254	0.384	0.820	
Internal Process	0.064	0.095	0.134	0.096	0.109	4.447	0.002	G>B M>B; M>G; M>R
Learning and Growth	0.394	0.324	0.236	0.280	0.225	7.894	0.000	B>G; B>M; B>R; B>D G>M; G>D

<Panel B> Dynamism

Weight of the BSC Measures	Mean of the Weight by Environmental Dynamism			F	Sig	Result of LSD Test (p<0.05)
	Low (LD)	Middle (MD)	High (HD)			
Financial	0.387	0.318	0.352	2.445	0.089	LD>MD
Customer	0.264	0.257	0.262	0.040	0.960	-
Internal Process	0.128	0.103	0.084	2.951	0.054	LD>HD
Learning and Growth	0.221	0.320	0.298	5.626	0.004	LD<MD; LD<HD

<Panel C> Heterogeneity

Weight of the BSC Measures	Mean of the Weight by Environmental Heterogeneity			F	Sig	Result of LSD Test (p<0.05)
	Low (LH)	Middle (MH)	High (HH)			
Financial	0.406	0.344	0.324	2.571	0.079	LH>MH; LH>HH
Customer	0.220	0.250	0.278	1.919	0.149	HH>LH
Internal Process	0.153	0.119	0.078	12.587	0.000	LH>MH; LH>HH MH>HH
Learning and Growth	0.221	0.287	0.320	4.415	0.013	HH>LH; MH>LH

In addition, the pairwise test results can be summarized as follows: First, the weight of the financial perspective increases as firms move from birth through decline stage. Second, the BSC weights in the customer perspective reveal no statistical difference across life cycle stages. Third, the BSC weight of the internal process perspective is the highest for firms at maturity. Fourth, the weight of the learning and growth perspective is the highest for firms at birth.

Environmental variables are measured based on three different levels of strength: low, middle, and high. 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 3 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 3, 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.

Similarly, firms in the 'low' level of heterogeneity are operating under the most homogeneous environment. Panel B of Table 3 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 3, 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. Zahra (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 life cycle; i.e., the weights of proximate companies can be useful as a reference. For this determination, WDSS employs 3-dimensional axes: corporate life cycle, dynamism, and heterogeneity. The WDSS enables us to identify which companies are the most similar to a particular one in terms of corporate life cycle, 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. 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 and 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 3-dimensional axes: corporate life cycle, dynamism, and heterogeneity. The dynamism and heterogeneity dimensions of the space are normalized to have the range [0,1], and the corporate life cycle 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 $[0, \infty]$. 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, $dist(C_i, C_j)$, between two companies, $C_i(c_{i,1}, c_{i,2}, \ldots, c_{i,n})$ and $C_j(c_{j,1}, c_{j,2}, \ldots, c_{j,n})$ 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:

$$dist(C_i, C_j) = \left(\sum_{1 \le d \le n} |x_d|^2 \right)^{\frac{1}{2}}, \quad where \begin{cases} x_d = c_{i,d} - c_{j,d} & \text{if } c_{i,d}, c_{j,d} \in NA \\ x_d = 0 & \text{if } c_{i,d}, c_{j,d} \in CA \text{ and } c_{i,d} = c_{j,d} \\ x_d = \infty & \text{if } c_{i,d}, c_{j,d} \in CA \text{ and } c_{i,d} \neq c_{j,d} \end{cases}$$

In the WDSS, dynamism and heterogeneity are numeric attributes while corporate life cycle is a categorical attribute. Using the above equations, we can compute the distance, $dist(C_i, C_j)$, between two companies in a 3-dimensional space: corporate life cycle, dynamism, and heterogeneity.

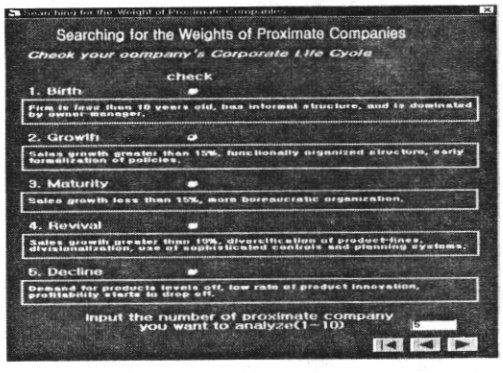
Suppose we have a set ζ of companies in a database. For a nearest neighbor query, we are given a query company q and the number k of target companies to be retrieved. The goal is to determine the nearest neighbor set $NN(q)$ that has k elements. The set $NN(q)$ is defined as:

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

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 & Electronic Division as a pilot test. In order to ensure a strategic and environmental fit, D corporation attempted to use our WDSS.

The corporate life cycle of D corp. can be determined by the paragraph method. D corp. identified itself as being at growth stage in terms of corporate life cycle.

Figure 1. Corporate life cycle Analysis and Selection



As shown in Figure 1, by giving a particular corporate life cycle of a company and the number of proximate companies, we can obtain the BSC weights of the proximate companies. The user can select "2. Growth" in the menu.

Figure 2 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 determined, and the system responds with the weights of companies proximate to D corporation in the given dimensions.

Figure 2. Measuring the Environmental Dynamism and Heterogeneity

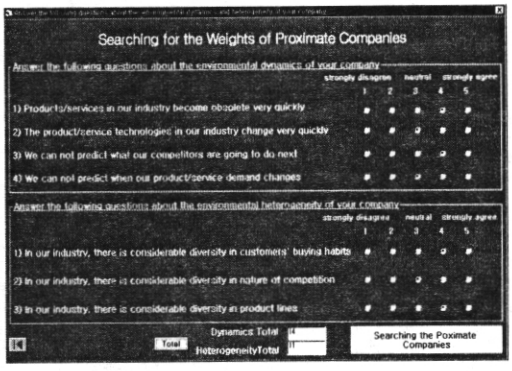
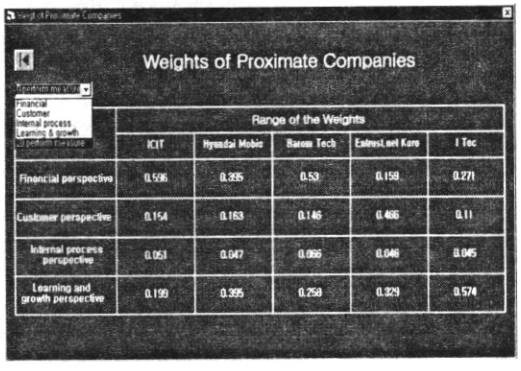


Figure 3 displays a final output by applying the k-nearest neighbor technique. The output can provide a useful reference to the weighting scheme of the neighbor companies. The k-th nearest company is displayed on the k-th column under the "Range of the Weights." More detailed results are obtained by 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.

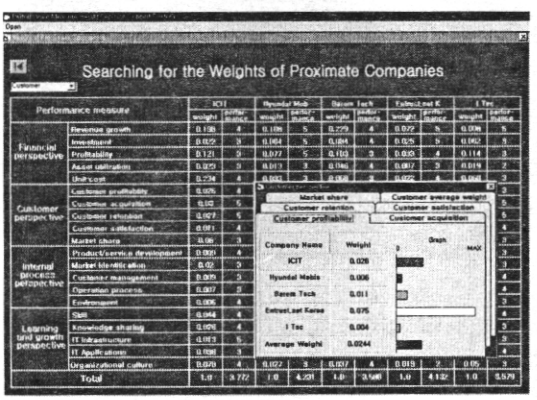
Figure 3. Result for the Weights of Proximate Companies



	ICIT	Hyundai Mobis	Barom Tech	EstrusLoet Kore	I Tec
Financial perspective	0.506	0.335	0.53	0.159	0.271
Customer perspective	0.154	0.163	0.146	0.486	0.11
Internal process perspective	0.051	0.047	0.066	0.046	0.045
Learning and growth perspective	0.199	0.395	0.258	0.329	0.574

Figure 4 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. Figure 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 similar to it in terms of corporate life cycle and environments. The information will serve as a good benchmark for its own optimal weights.

Figure 4. Detailed Result for the Weights of Proximate Companies



6. Conclusion

The major objective of this paper is to explore the relationship between corporate life cycle, environmental forces, and the weighting of the BSC performance measures. As an application, a system is proposed to mobilize this relationship for sharpening the corporate life cycle. Corporate life cycle is examined under the Miller and Friesen's framework, where corporate life cycle is categorized into birth, growth, maturity, revival, and decline. We found the substantial evidence suggesting that there is relationship among corporate life cycle, environmental forces, and the BSC weights.

The key implication is 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 verifies that corporate life cycle 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 corporate life cycle and environments. Third, the proposed weights are useful for firms operating at a particular stage of corporate life cycle and 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. The first 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 second 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.

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