Winter 12-9-2003

Fuzzy Based Balanced Scorecard for e-Business

Pradeep Kumar

Tapas Mahapatra

M P Gupta

Fuzzy-based Balanced Scorecard for E-business

Pradeep Kumar
ICFAI Business School
ICFAI University
Gurgaon – 122016
pkgarg@ibsdel.org

Tapas Mahapatra
ICFAI Business School
ICFAI University
Gurgaon -122016
tapasm@ibsdel.org

M P Gupta
Faculty of Management Studies
University of Delhi
Delhi – 110007
guptas@vsnl.com

Abstract

The balance scorecard [6] is a performance measurement system that supplements traditional financial measures with the criteria that measures performance from three additional perspectives: customer perspective, internal business perspective, and innovation and learning perspective. In recent years, the balanced scorecard has been applied to information technology in order to ensure that IT is fairly evaluated. The same methodology has also been applied to E-business. Since some of the parameters in the measurement are somewhat inexact, the idea of fuzzy logy can be applied to allow manipulation of both exact and inexact (fuzzy) inputs from the e-business to the balanced scorecard. This fuzzy model works with a grade of membership and portrays inexact information represented by fuzzy statements, and explains both fuzzy conditional statements and the inference mechanism. This paper tries to develop a frame-work for Fuzzy-based Balanced Scorecard for E-business.

Introduction

Internet technology is creating a universal technology platform for buying and selling goods and for driving important business processes inside the firm. It has inspired new ways of organizing and managing that are transforming businesses and the use of information systems in everyday life. Along with bringing many new benefits and opportunities, electronic business (E-business) has created a new set of management challenges. An organization must understand the management, organization, and technology issues that must be addressed to benefit from E-business. The successful organization requires the high level information integration, and companies increasingly are depending on such infrastructure to remain efficient and competitive. The Internet has shrunk the information asymmetry. Now the businesses are not required to make trade-offs between the richness and reach of their information.

E-Business

E-business can be described as the process of buying and selling or exchanging of products, services, and information; generating demand for them through marketing and advertising; servicing customers; collaborating with business partners; and conducting electronic transactions within an organization via computer networks, including the internet. E-business will improve business performance through low cost and open connectivity by introduction of new technologies in the value chain and connecting value chains across businesses in order to improve service, reduce costs, open new channels and transform the competitive advantage. [15]

Companies are becoming increasingly aware of the many potential benefits provided by E-business. [15],[2]. Some of the E-business potential benefits are: support of Business Reengineering efforts, expansion of the market reach that goes beyond any border, strengthening of relationships with customers and suppliers, cost reductions through the deployment of electronic internal and external business processes, and lower telecommunications costs as a result of the inexpensive Internet infrastructure. E-business projects often are deployed on the basis of a step-by-step approach. A well-known Gartner-model describes four levels of E-business: (1) the publishing level focusing on showing information of the company on a web site, (2) the prospecting level with customer oriented information, (3) the business integration level which is transaction centric and can be defined as E-commerce, and (4) the business transformation level which is the mature level of E-business that includes supplier and customer integration. *Completion of steps of the E-business project plan* will represents this evaluation item. An E-business project represents a capital investment that entails expenses as well as revenues. The start of an E-business project is also the initiation of a permanent commitment to resource demands because of ongoing expenses that often difficult to predict.

Because of the intangible nature of some of these benefits, it is difficult to measure the contribution of E-business initiatives to business performance and to manage these projects to ensure that real profits are realized. In practice, E-

business projects are often managed too technically and little attention is paid to the business case.

Uncertain Future

The new world of business imposes the need for variety and complexity of interpretations of information outputs generated by computer and information systems. Such variety is necessary for deciphering the multiple worldviews of the uncertain and unpredictable future. With increasing computerization in organizations, organizational routines originally embedded in standard operating procedures and policies become embedded in the firm's dominant logic embedded in programs and databases in the form of 'best practices'. Such formalized information systems tend to be inflexible and are often based upon designers' belief that they have already identified the organizational and environmental properties. However, with increasingly rapid, dynamic and non-linear changes in the business environment, static assumptions embedded in such systems become vulnerable. Growing realization of such vulnerabilities is behind increasing interest in designing information systems that can take dynamic and diverse interpretations of changing information into account.

Performance Measurement

For years, firms valued financial performance or market share as the most important success measures. The large firms fostered competition among their brand groups or retail outlets and measured success by the bottom line (profits). Many still do. During the mid- to late-1990's, the dot-com firms ignored financial measures and focused on growth, much to their dismay. These approaches are narrowly focused and place more weight on short-term results rather than addressing the firm's long-term sustainability [1].

These weaknesses paved the way for enterprise performance management systems that measure many aspects of a firm's achievements. The **Balanced Scorecard**, developed by two Harvard Business School professors in 1990 [6], is one such system. Fifty percent of organizations worldwide have adopted the Balanced Scorecard with excellent results ("The E-Commerce Balancing Act" 2000). The scorecard approach links strategy to measurement by asking firms to consider their vision, critical success factors for accomplishing it, and subsequent performance metrics in four areas: customer, internal, innovation and learning, and financial. In the following sections typical goals and metrics in each perspective are described.. However, it is important to remember that each firm defines the specific measures for each box—the system is very flexible.

Customer Perspective		**Internal Business Perspective**		**Innovation and Learning Perspective**		**Financial Perspective**	
Goals	**Measures**	**Goals**	**Measures**	**Goals**	**Measures**	**Goals**	**Measures**

Four Perspectives

The *customer perspective* uses measures of the value delivered to customers. These metrics tend to fall into four areas: time, quality, performance and service, and cost. They can include measures such as time from order to delivery, customer satisfaction levels with product performance, amount of sales from new products, and industry-specific metrics such as equipment up-time percentage or number of service calls.

The *internal perspective* evaluates company success at meeting customer expectations through its internal processes. The items with greatest impact in this area include cycle time (how long to make the product), manufacturing quality, and employee skills and productivity. Information systems are a critical component of the internal perspective for e-business firms.

The *innovation and learning perspective*, sometimes called the *growth perspective*, is one of the Balanced Scorecard's unique contributions. Here, companies place value on continuous improvement to existing products and services as well as on innovation in new products. These activities take employees away from their daily work of selling products, asking them to pay attention to factors critical to the firm's long-term sustainability—especially important for e-business firms. Measures in this area include number of new products and the percentage of sales attributable to each; penetration of new markets; and the improvement of processes such as CRM or SCM initiatives.

If the projected outcomes result from the previous perspectives and performance metrics, the financial perspective will be on target too. Financial measures include income and expense metrics as well as return on investment, sales, and market share growth. Companies must be careful to relate measurements from the first three perspectives to the financial area whenever possible.

Each firm will select metrics for the four perspectives based on its objectives, business model, strategies, industry, and so forth. The point is to understand what the company wants to accomplish and devise performance metrics to monitor the progress and see that the goals are reached.

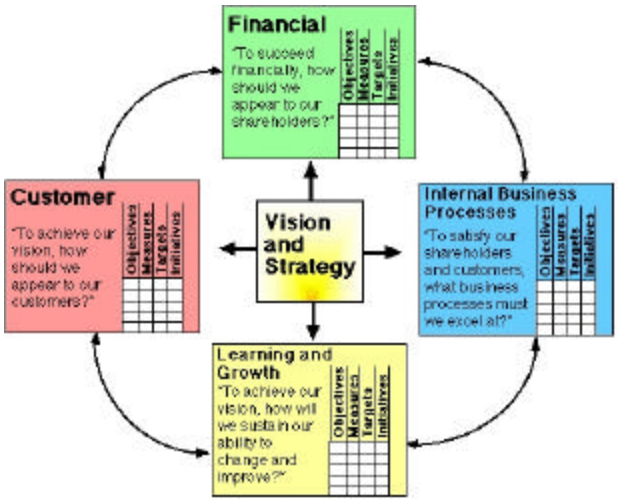

Figure 1

Scorecard Benefits

The Balanced Scorecard system helps a firm obtain timely information to update its strategy. Its four perspectives balance long-term and short-term measures and evaluate every part of the firm and how each contributes toward accomplishing selected goals. It also helps firms leverage their relationships with partners and supply chain members. The scorecard can be used by all types of organizations, both profit and not-for-profit, and in all industries, if they select appropriate metrics.

The Balanced Scorecard has many other specific benefits. First, it provides a way to go beyond financial metrics in measuring many different aspects that lead to effective and efficient performance. Second, it creates a long-term perspective for company sustainability. Third, it forces companies to decide what is important and translate those decisions into measurable outcomes that all employees can understand. Next, it is a great communication tool because employees can use the scorecard as a guide to coordinate their efforts. In addition, it supports employee evaluation in that individual performance can be tied to successful outcomes on the metrics. Also, it provides a way to measure intangible as well as tangible assets. This is especially important for firms using e-business models because knowledge, information, and innovation are critical to their success. Finally, the Balanced Scorecard is valuable because of its flexibility in allowing firms to select appropriate metrics for their goals, strategies, industry, and specific vision.

The general BSC-framework can be translated to the more specific needs of the monitoring and evaluation of the IT function and recently the IT BSC has emerged in practice [5],[18],[16],[17]. Many firms have successfully implemented the Balanced Scorecard. Hilton Hotels attributes its number-one ranking in customer satisfaction during 2000 and highest industry profits to this approach (Jackson and Baskey 2000). In another example, Wells Fargo Bank created Online Financial Services in the early Internet days to capitalize on new technologies. Its goal was to migrate current customers and draw new customers to the online channel. Using the scorecard as a roadmap to provide value to customers and to be sure internal processes and the technology could handle the anticipated volume, Wells Fargo beat its goal of 1 million customers within a short time ("The E-Commerce Balancing Act" 2000).

Balance Scorecard in E-Business Application

The Scorecard can use a Business-Centred model and structured sets of questions to enable you to assess where and how effectively you currently use e-business, and to explore and identify areas where e-business can be extended and improved [10], [3]. It is not a rigid 'e-specification' for every business but an independent and balanced source of innovation and challenge across key business processes [11], [12]. It can be designed to cover the impact of e-business on commercial strategy and operations and also reviews technical strategy in areas such as infrastructure and security.

The Scorecard can provide a comprehensive real-world framework coupled with a business process focused diagnostic tool to help the organization, irrespective of its size or nature of business, to identify 'where its main e-business opportunities are' and 'what it needs to do to enhance its e-business'. Larger, more complex, organizations can leverage key recommendations from the Scorecard assessment process across the business. Smaller organizations can benefit from the 'knowledge investment' made by medium and larger sized companies in e-business and are able to implement solutions more quickly. Appendix shows the generic measurement parameters [18], [12], [4].

Measurement

You can't improve what you can't measure. So metrics must be developed based on the priorities of the strategic plan, which provides the key business drivers and criteria for metrics managers most desire to watch. Processes are then designed to collect information relevant to these metrics and reduce it to numerical form for storage, display, and analysis.

Decision makers examine the outcomes of various measured processes and strategies and track the results to guide the company and provide feedback. Leading organizations agree on the need for a structured methodology for using performance measurement information to help set agreed-upon performance goals, allocate and prioritize resources, inform managers to either confirm or change current policy or program direction to meet those goals, and report on the success in meeting those goals. Also it is essential to know the data flow correctly so that it can be measured accurately.

Data Flow in BSC

There are two sets of more-or-less continuous data flows required in the BSC system:

1. Downward information flow

Line managers at the Directorate, Department, and Branch levels define goals, desired outcomes, initiatives, metrics, targets, and schedules. The goals, metrics, targets and schedules are aligned with those specified in the top-level strategic plan and balanced scorecard performance plan. Some ofhese parameters may have to be translated from general to more mission-specific to apply to the work being performed at each organizational level. Specific desired outcomes and initiatives to attain them are developed by these managers, and the metrics, targets and schedules are then developed. This results in a hierarchical set of balanced scorecards that are pertinent at each organizational level. It also has the effect of giving the organizational stakeholders a meaningful role in performance evaluation and strategic management.

2. Upward information flow

Define collection methods for each of the BSC metrics. This is the most expensive, labor-intensive, aspect of the BSC system, and has the most impact on the rank-and-file employees. I therefore recommend that for survey-based measurements, surveys should be carefully and professionally designed to minimize complexity and impact on the employees' time. Aggregate metrics data by organizational code. Create reports at each line management layer. These will provide feedback to the managers on metrics that are pertinent to their own strategic interests. Aggregate at each level (without filtering or loss of data). At the senior management layer, combine the metrics data into the 'vital few' needed to give an overall picture of the agency's balanced scorecard, on a continuous basis. These two information flows are illustrated in the Figure 2, using a notional organization chart:

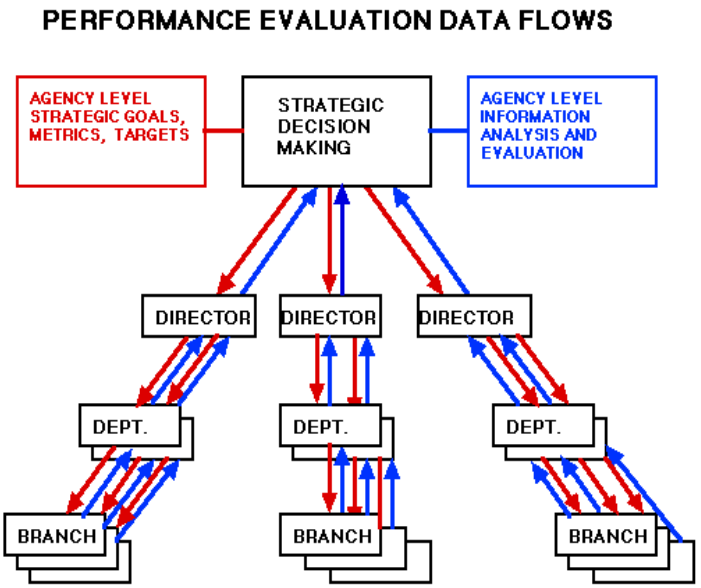

Figure 2 : Performance Evaluation Data Flows

In this figure, the top-level strategic goals, metrics and targets are in red, and they flow downward from the headquarters strategic planning office. The balanced scorecard measurements, in blue, are collected starting at the bottom (branch level) and flow upward. (This is analogous to the circulation of blood from arteries to veins.)

At each level of the organizational hierarchy, the data are aggregated across the lower levels. Aggregation serves to reduce information overload. Periodically, measurements can be collected, aggregated and analyzed at each management level. These data provide the managers with knowledge of strategic performance within their own part of the organization. In other words, the performance evaluations are not only for the top-level managers. Each manager, at each level, benefits by seeing the same metrics as they apply to his or her own area of responsibility. This is an incentive to support the balanced scorecard: *we are measuring ourselves -- and we get to use the data we collect for our own purposes*.

As it is clearly evident from the discussion above, there area a number of parameters in the performance measurement as far as the E-business balance scorecard is concerned. Out of all these parameters, some are exact (like financial data) and some are inexa ct (like customer satisfaction, etc.). As far as the inexact parameters are concerned, most of the items depend on some information flow and communication. The communication may be in the form of analog (human-based) or digital (computer-based). The analog communication may be ambiguous, vague or unclear. Since the measurement in these case are, somewhat, inexact, the idea of fuzzy logy can be applied to allow manipulation of both exact and inexact (fuzzy) inputs from the e-business to the balanced scorecard.

This fuzzy model works with a grades of membership and portrays inexact information represented by fuzzy statements, and explains both fuzzy conditional statements and the inference mechanism.

The Notion of Fuzzy Sets

The characteristic function of a crisp set assigns a value of either 1 or 0 to each individual in the universal set, thereby discriminating between members and nonmembers of the crisp set under consideration. This function can be generated such that the values assigned to the elements of the universal set fall within a specified range and indicate the membership grade of these elements in the set in question. Larger values denote higher degrees of set membership. Such a function is called *membership function* and the set defined by it a *fuzzy set* [20].

Let X denote a universal set. Then, the membership function μ_A by which a fuzzy set A is usually defined has the form

$$\mu_A : X \rightarrow [0,1] \quad (1)$$

where [0,1] denotes the interval of real numbers from 0 to 1, inclusive.

The fuzzy set provides us with an intuitively pleasing method of representing one form of uncertainty. Obviously, the usefulness of a fuzzy set for modeling a conceptual class or a linguistic label depends on the appropriateness of its membership function. Therefore, the practical determination of an accurate and justifiable function for any particular situation is of major concern. The methods proposed for accomplishing this have been largely empirical and usually involve the design of experiments on a test population to measure subjective perceptions of membership degrees for some particular conceptual class. There are various means for implementing such measurements. Subjects may assign actual membership grades, the statistical response pattern for the true or false question of set membership may be sampled, or the tie of response to this question may be measured, where shorter response times are taken to indicate higher subjective degrees of membership. Once these data are collected, there are several ways in which a membership function reflecting the results can be derived.

Fuzzy-based Measurement

The process of human-based communication consists of a vast array of different types of simultaneously communicated signals, many of which conflict with each other. It is, therefore, difficult to determine the precise intention and meaning of the communication, because of both distortion from environmental noise and ambivalence on the part of the sender. Nevertheless, the receiver must respond appropriately in the face of this fuzzy or vague information [21].

Suppose that X constitutes the universal set of all possible signals x that may be communicated by the sender. Because of the distorting factors mentioned above, a clear, unique signal may not be available. Instead, the message received is a fuzzy subset of M of X, in which M(x) denotes the degree of certainty of the receipt of the specific signal x. In order to determine whether an appropriate response can be chosen based on the message received or whether some error was involved in the communication, an assessment of the quality of the transmission must be made. Let the maximum value of membership that any x e X attains in the set M correspond to the *strength* of the transmission. If the set M is large , no unique maximum, then the message is called *ambiguous.* If the support of M is large, then M is considered to be *general*. The clarity of the message can be measured by the distance between the maximum membership grade attained in M and the next largest grade of any signal x in M. When the message received is strong, unambiguous, and clear, then the signal attaining the maximum membership grade in M can easily be selected as the most obvious intended communication. Difficulty occurs, however, when the message is weak, ambiguous, or unclear. In this case, the receiver must determine whether the problem in the communication lies in some environmental distortion (in which case a repetition of the signal may be requested) or in the sender of the message (in which case a response must be made that is, as far as possible, appropriate).

Usually, the receiver of the communication possesses some background information in the form of probabilities or possibilities of the signals that can be expected. If $p(x_1)$, $p(x_2)$, ……, $p(x_n)$ represent the probabilities associated with each of the signals x_1, x_2, ….., x_n e X, then the probability of the fuzzy event of the receipt of message M is given by

$$p(M) = \sum_{x \in X} M(x)\, p(x) \quad (2)$$

The receiver can use this information to assess the consistency of the received message with his/her expectations. If the probability of the received message is high, then it can be assumed that little distortion was introduced by the environment. On the other hand, if the message is very clear and unambiguous, then as appropriate response can be made even if the probability of the signal was low.

Instead of the expectation or background information being given in probabilistic form, this information may be given in

the form of a possibility distribution r on X. In this case, r(x) e [0,1] indicates the receiver's belief in the possibility of signal x being sent. The total possibility of the fuzzy message M is calculated as

$$r(M) = \max_{x \in X}[\min(M(x), r(x))] \quad (3)$$

As in the case of probabilistic expectation, if the received message conflicts with the expected possibility of communication, then the receiver may attempt clarification by requesting a repetition of the transmission. Before this new transmission is sent, the receiver will probably have already modified his/her expectations based on the previous message. If r_0 indicates the initial expectations of the receiver, and r_1 is the modified expectations subsequent to the receipt of message M, then

$$r_1(x) = \min [r_0^{a}(x), M(x)] \quad (4)$$

for each x e X, where a indicates the degree to which past messages are considered relevant in the modification of expectations. The procedure for signal detection now consists of the following: a test of the consistency of M against the expectations and a test of the message M for strength and clarity. If both of these values are high, the signal attaining the maximum value in M be comfortably assumed to be the intended signal. If both tests yield low values, the expectations are modified and a repetition is requested. If only one of these tests yields a satisfactory value, then either a new signal is requested or a response is made despite the presence of doubt.

An additional complication is introduced when we consider that the receiver may also introduce distortion in the message because of inconsistency with the expectations. Let

$$s(M,r) = \max_{x \in X}[\min(M(x), r(x))] \quad (5)$$

correspond to the consistency of the received message with the possibilities expectations. Then, let M` denote the message that the receiver actually gets, where

$$M`(x) = M^{s}(x) \quad (6)$$

for each x e X where s = s(M,r). The less consistent M is with the expectations, the less M` resembles M. Since the receiver will be modifying his or her expectations based on the message thought to have been received, the new possibility expectation structure is given by

$$r_1(x) = \min[r_0^{1-s}(x), M`(x)] \quad (7)$$

for each x e X.

Finally, once a determination has been made of the signal x e X that was sent, an appropriate response must be chosen. Let Y be the universal set of all responses, and let R, the subset of Y x X be a fuzzy binary relation in which R(y,x) indicates the degree of appropriateness of response y given signal x. A fuzzy response set A e Y can be generated by composing the appropriateness relation R with the fuzzy message M,

$$A = R \circ M \quad (8)$$

or

$$A(y) = \max_{x \in X}[\min(R(y,x), M(x))] \quad (9)$$

for each y e Y. The membership grade of each possible message y in fuzzy set A thus corresponds to the degree to which it is an appropriate response to the message M. A more interesting case occurs when the elements y e Y are not actual messages, but instead indicate characteristics or attributes that the appropriate message should possess. This allows for creativity in formulating the actual response.

Conclusion

In this paper, the balanced scorecard concepts are applied to E-business projects. The fuzzy logic framework has been applied to a generic E-business balanced scorecard and presented as a measuring and management isntrument. The proposed fuzzy logic framework can be applied to the inexact parmeters of three perspectives (out of four): the customer perspective, internal perspective, and Innovation and Leraning perspective. These fuzzy-based monitoring instruments are a must when building, implementing and maintaining an E-business balance scorecard.

Appendix

Measurement Parameters

Customer Perspective	
Goals	**Possible Measures**
Build awareness of a new Web site service	Survey target awareness of service Number of visitors to the site
Position firm as high tech	Survey target attitudes
Increase number of software downloads from the Web site	Number from Web site log
High customer satisfaction with Web site	Survey of target at Web site Number of visits and activity at site
High customer satisfaction with value of online purchasing	Number of complaints (e-mail, phone) Number of abandoned shopping carts Sales of online versus offline for same products
Increase the amount or frequency of online sales from current customers	Mine the database for change in frequency of purchases over time
Build customer relationships	Number of purchases per customer over time (using cookie data) Customer retention percentage
Appropriate target markets	Data mining to find purchase patterns by targeting criteria
Buy-to-delivery time faster than competition	Number of days from order to delivery Competition delivery times
Increased coupon use from Web coupons	Number who redeem
Build communities on the site	Number of registrations to community Number of posts to community bulletin board
Value for Business Partners	
Increase number of affiliates in program	Number of affiliates over time
Cross-sell to partner sites	Number of visitors to partner site from our site

Innovation and Learning Perspective	
Goals	**Possible Measures**
Online service innovation	Number of new service products to market in a year Number of new service features not offered by competitive offerings Percent of sales from new services
Continuous improvement in CRM system	Number of employee suggestions Number/type of improvements over time
High Internet lead to sales conversion	Revenue per sales employee from Internet leads Number of conversions from online leads
Increased value in knowledge management system	Number of accesses by employees Number of knowledge contributions by employees
Successful penetration of new markets	Percentage of the firm's sales in each new market

Internal Perspective	
Goals	**Possible Measures**
Improve the quality of online service	Target market survey Number of customers who use the service Time to run the service software from Web site
Quality online technical help	Amount of time to answer customer e-mail Number of contacts to solve a problem Number of problems covered by Web site FAQ Customer follow-up survey
Quick product cycle time	Number of days to make the product
High product quality for online service	Product test statistics on specific performance measures

Web server size adequate and operational 24/7	Number of actual simu ltaneous Web page requests ? maximum possible Percentage of up-time for server Number of mirrored or backup sites
Optimized number of customer service reps responding to online help	Number of inquiries to customer service rep ratio
Superior Web site content management	Number of updates per week Web site log traffic pattern statistics
Optimized inventory levels	Average number of items in warehouse Inventory turnover Supplier speed to deliver product
Supply Chain Value to firm	
High supplier satisfaction	Supplier profits from our firm's orders
Partner value	Number of visitors from partner site to ours and number that purchase Partner contribution to product design

Financial Perspective	
Goals	**Possible Measures**
Increase market share for online products	Market share percentage (firm's sales as percentage of industry sales)
Double digit sales growth	Dollar volume of sales from one time period to the next
Target 10% ROI within one year for each new product	ROI
Lower customer acquisition costs (CAC) in online channel	CAC (costs for advertising, etc. divided by number of customers)
Increase conversion rates at Web site	Number of orders divided by number of visitors to site
Increase individual customer profit	Average order value Profit contribution over time less CAC
Achieve at least a 10% Net profit in first year of new product	Net profit as percentage of sales

References

[1] Adams, C., Kapashi, N., Neely, A., and Marr, B. Measuring eBusiness performance, Cranfield University School of Management/Acc enture, http://www.accenture.com.2001.

[2] Amor, D. *The E-business revolution: living and working in an interconnected world.* Upper Saddle River (NJ): Prentice Hall,2000.

[3] Berghout, E., and Renkema, T. "Methodologies for IT Investment Evaluation: A Review and Assessment", in Van Grembergen, W., *Information Technology Evaluation Methods and Management,* Hershey (PA): Idea Group Publishing,2001, pp.78-97.

[4] Chaffey, D., Mayer, R., Johnston, K., and Ellis-Chadwick, F.. *Internet Marketing*. Harlow: Pearson Education,2000.

[5] Graeser, V., Willcocks, L., and Pisanias, N. *Developing the IT scorecard.* London: Business Intelligence, 1998.

[6] Kaplan, R., and Norton, D. *The balanced scorecard translating strategy into action.* Boston: Harvard Business School Press, 1996.

[7] Lee, S. The Business Value of Transaction - Based Web Sites. In Proceedings of the 9th Information Resources Management (IRMA) International Conference,1998, 749-751. Boston.

[8] Parker, M. *Strategic transformation and information technology*, Upper Saddle River (NJ): Prentice Hall, 1996.

[9] Paulk, M., Curtis, B., Chrissis, M-B., and Weber, C. Capability maturity model for software, version 1.1, Technical Report, CMU/SEI-93-TR024, ESC-TR-93-177, Software Engineering Institute,1993.

[10] Raisinghani, M. "A Balanced Analytic Approach to Strategic Electronic Commerce Decisions: A Framework of the Evaluation Method", in Van Grembergen, W., *Information Technology Evaluation Methods and Management*, Hershey (PA): Idea Group Publishing, 2001,pp.185-197.

[11] Robson, W. "Information value and IS investment", in Robson, W., *Strategic management and information systems*, London: Pitman Publishing, 2001,pp.347-394.

[12] Rosemann, M. "Evaluating the Management of Enterprise Systems with the Balanced Scorecard", in Van Grembergen, W., *Information Technology Evaluation Methods and Management*, Hershey (PA): Idea Group Publishing,2001, pp.171-184.

[13] Schwartz, E. *Webeconomics*. New York: Broadway Books.,1998.

[14] Stewart, T. "The E-business Tidal Wave", http://www.deloitte.com/tidalwave/,1998.

[15] Turban, E., Lee, J., and King D. *Electronic commerce: a managerial perspective.* Upper Saddle River (NJ): Prentice Hall, 2000.

[16] Van Grembergen, W., and Van Bruggen, R. Measuring and improving corporate information technology through the balanced scorecard technique. In Proceedings of the 4th European Conference on the Evaluation of Information Technology , 1997,163-171. Delft.

[17] Van Grembergen, W., and Timmerman, D. Monitoring the IT process through the balanced scorecard. In Proceedings of the 9th Information Resources Management (IRMA) International Conference,1998, 105-116. Boston.
[18] Van Grembergen, W., and Saull, R. Information Technology Governance through the Balanced Scorecard. In Proceedings of the 34th Hawaii International Conference on System Sciences (HICSS),2001.
[19] Zeithaml, V., Berry, L., and Parasuraman, A. The nature and determinants of customer expectations of service. *Journal of the Academy of Marketing Science* 21 (winter): 1-12,1993.
[20] Klir, G.J. and Folger, T.A. Fuzzy Sets, Uncertainty and Information. Prentice-Hall,2002.
[21] Klir, G.J. and Yuan B. Fuzzy Sets and Fuzzy Logic. Prentice-Hall, 2002.

Note: The full paper is available from the CD of conference proceedings.