

Assessing e-Business Capabilities and Effectiveness: A Set of Key e-Business Metrics

Debabroto CHATTERJEE[†]
Albert H. SEGARS[‡]

Measuring e-business activities and initiatives poses two major challenges. First, the all-encompassing and abstract nature of e-business makes it difficult to develop metrics that will solely measure the effectiveness of e-business ventures. In fact, many experts contend that companies make a mistake in trying to separate e-business from the rest of business. Therefore, a more holistic approach to e-business measurement is needed. The other challenge lies in identifying the key measures. Several e-metrics are available, and if a company tried to adopt every one of them, it would be lost in a flood of e-metric data. Thus, companies need a set of key metrics to assess their e-business capabilities and performance efficiently and effectively. This paper presents such a set of metrics by drawing from best practices data from a major field study that examined e-business transformation efforts across several industries and firms in the United States and abroad. Conceptualizing e-business capability as the ability to engage effectively in different forms, scopes, and modes of electronic exchange, this study provides three classes of metrics to assess digital readiness, collaborative capability, and viability of electronic marketplaces.

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Introduction

While the hype around the Internet has mellowed, especially with the demise of the dot.com companies, the need to develop e-business capabilities continues to gather momentum. Recent surveys and benchmarking studies report continued and sustained corporate investments in enterprise digitization projects.

As companies contemplate and pursue a variety of e-business initiatives, most of which require significant investments of financial and other resources, there is a need for a robust and sound set of metrics to evaluate the feasibility and effectiveness of such initiatives. A Forrester survey found that 90% of the top 50 global companies use traditional metrics such as return-on-investment (ROI) to evaluate the success of their e-businesses. The report stated that surveyed executives relied on conventional financial measurements such as ROI and payback period when deciding which e-business projects to fund. However, the executives also admitted that these traditional evaluation methods were not effective in measuring the success or failure of e-business projects [1].

Measuring e-business activities and initiatives poses two major challenges. First, the all-encompassing and abstract nature of e-business makes it difficult to develop metrics that will solely measure the effectiveness of e-business ventures. In fact, many experts contend that companies make a mistake in trying to separate e-business from the rest of business [1, 2]. To cope with this challenge, a more holistic approach to e-business measurement is needed. Using the balanced scorecard approach to develop e-business metrics is a concrete step in this direction [2, 3]. The other challenge lies in identifying the key measures. Several e-metrics are available, and if a company tried to adopt every one of them, they would be lost in the flood of e-metric data. One suggested approach to cope with this challenge is to combine several measures into some aggregate metric that can be tracked easily [4].

Thus, companies need a set of key metrics to assess their e-business capabilities and performance efficiently and effectively. This paper attempts to provide such a set of metrics by drawing from best practices data collected from a major field study (see Appendix 1 for methodology details) that examined e-business transformation efforts across several industries and firms in the United States and abroad. Another unique strength of this paper lies in providing a list of measures to assess the viability and performance of electronic marketplaces. Leveraging public

[†] University of Georgia (USA)

[‡] University of North Carolina at Chapel Hill (USA)

marketplaces and private exchanges is often an integral component of the e-business strategy of a company; so it is important that companies soundly assess these marketplaces.

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Conceptualizing e-Business Capabilities and Effectiveness

We conceptualize e-business in terms of electronic exchanges that may differ in form, mode, and scope. Forms of electronic exchange can be broadly classified as transactions, coordination (for supply chain management), or collaboration. Transactions are the simplest types of commerce and entail the exchange of product/service for cash. This form of exchange was the primary focus of the first wave of business-to-business (B2B) commerce. Coordination refers to the sharing and exchange of information to better coordinate and synchronize various supply chain processes. It represents a higher level of exchange where business partners have greater and deeper access to key information such as inventory levels, production volume, manufacturing capacity, order status, and customer needs. Collaboration involves exchange of information and knowledge among business partners and competitors to deliver value-added products/services to customers. It represents the highest level of involvement and engagement, enabling companies to outsource non-critical operations and focus on their core competencies.

Firms may conduct the different forms of electronic exchange (i.e., transactions, coordination, and collaboration) in different market modes. A closed market mode is typically a small collection of firms that agree on a process and technology protocol for exchanging goods, information, and/or knowledge. These closed marketplaces especially find favor with firms that want to execute mission-critical and complex processes and exchange information of strategic importance. Numerous participants, a variety of product categories, and extremely short lead times characterize the open marketplace mode. Most firms use the open marketplace to contain costs associated with the procurement of commodity-based items.

The scope of an electronic exchange may be static or dynamic. Due to the rigid structure of process (time order of events, sequence), technology, and policy governing exchanges, firms often become locked into a rather static set of exchanges that cannot be reconfigured without incurring steep coordination costs. As a result, these firms utilize electronic linkages in a very regimented and defined manner. Firms that have developed dynamic exchange capability are able to execute a variety of electronic transactions with a variety of business partners. The competitive objective of dynamic capability is to transform the supply and demand chain from a linear structure into a constellation of potential arrangements. In other words, the firm attempts to 'plug and play' into different supply chain configurations to increase responsiveness to the marketplace [5, 6].

Thus, e-business capability refers to the ability of a firm to participate effectively in different forms of electronic exchanges, create and leverage open and closed modes of exchanges, and engage in dynamic exchanges. Cisco, Intel, Unilever, Occidental Chemical Corporation, and Dell are examples of companies that have very strong e-business capabilities. Such capabilities are reflected in how they engage in higher forms of exchange whereby they not only execute business transactions electronically but also engage in collaborative planning, fulfillment, and replenishment. These companies are also known to e-enable their buy and sell side processes by establishing electronic partnerships through private exchanges and public marketplaces. Finally, they are also capable of rapidly and efficiently configuring and reconfiguring their electronic supply chain linkages to meet the ever changing demands of business [7, 8, 9 and 10].

Considering the multi-dimensional nature and far-reaching impacts of e-business capability, the measures must provide a rich and multi-level assessment. The following classes of metrics do offer a balanced and holistic assessment by including both process and outcome measures.

1. Metrics for assessing the digital readiness of the firm (see [Table 1](#)).
2. Metrics for assessing the collaborative capability of the firm (see [Table 2](#)).
3. Metrics for assessing the viability of electronic marketplaces (see [Table 3](#)).

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Digital Readiness of the Firm

As shown in **Table 1**, measures of digital quotient assess the percentage of digital processes, the percentage of suppliers who are electronically enabled, and the percentage of customers who are electronically enabled. Together, these measures address digitization from the sell side, the buy side, and from the perspective of internal operations. These measures also assess the visibility of information between the firm and its suppliers and customers. In some firms like Raytheon and Deere & Co., these metrics are used as a driver in identifying customers who are costly to service and suppliers who impose high purchasing costs. These metrics are also used to identify areas of the firm that are using technology effectively.

A second set of 'digital readiness' measures address responsiveness to the customer. Electronic responses that are generated automatically and by customer service representatives are timed. In addition, the percentage of customers who are sent personalized content through automated reply is measured. Together, these measures provide a glimpse into the ability of the firm to use its electronic and informational resources to address customer concerns and gather key marketing research. Conversion of site visits to sales or leads is another key metric among firms studied. Measures of electronic sales as a percentage of site visits, electronic inquires, and total sales assess the firm's ability to sell and market successfully with Web based technology. Many firms such as Dell, Intel, and Cisco collect these measures across product categories to drive more electronic selling for simple products and less electronic selling for complex products. For example, Cisco has actually lessened its electronic selling of high-end switching gear as the needs of their customers have become more complex. A final measurement of this set is confirmation cycle time. This measure gauges the flow of information between selling technology and manufacturing/scheduling technologies. Ideally, a customer should be given instant confirmation of product availability and pricing. Unfortunately, this area of information integration has been difficult for firms to master.

Table 1. Metrics for Assessing Digital Readiness

Metric	Explanation
Digital Quotient	
Digital Processes/Total Processes	Percentage of Digital Processes
e-Enabled Suppliers/Total Suppliers	Percentage of Suppliers doing Business Electronically
e-Enabled Customers/Total Customers	Percentage of Customers doing Business Electronically
Transparent Suppliers/Total Suppliers	Percentage of Suppliers with Two-Way Views into Databases
Transparent Customers/Total Customers	Percentage of Customers with Two-Way Views into Databases
Online Transactions/Total Transactions	Percentage of Transactions done Electronically
Customer Service	
Customer Response Time	Time to Respond to Customers in Automated Reply and in Personalized Electronic Reply
Recognized Customers/Total Customers	Percentage of Customers Sent Personalized Content during Electronic Inquires
Electronic Purchases/Visits	Conversion of Visits to Purchases
Customized Products/Total Products	Percentage of Customized Products Sold
Electronic Inquires/Total Inquires	Percentage of Inquires Initiated Electronically
Electronic Sales/Total Sales	Electronic Sales as a Percentage of Total Sales
Confirmation Cycle Time	Time to Confirm Availability and Pricing
Cash Flow	
Average Price/Electronic Price	Yield for Reverse Auction Format Selling
Bid to Cash Cycle	Days from Bid to Cash Generation
Days Sales Inventory + Days Sales Receivables – Days Sales Payables	Free Cash Flow
Sales/Inventory	Inventory Turns

The final set of 'digital readiness' measures are based on cash flow. For the firms studied, a major target of e-business efforts is improved flow of financial capital throughout the firm and throughout the supply chain. Bid to cash cycles and free cash flow directly address the efficiency of cash flow. Respectively, these measures assess the speed of turning bids into cash and the ability of the firm to collect revenue before it pays suppliers. Inventory efficiency is also a key consideration in this set of metrics. Inventory turns are expected to increase dramatically as firms form electronic partnerships to improve visibility and sharing of supply chain data. Companies like Dow Chemical, Eastman Chemical, General Motors and Ford are known to realize the various benefits of improved supply chain coordination and synchronization. Related to inventory turns are measures associated with yield pricing. As shown in [Table 1](#), a popular measure for capturing price dynamics is yield price percentage. This ratio captures the percentage gain in pricing from reverse auction formats. Given that prices are driven up in reverse auctions, the firm should yield better pricing thresholds. Other variations of this measure are used to assess revenue growth from yield pricing. Similar to the airline industry, manufacturing and service firms are now using dynamic pricing to manage capacity and unsold inventory more efficiently.

This collection of 'digital readiness' measures capture multiple factors of organizational performance. Similar to a balanced scorecard methodology, the metrics address aspects of customer, process, and finance. In other words, this set of metrics consists of both process and outcome measures. Moreover, these metrics are good measures of the 'form' dimension of e-business because the extent of digitization of business processes is critical to a firm's ability to engage in all forms of electronic exchanges ranging from transactions to coordination and collaboration.

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Collaborative Capability of the Firm

The set of measures listed in [Table 2](#) addresses the ability of a firm to collaborate electronically on the development of new products and services. Some firms utilize these measures for internal collaboration between business units. Others use these measures to assess their collaborative efforts with members of their business network (suppliers, customers, competitors, and complementary product producers). In each of these instances, the focus is on measuring the exchange of knowledge and the amount of innovation that result from these exchanges.

Innovation is the underlying theme of the first set of collaborative measures. Metrics such as the number of new concepts screened, the number of prototypes developed, and the cycle time between concept and development measure the ability of the business to move ideas from the drawing board into production. This theme seems to be a strong force in assessing the effectiveness of technologies as simple as a discussion group or as complex as a collaborative development tool. Other key innovation measures are reaction time and time frame of exclusivity. Together, these measures assess the ability of an organization to hold a competitive advantage and to strike quickly once another firm has gained competitive advantage. Finally, firms employing collaborative technologies tend to measure the number of novel inventions or intellectual property that results from their cooperative efforts. These measures tend to be simple counts, valuation based on discounted cash flow, or licensing revenue from inventions, patents, and other intellectual property. These measures are also an important source of assessment in terms of ensuring that collaborative technologies are yielding tangible products rather than superfluous information. As noted by a few respondents, collaboration creates a strong potential for the collection and creation of too much information and knowledge. Unless efforts are focused around innovative products with significant market potential, collaboration can turn into an unproductive activity of creating products with no market or reasonable price threshold.

Measures of learning address the efficiency of creation and usage of both knowledge and information. These measures also address the number of new knowledge sources and the accuracy and usefulness of information and decision-making tools. Two themes tend to characterize this set of measures. First, the firm should have a better sense of 'knowing what it knows' after the launch of an e-business effort. Improved access to information and knowledge through storage schemes, technology-based access to experts, and other collaborative software are sometimes as-

Table 2. Metrics for Assessing Collaborative Capability

Metric	Explanation
Innovation	
Concepts Screened per Quarter	Number of New Concepts Evaluated
Prototypes Developed	Number of Prototypes Formally Evaluated
Concept Cycle Time	Days from Concept to Development
Reaction Cycle Time	Days to Match a Competitor's Initiative
Exclusivity	Days before Competitors Match an Initiative
Patents and IP	Number of New Patents and IP
Learning	
Information/Knowledge Acquisition	Time to Find Documents or Access to Experts
Forecasting Accuracy	Improvement in Forecasting Capabilities
New Knowledge Access	Number of New Sources for Knowledge and Information
Reduced Duplicity	Savings Gained through Elimination of Duplicate Tasks
Investment	
Net Income/Assets	Risk Sharing through Investment with Fewer Assets
Firm Cap/Industry Cap	Migration of Market Cap through Firm and Industry Growth
Weighted Average Cost of Capital	Propensity to Invest in Riskier Projects without a Severe Downward Impact on Cost of Capital
Beta	Propensity to Invest in Riskier Projects without Adversely Impacting Market Position of Stock

essed by measuring the time to find required documents or the number of mouse clicks. Secondly, the firm should have an improved sense of 'knowing what it does not know'. Information and knowledge filtering become significant issues as more information and knowledge are contributed by more people. Excess time in finding documents or too many mouse clicks may be a sign of too much information. Clearly, the goal of these measures is to strike a balance of efficiency and effectiveness in managing knowledge and information resources.

Similar to measures of digital readiness, a heavy return on investment component is found in measures of collaboration. Three sub-themes characterize this set of measures. First, collaboration is expected to result in growth of the industry; therefore, if a firm is competitively active in creating a new industry boundary, then its share of industry market capitalization should rise. Many dynamics are at work in this metric: stock price, competitor's stock price, market rate of return, and general investor sentiment. Overall, the objective is to assess how cooperation and collaboration have impacted the industry and the firm.

The second sub-theme of this set is simple return on investment, which is most typically captured in simple measures of return on assets (ROA). Collaboration should allow a firm to enter markets with fewer commitments to assets. For example, a firm may outsource manufacturing of a new product rather than committing investment to a new plant and equipment. ROA should become much higher if the initiative succeeds. While simplistic, this theme is a very important driver in collaborative investment decisions. Improved revenue without the risk of committing the firm to fixed assets and, therefore, strategic inflexibility is viewed as critical in effective collaboration. The final sub-theme is best captured as risk management. Through collaboration, it is hoped that the firm will be able to invest in riskier projects without adversely affecting its capital structure. Market beta as well as weighted average cost of capital are measures to assess the impact of technology-based partnerships on a firm's profile of market risk.

The fact that these measures focus on assessing the collaborative capabilities of a firm makes them an excellent set of indicators of a firm's ability to engage in all forms of e-business, especially the highest form of exchange: collaboration. Moreover, the extent of collaborative capability is also a reasonable indicator of a firm's flexible ability to plug in and out of supply chain relationships. Thus, this set of metrics provides 'outcome' measures that tap into the 'form' and 'scope' dimensions of e-business capabilities.

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Viability of Electronic Marketplaces

Electronic marketplaces serve as hubs or gateways for the exchange of products/service, information, and knowledge among business entities [11 and 12]. These marketplaces provide value to their members in many different ways. By serving as trading exchanges, they provide new and efficient markets for the purchase and sale of products and services. Especially in fragmented industries, where buyers have difficulty in locating suppliers with the right parts and prices, these B2B marketplaces are of great value. By providing tools for e-enabling and integrating both buy-side and sell-side business processes (e.g., procurement, ordering, payment, and fulfilment), these electronic hubs reduce transaction costs and enhance transaction efficiency. Moreover, inter-enterprise integration of business processes results in greater information access and visibility, which in turn enables collaborative planning, forecasting, and replenishment [13]. Many of these marketplaces also offer tools for collaborative product design and development and project management. In addition, decision support and other analytical tools are available to help member firms derive maximum business intelligence.

Despite the many benefits that these marketplaces provide, several have closed down because of lack of critical mass. It has been a challenge for companies to get their business partners (i.e., customers and suppliers) to join these marketplaces. Concerns have ranged from impersonalization of business relationships to loss of control, ownership, and flexibility. Many of them, especially the smaller companies, have found the membership and transaction fees to be too high. Moreover, success of collaborative commerce hinges on the extent to which companies are willing to trust each other; it requires companies to adopt a collaborative mind-set when working not only with business partners but also with competitors. This change in mind-set is not easy to achieve [14 and 15].

Since the cost of building and operating a collaborative exchange can run into millions of dollars, there is a definite need for appropriate metrics to measure the performance of these sites. Investors and strategic partners are no longer willing to accept metrics such as relevance to customers, number of registered users, and the size of transactions conducted via the site, for it is difficult to anticipate revenue and profits based on these metrics. Thus, identification and usage of appropriate measurement criteria are critical to the survival and success of these collaborative marketplaces [16]. Table 3 provides a listing of metrics that focus on assessing the competitive strength and long-term viability of these marketplaces. As shown, the metrics can be subdivided into three categories:

- The first category focuses on 'acquisition,' or the ability of the electronic marketplace to attract participants/clients. When an electronic marketplace is competitively viable, growth in active users should rise, growth in successfully settled transactions should rise, and the churn rate of members should be low. Together, these measures gauge the strength of the marketplace in terms of member loyalty and member growth.
- The second category of measures gauges the activity of members in terms of number and value of transactions. Viable electronic marketplaces should exhibit growing volumes of transactions per active user and rising transaction value per active user.
- Finally, monetization measures assess the profitability of the electronic marketplace. Higher revenues per user and higher returns on operating income suggest that the marketplace is strong financially and will likely remain a thriving entity.

These set of measures enables a company to assess the viability and usefulness of public and private marketplaces and, therefore, decide whether to join, pull out, or continue to participate. Since developing, implementing, and running private exchanges can be a costly proposition, the measures are also useful for companies that have their own private exchanges [17].

Table 3. Metrics for Assessing Electronic Marketplaces

Metric	Explanation
Acquisition	
Buyer Growth Rate	Rate of Increase in Active Buyers in the Marketplace
Marketing Expenses/Sales per Active User	Dollars of Sales Generated through Marketing Expense
Active Users/Total Members	The Percentage of Active Users Relative to Members
Acquisition Effectiveness	Percentage of Transactions in which Buyer and Seller Settle
Former Members/Total Members	Churn Rate
Penetration	
Transactions/Total Transactions	Electronic Transactions as a Percentage of Total Transactions
Transactions per Active User	Average Number of Transactions for All Active Users
Average Transaction Value	Average Transaction Value for All Active Users
Transaction Growth Rate	Growth in Transactions for Active Users
Transaction Value Growth Rate	Growth in Transaction Value for Active Users
Number of Transaction	Total Number of Transactions
Monetization	
Revenue/Active User	Revenue per Active User
Revenue/Total Transactions	Revenue per Transaction
Operating Expenses/Revenue	Operating Margin
Income/Total Transactions	Average Transaction Fee
Net Income/Operating Expenses	Return on Operating Expenses

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Conclusion

The days of the Internet boom era (1994-2001), when cheering investors were simply happy to see their companies set up shop on the Internet, are over. Especially after the Dot com bust, companies can no longer afford simply to sink money in e-business initiatives without developing and using appropriate metrics to assess the returns from such investments. As more and more companies invest significant resources to e-enable their business activities and transform traditional ways of doing business, the need to measure the success of such transformation efforts has never been felt more.

This paper has presented a set of metrics that measures the extent to which companies have succeeded in electronically enabling their internal and inter-organizational business processes. The first class of metrics focuses on the 'digital readiness' of the firm to conduct the various types of exchanges electronically. Digital quotient, customer service, and cash flow measures can be used to make this assessment. A second set of measures can assess the ability of firms to collaborate electronically on the development of new products and services. Innovation, learning, and investment metrics can be used to make this assessment of collaborative readiness. Finally, there is a third class of metrics that assess the viability of electronic marketplaces to conduct various types of exchanges. Acquisition, penetration, and monetization measures can be used to assess such marketplace readiness and feasibility. Considering that the above classes of metrics provides a set of measures from the customer, internal business, innovation and learning, and financial perspectives, the scope of coverage is balanced and quite comprehensive.

Appendix 'Methodology'

Research Design

This paper is one of several papers that come out of an extensive field study on e-Business. The overarching goal of this field study was to examine and explore the various aspects of the e-Business phenomenon – ranging from conceptualization to implementation and measurement. A multi-phase and multi-method approach was adopted to gather data over a period of 3 years, starting 2001.

Data Collection Methods

During the first phase, we extensively reviewed the literature and conducted interviews with several practitioners and academics to get a better handle on the phenomenon. In phase 2, we further expanded the coverage of perspectives by interviewing 15-20 senior IT and business executives from a set of carefully selected firms. Two preliminary case studies were also conducted during this phase. In phase 3, six more case studies were conducted to develop a richer understanding of the implementation challenges associated with the various viable e-business models. Finally, several follow-up and new interviews were conducted to make better sense of the findings and probe into emerging best practices.

Several executives at senior and junior levels were interviewed. These interviewees included 36 VPs, 10 CIOs, 42 Functional Heads, and 20 Account/Sales Representatives.

Sample Description

Our sample comprised of firms from a variety of manufacturing and service oriented industries. These industries included Aerospace, Financial Services, Banking, Energy, Chemicals, Airlines, Telecommunications, Wireless, Computer Hardware and Software, and Transportation. The companies in the sample included Boeing, Seimens, IBM, Putnam, GE (Aircraft Engines), Ford Motor, Nortel, Intel, Cisco, Bose, Texaco, Delta, United Parcel Service, SAP, FEDEX, GMAC, US Navy, Raytheon, Bank of America, Exxon/Mobile, ChevronTexaco, Commerce One, Charbroil, Ariba, Microsoft, Oracle, Nokia, Wells Fargo, Sprint, Dell, AT&T, Amazon.com, Sun, Wal Mart, Ericsson, Dow Chemical, FreeMarkets, Dupont, Disney, BAE Systems, General Dynamics, Shell Oil, Unilever, Colgate-Palmolive, and Occidental Chemical Corporation.

Validation

To enhance the face and content validity of the metrics presented in this paper, both academics and practitioners were asked to review them and provide feedback. Such feedback was used to make the necessary modifications. Several of these metrics are already in use in organizations and that enhances the legitimacy of these measures.

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