A Framework for Developing E-Business Metrics Through Functionality Interaction

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Abstract

As firms move toward a more disciplined approach to e-business strategic planning, managers are seeking metrics that will help them analyze the success of their e-business investments. Likewise, researchers require metrics to build analytical models of the impact of managerial strategy on firm performance and to validate empirical field research on specific managerial tactics. In this paper, we develop a comprehensive framework for identifying e-business applications associated with activities upstream in the value chain, that complements an existing framework for applications further down the value chain. We propose that the real value proposition in e-business applications can be found in *functionality interaction* where one application enables the successful functionality in another application. The framework provides a methodology for mapping e-business applications within the proposed frameworks, which then can be used to generate three different types of metrics that should be considered for evaluating e-business strategic initiatives. Further, a classification of e-businesses provides the basis for selecting those metrics that are important to the strategic thrusts of the organization. The methodology allows the e-business strategist to map the organization's e-business objectives into a coherent, easily understood visual representation. The framework is based on an extensive literature review of several reference disciplines.

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1. Introduction

The traditional management functions of planning, organizing, leading, and controlling are as old as the management science discipline itself. These functions are based on a preconception that executives can measure what they are attempting to manage and take corrective action when necessary. The traditional management saying, "You cannot manage what you do not measure," has motivated the development of metrics in the fields of accounting, finance, human resources, manufacturing, marketing, and management information systems (Measuring Business Value of IT 1988; Kaplan and Norton 1992; Hauser and Katz 1998). Managers rely on established metric tools to validate assumptions about their business environment and judge the results of managerial practice. Researchers rely on accepted metrics to build analytical models of the impact of managerial strategy on firm performance and to validate empirical field research on specific managerial tactics. The importance of metrics in any field of study can hardly be argued.

Until now, researchers and practitioners have approached the emerging and fast-paced field of e-business with ad hoc metrics of firm success (Novak and Hoffman 1997). Today, corporations operate in a complicated electronic environment, competing simultaneously against dot-com e-commerce start-ups and established companies seeking to transform their organizations into lean e-businesses. As the early days of frantic Internet technology investments give way to a more disciplined approach to e-business strategic planning, today's managers are seeking metrics that will help them analyze the success of their e-business initiatives. A recent report by NetGenesis (2000) stated an e-business addendum to the traditional saying, "You cannot measure what you do not define."

In developing a set of e-business metrics, it is important to make a distinction between "electronic commerce" and "electronic business". The online glossary whatis.com defines electronic commerce as "the buying and selling of goods and services on the Internet, especially, the World Wide Web." In contrast, they define e-business using a much broader construct that incorporates "the conduct of business on the Internet,

not only for buying and selling, but also servicing customers, and collaborating with business partners." Any set of "e-metrics" should extend beyond e-commerce to incorporate the various aspects of e-business including internal Intranet applications, business-to-business (B2B) extranets, and business-to-consumer (B2C) Internet applications (Applegate, et al. 1996; Riggins and Rhee 1998).

In this paper, we provide a new framework for developing e-business metrics. The framework is developed with the following three objectives in mind. First, we must clearly define what we want to measure. The framework achieves this through a comprehensive categorization of e-business applications that considers both upstream and downstream value chain activities. Existing and future e-business applications can be mapped within this categorization. Second, e-business metrics should incorporate the *functionality interaction* that occurs when an e-business application is enabled by the functionality of other e-business applications within the framework. The framework achieves this by defining three types of metrics that capture the important functionality interactions that occur between e-business applications. Third, the set of metrics that managers choose to measure success will depend, to a large extent, on the overall strategic thrusts of the firm and the industry. The IS literature has often highlighted the importance of linking IS and corporate strategy to achieve measurable benefits of system implementations (Broadbent and Weill 1993; Konsynski 1993; Chan et al. 1997). We incorporate this in the framework through a proposed categorization of e-businesses and their strategic thrusts, based on the benefits they can derive from e-business applications. This allows us to define the metrics that are important for each e-business category. When combined together, the business categorization and strategic thrusts, the e-business application categorization, and the concept of functionality interaction provide a comprehensive framework for identifying e-business metrics.

We believe that the contributions of the paper are as follows. The paper provides a new and comprehensive framework for systematically identifying e-business metrics based on IS, e-commerce, and strategy literature that has important implications for managers and researchers. For the e-business manager, the framework allows the mapping of the organization's e-business objectives into a coherent, easily understood visual representation. It aids in the definition of precise metrics that capture all aspects of

the firm's e-business endeavors. For the researcher, the framework provides several benefits in the rigorous investigation of e-business and e-commerce strategy and applications. For case studies of specific organizations, the framework identifies the major application areas of interest and provides a structured methodology for understanding the interaction between various e-business applications. For empirical analysis of the impact of e-business on firm performance, the framework aids in the more precise definition of the hypotheses and the identification of specific metrics for analysis. The framework also provides guidance for future research by outlining the basis for the development of more detailed metrics within each category of the framework.

The paper is organized as follows. Section §2 explains the basic framework and the underlying philosophy of the approach. This is followed in section §3 with a background description of an existing e-commerce framework that has been used to identify areas where organizations can use their Web presence to add value to the Web site user and achieve advantage over their rivals. We explain how a slightly modified version of this framework can be used for any Web-based application where the Web browser acts as the main interface device. Section §4 develops a second, complementary framework for back-end e-business applications that is particularly useful in defining B2B uses of the Internet. In §5, we introduce a methodology called *functionality interaction* where the e-commerce and e-business application frameworks can be used in tandem to define an organization's e-business strategic thrusts. Functionality interaction is based on the idea that a given e-business application is enabled and made more effective by interaction with other e-business applications. The methodology allows the e-business strategist to map the organization's e-business objectives into a coherent, easily understood visual representation and defines relevant metrics to measure success. In §6, we develop a business classification scheme where eight different categories of businesses can be differentiated along three dimensions: B2B versus B2C, location along the value chain, and physical versus information products. We also explain how the e-business classification and the strategic objectives of the company impact its choice of e-metrics to measure success. Then in §7, we discuss how functionality interaction mapping generates three different types of e-business metrics and how these metrics

impact each of the eight categories of e-businesses. We conclude in §8, with a discussion of future research issues.

2. The Basic Framework

Figure 1 depicts the basic framework at a conceptual level. The framework is organized into three levels – *organization, application* and *metric.* At the organization level of the framework, the e-business type determines the organizational strategic thrusts for its e-business applications. The type and strategic thrusts of the organization, in turn, determines the desired functionality of its e-commerce (front-end) and e-business (back-end) applications. The desired functionality of these applications affects the choice of metrics that measure the effectiveness of online applications.

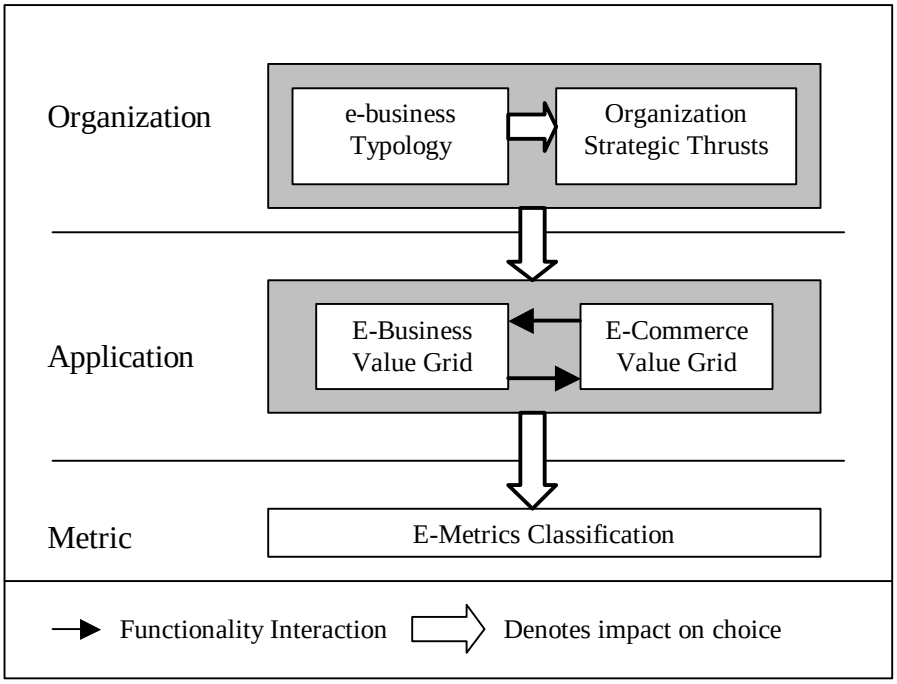

Figure 1: The Framework Overview

Although simple, the framework has a few salient features that emphasize its underlying philosophy. Implicit in the framework is the assumption that the choice of metrics must be based on the overall strategic objectives of the firm. Clearly, the firm must focus on only those e-commerce and e-business applications that support and strengthen its strategic objectives. Further, front-end e-commerce applications are often

enabled through the functionality of the back-end e-business applications. For example, the ability to provide an instantaneous delivery promise date to the customer (a front-end activity) is enabled through the access to detailed inventory, production and vendor data (a back-end activity). In addition, many of the back-end e-business applications are enabled by front-end functionality, for example when the Web interface is used to collect data that populates the back-end data warehouse. In the remainder of the paper, we develop each construct of this basic framework in more detail.

3. The E-Commerce Value Grid

In an effort to categorize different e-commerce applications, Riggins (1999) developed the Electronic Commerce Value Grid. The grid is based on the concept that businesses compete along five "dimensions" of commerce. By using various modes of *interaction*, firms compete over both *time* and *distance* in order to provide some *product* or service through a chain of *relationships* eventually ending with the end customer. Hammer and Mangurian (1987) focused on the use of communications technology to impact time, geography, and relationships. Riggins (1999) expands on this to include the impact on altering the nature of the interaction, the potential to offer entirely new products and services, and the application of the framework to a Web-based e-commerce environment.

Each row in the grid is based on a different dimension of the firm's competitive environment. First, companies compete on "Internet time" to develop, produce, and market new products to customers. Using Internet technology, companies implement intranets to service users inside the organization, extranets to allow external trading partners to access information inside the organization, and Web-based storefronts to promote products to outside customers. Second, geographical distance takes on a very different meaning in cyberspace. Firms can achieve a global presence by developing strategic alliances with Web-traffic control sites that generate valuable traffic to the company's home page, and order fulfillment partners to physically deliver goods to distant locations. Third, the Internet presents opportunities to alter the structure of relationships in both B2B and B2C commerce. Dis-intermediation, re-intermediation, personalized service, and lock-in via network effects are important issues that need to be

considered as the Internet alters relationships. Fourth, the Web changes the nature of communication by allowing interactive two-way dialog, Web-based customer self-service, or online communities of interaction. Finally, the Web allows entirely new types of products and services to be created such as online intelligent agents, online decision support systems, and rich interactive multimedia applications.

The columns in the grid are based on the three ways in which information technology (IT) investments are traditionally justified: *efficiency* benefits, *effectiveness* benefits, and *strategic* benefits (Gorry and Scott Morton 1971; Hammer and Mangurian 1987). Improving efficiency has traditionally been the primary use of information technology. Even before the Internet, companies engaged in electronic commerce using electronic data interchange (EDI) to improve the efficiency of coordinating with external trading partners (Riggins, Kriebel and Mukhopadhyay 1994). The opportunity to improve the effectiveness of decision-makers by getting the right information, to the right person, in the right format, at the right time, forms the basis for management information systems and decision support systems. Finally, the Web can be used for strategic purposes if it results in increased revenues by opening up new markets, new products and services, or allows firms to gain an advantage over competitors by developing customer loyalty.

By combining the three types of justification or value creation with the five dimensions of electronic commerce, the grid identifies fifteen different areas where managers can use Web-based electronic storefronts to add value to their customers to create a unique online buying experience. In particular, the grid can be applied to many Web-based applications where the browser acts as the main interface device. The slightly modified version of the grid shown in Figure 2 incorporates more generic terminology that can represent a complete portfolio of Intranet applications, a B2C portal/community site, a Web-based information news site, and an online storefront selling physical or information goods. In this way, the EC Value Grid can be used to describe the scope of both internally focused Web sites as well as externally oriented sites.

Value Creation / Dimension	Efficiency	Effectiveness	Strategic
Time	Accelerate User Tasks	Eliminate Information Float	Establish 24/7 Integrated Service
Distance	Improve Scale to Look Large	Present Single Gateway Access	Achieve Global Presence
Relationships	Alter Role of Intermediaries	Engage in Personalization to Look Small	Create Dependency to Lock-in User
Interaction	Make Use of Extensive User Feedback	User Controls Detail of Information Accessed	Users Interact via Online Community
Product	Automate Tasks Using Software Agents	Provide Online Decision Support Tools	Bundle Diverse Content with Rich Multimedia

Figure 2. E-Commerce Value Grid (adapted from Riggins 1999)

However, while many e-business applications are Web-based in their interface design, others utilize the Internet to transmit server-to-server information to support process oriented tasks such as inventory flow or logistics coordination, or are based on back-end database technologies linked to the browser front-end. Therefore, for many e-business applications, particularly many B2B applications, the EC Value Grid is insufficient to represent a comprehensive e-business strategy. Consider some of the traditional activities of the firm's value chain: inbound logistics, operations, outbound logistics, marketing and sales, and service (Porter and Millar 1985). The EC Value Grid is useful for defining marketing/sales and service applications because it is primarily concerned with functionality using the browser interface, however it does not address issues related to the activities further up the value chain. In the next section, we introduce a complementary E-Business Value Grid that takes into account these upstream activities.

4. The E-Business Value Grid

In developing the E-Business Value Grid, we adopt the same three columns used in the EC Value Grid to identify the justification or the type of value created by the application. However, where the EC Value Grid incorporates activities down the value chain, we now introduce five additional dimensions associated with activities further up the value chain. The upstream activities normally associated with the value chain are *inbound* logistics, internal *production* systems, and *outbound* logistics (Porter and Millar 1985). However, even before considering these activities, two preliminary support activities include *planning* the overall value chain strategy and technology *development* through R&D. Planning the value chain involves analyzing market conditions to determine market potential, putting the right team of knowledge workers together to plan and execute strategy, and converting intellectual capital into concrete product plans. Technology development involves basic research, product design, prototype development, and product commercialization. Using the three types of justification and the five upstream supply chain activities, we can identify fifteen additional back-end Internet applications as shown in the E-Business Value Grid in Figure 3. We now address each of these applications in turn.

	Efficiency	Effectiveness	Strategic
Plan	Implement Rich Media for Company Wide Interaction	Provide Online Executive Information Systems	Facilitate Knowledge Management Between Partners
Develop	Standardize Platform for Cross-Functional Design	Achieve Design for Manufacturability	Enable Concurrent Design Across Virtual Organization
Inbound	Support Electronic Transactions with Suppliers	Generate Supply Flexibility through E-Hub Communities	Offload Replenishment Responsibility to Suppliers
Produce	Integrate Shop Floor with ERP System	Exchange Production Data Between Partners	Optimize Utilization of Global Production Capacity
Outbound	Support Electronic Transactions with Customers	Furnish Online Order Status Information	Institute Seamless Integration with Fulfillment Partners

Figure 3. E-Business Value Grid

Planning the Overall Value Chain Strategy

Implement Rich Media for Company Wide Interaction. E-business efficiency benefits are derived when the Internet provides a backbone on which to automate tasks and quickly exchange high bandwidth information across functional areas within the organization. In formulating an overall value chain strategy, managers need to be able to communicate across functional boundaries in real time and using a rich medium such as videoconferencing, white-boarding, and on-demand presentation Web-casting. These tools can be used to formulate and negotiate the Master Production Schedule (MPS) which must be based on the sales forecasts provided by the sales managers and must be constantly updated as new information about customer orders become available. Updated manufacturing capacity information must also be evaluated in modifying the MPS. Achieving this communication is critical in developing an integrated plan and responding to changing conditions.

Provide Online Executive Information Systems. Effectiveness benefits are those that aid decision-makers by presenting the right information, at the right time, and in the right format to the appropriate person. In overall value chain planning, executives in the organization need to have Web-enabled access to executive information systems that integrate internal and external data on industry trends, competitors, market analysis, and industry forecasts from multiple sources. In addition, providing access to online expert and decision support systems can aid the high-level decision-maker and, in some cases, automate certain decision tasks.

Facilitate Knowledge Management Between Partners. In today's environment, only a consortium of cooperative business partners, or a "business ecosystem" is suited to assemble creative ideas necessary to develop complex new products, achieve manufacturing agility, and maintain a long-term customer focus (Moore 1997). Riggins and Rhee (1999) shows how different types of B2B extranets can be used to create a learning network environment across the ecosystem. Huber (1991) states an "entity learns if, through its processing of information, the range of its potential behaviors is changed". He goes on to state that this definition applies to a wide range of entities,

including an entire industry. The processing of information includes acquiring information, distributing information, or interpreting information. In addition, Huber identifies memory, or what we refer to as retaining information, as a fourth idea related to learning. Based on this, Riggins and Rhee (1999) define a learning network as:

> "a group of trading partners that purposely coordinates their efforts to acquire, distribute, interpret, and retain information about its members, competitors, customers, and other external entities for the purpose of altering its range of potential actions."

By using e-business extranet applications, advantage can be gained when an innovative, learning culture is fostered across the entire consortium, not just within an organization. For example, such a culture will facilitate the joint planning of new product launches with partners, to achieve time-to-market benefits and seamless integration across the virtual enterprise.

Developing New Products Concurrently Across the Virtual Organization

Standardize Platform for Cross-Functional Design. According to Peter Drucker (1998), new product development is a critical activity that, along with marketing and sales, forms the core of an organization. Globalization, increased competition, and shorter product life cycles have made this task much more complex and demanding. Efficiency benefits are achieved in new product development when the Web is used as a standardized, universally accessible platform to support geographically dispersed, cross-functional teams. This standardization is necessary for the efficient exchange of engineering CAD/CAM documentation. Many technology companies such as HP, Microsoft and Intel have design facilities around the globe to facilitate 24-hour work on critical projects to achieve faster time-to-market. As the product development is underway, extranet applications allow trading partners to access engineering documentation and product specifications as they evolve.

Achieve Design For Manufacturability. Designers often make component choices for technical and engineering reasons that can have a negative impact on the supply chain (Huang and Mak 1999). Design for manufacturability emphasizes the importance of taking supply chain and manufacturing issues into consideration while making design

choices. Effectiveness benefits occur when the designer has Web-enabled access to supply chain information while making critical design choices, or can communicate with potential suppliers to exchange complex product definitions and technical specifications at the time of design. For example, a designer may choose a slightly inferior part from a vendor with an excellent record of on-time delivery.

Enable Concurrent Design Across the Virtual Organization. As companies concentrate on their core competencies, they rely more on their value chain partners to perform critical tasks. For example, in the electronics manufacturing industry many companies rely on offshore manufacturing facilities that are owned and operated by third party contract manufacturers. Strategic benefits are obtained when the company uses Web technology to jointly design the product with the contract manufacturer, which enables them to optimize total delivered cost and features of the product. Concurrent design by partners also reduces time-to-market and identifies integration problems early in the design. Using the Web interface, authorized external users can be given permission to alter drawings and post them back on the Web site, creating a powerful virtual product design environment.

Managing Inbound Logistics

Support Electronic Transactions With Partners. Efficiency benefits are realized when companies use the Web to facilitate electronic transactions with their suppliers. Early interorganizational systems such as EDI have allowed manufacturers to significantly streamline their inbound logistics operations. More recently, new Internet technologies such as eXtensible Markup Language (XML) that promote server-to-server communications, promise to further improve supply chain management (SCM) processes. XML provides for the standardization of quotations, orders, invoices and payment transactions for vertical industry segments. Thus, the next phase of SCM will be to link disparate enterprise resource planning (ERP) and other business systems at partner facilities through standardized interfaces in XML. By creating an inter-ERP system that cuts across the virtual enterprise, manufacturers will achieve unprecedented efficiency gains as the consortium functions as a single entity.

Generate Supply Flexibility Through E-Hub Communities. E-Hubs are vertical portals and B2B exchanges that bring together players from within and outside the industry. Kaplan and Sawhney (2000) provide a useful classification of e-hubs based on what and how buyers purchase goods on these exchanges. They discuss how E-Hubs allow a company to optimize its sourcing arrangements by posting requirements and technical specifications on-line, setting up alternate suppliers, switching easily between suppliers to obtain supply flexibility, and selling obsolete inventory to other members of the business consortium.

Offload Replenishment Responsibility to Suppliers. Companies have achieved significant strategic benefits by offloading the responsibility for inventory management directly to their suppliers. By providing a direct link to their point-of-sale terminals, retailers reward or coerce suppliers to take direct responsibility for stocking store shelves (Hammer and Champy 1993). In some cases, the supplier is considered to be leasing space on the retailers' shelves and retains ownership of the goods until purchased by consumers. In just-in-time manufacturing environments, suppliers are responsible for their parts until the point of assembly. When suppliers have an incentive to deliver goods only at the last minute, inventory levels are dramatically lowered for the manufacturer and quality improves because the supplier maintains control of the item until it is required on the factory floor.

Operations Management for the Production of Goods and Services

Integrate Shop Floor with ERP Systems. Companies can achieve significant efficiency benefits by integrating their entire shop floor operations with their ERP systems. Because ERP systems are only as good as the information that goes into them, integration with manufacturing execution systems and shop floor data collection systems is necessary for smooth ERP operations (Chalmers 1999). Seamless integration of several business systems (accounting, order management, warehouse management, and production planning) with shop floor scheduling and manufacturing execution will enable better inventory management, order tracking, and more responsive manufacturing execution based on incoming customer orders from the e-commerce front-end.

Exchange Production Data Between Partners. By integrating shop floor and ERP systems, the company will be able to provide real time access to production plans and operations scheduling data to suppliers so that they can better plan their production and delivery schedules. This will enable inventory management schemes such as automatic replenishment and supplier managed inventory. Further, real-time data from partners can be used to control the production process as well. For example, consider a manufacturer that has implemented lights-out manufacturing using significant factory automation. The major variable in this manufacturer's operations is the fluctuating power costs from a major utility company. This manufacturer has implemented a system where the power company sends real-time pricing information to the manufacturer's automated system. When the power pricing reaches a certain high threshold, perhaps due to excessive home consumption during a heat wave, manufacturing operations are automatically shut down temporarily. Operations are then resumed when prices are lowered or when demand dictates that operations commence regardless of energy prices.

Optimize Utilization of Global Manufacturing Capacity. While manufacturers have been moving in this direction for well over a decade, the emergence of secure Internet technology makes this proposition much more cost effective, particularly when linking multiple manufacturing facilities dispersed around the globe. By combining the public Internet infrastructure with secure tunneling protocols, companies can link their manufacturing operations regardless of location. This provides a seamless global manufacturing capacity planning system that can be controlled through the business ERP systems, thereby allowing for optimal use of manufacturing resources and load balancing.

Managing Outbound Logistics

Support Electronic Transactions With Customers. Another component of supply chain management is managing the outbound logistics process. Electronic transactions through new Internet technologies such as XML (described earlier) will result in significantly lower transaction costs, reduced order fulfillment times and better on-time delivery performance.

Furnish Online Order Status Information. An important part of personalization of the Web is the ability to provide current order and delivery status information to customers. Through the seamless integration with fulfillment partners and the linking of their information database with the front-end Web site, companies can provide instantaneous order status via the Web browser. Companies such as Dell (Dell Online 1998) and OfficeDepot have set up B2B personalized sites for each corporate customer, allowing them to track current order status and access archived purchase history. In this way, buyers of frequently purchased items such as office supplies can offload the responsibility for maintaining historical documentation to their vendor. In return, customers are more loyal due to the effectiveness benefits of aggregating this information on one partner's site.

Institute Seamless Integration with Fulfillment Partners. Package delivery carriers such as UPS and FedEx are capitalizing on new opportunities to deliver items to customers' home when ordered online. E-commerce companies that have invested heavily in regional warehouse facilities, such as Amazon.com and Webvan, are moving toward using these facilities to act as third party logistic providers for other e-commerce companies. For example, Amazon is using its warehouse facilities to store and ship toys for ToyRUs.com. Companies that seamlessly integrate their front-end ordering system with their fulfilling partner's back-end inventory and logistics systems, will be in a position to gain significant efficiency benefits as each partner focuses on their core competency. Further, an important strategic role that these third party logistic providers play is in the delivery coordination of multiple system components originating at multiple facilities. For example, Dell monitors do not originate at Dell's manufacturing facilities, but rather from external partner facilities (Dell Online 1998). It is the responsibility of the shipper to ensure that the computer, monitor, and printer all arrive at the customer's premises at the same time regardless of originating company or facility. Clearly, a seamlessly integrated information system is necessary to ensure this capability. E-businesses are turning to Internet technology to enable this delivery process.

4.1 Literature Classification Based on the Value Grids

Several leading e-businesses have incorporated various parts of the functionality outlined in both the E-Commerce Value Grid and the E-Business Value Grid (Dell Online 1998; Cisco Systems 2000). However, academic researchers have investigated the implementation, usage, and contributions of this functionality with varying levels of completeness. In Table 1, we highlight the relevant academic literature for each cell in both grids. While not meant to be a complete reference list, this table provides a starting point for researchers seeking to understand and investigate the application of each cell to the firm's overall e-business strategy.

5. Functionality Interaction

Implementing any application from either the E-Commerce Value Grid or the E-Business Value Grid in isolation will meet with limited success. This is because each application outlined in these frameworks is enabled and aided by functionality in other cells. For example, to engage in personalization to look small requires the collection of user information, tracking of user activities on the Web site, and information drawn from back-end data warehouses that predict needs and wants of each type of user. Eliminating information float requires the establishment of 24/7 integrated service with linkages to back-end databases, innovative knowledge creation between multiple trading partners, and the provision of instantaneous order status information. In other words, *functionality interaction* increases the value proposition for a given application because information generated from functionality in one cell flows into the applications in other cells.

We can identify information sources and information sinks to illustrate how the flow of information creates functionality interaction. Suppose an information news site has as one of its main e-business goals to increase switching costs through innovation in order to create dependency to its Web site and thereby lock-in users. Figure 4 illustrates this strategy using five information sources (enabling functionality) and one information sink (create dependency to lock-in users). When information on the news site is updated

	Efficiency	Effectiveness	Strategic
Plan	Webster 1998; Dennis, Pootheri, and Natarajan 1998	Houdeshel and Watson 1987; Watson, Rainer, and Koh 1991; Young and Watson 1995	Scott 2000; Chau, Au, and Tam 2000; Riggins and Rhee 1999
Design	Miller 1999; Componation and Byrd 2000; Shin, Han, and Bae 2000	Hatch and Badinelli 1999; Huang and Mak 1999; Chang and Visser 1998	Scott 2000; Miller 1999; ; Componation and Byrd 2000; Hatch and Badinelli 1999; Roche 1999
Inbound	Srinivasan, Kekre, and Mukhopadhyay 1994; Lee, So, and Tang 2000; Chau, Au, and Tam 2000; Buvik and John 2000	Lee, So, and Tang 2000; Kaplan and Sawhney 2000; Wise and Morrison 2000; Kambil, Nunes, and Wilson 1999	Lee, Clark,and Tam 1999; Lee, So, and Tang 2000; Mukhopadhyay, Kekre, and Kalathur 1995
Produce	Howells 2000; Chalmers 1999; Kang, Kim, and Park 1998; Ghalayini, Noble, and Crowe 1997	Mukhopadhyay, Kekre, and Kalathur 1995; Chang and Visser 1998	Lee, Clark,and Tam 1999; Cachon and Fisher 2000
Outbound	Lee, Clark,and Tam 1999; Chau, Au, and Tam 2000; Hart and Saunders 1998; Barua, Ravindran, and Whinston 1997	Dell Online 1998; Cisco Systems 2000	Walker 2000; Gurin 1999; Trunk 2000; Dell Online 1998; Cisco Systems 2000
Time	Chaudhury, et al. 2001; Grover and Ramanlal 1999; Chau et al. 2000; Bakos 1997; Jarvenpaa and Todd 1997	Grover and Ramanlal 1999; Chau, et al. 2000; Dewan, Freimer, and Seidmann 2000; Cortese and Stepanek 1998	Gulati and Garino 2000; Chau, Au, and Tam 2000
Distance	Malone, Yates, and Benjamin 1987; Bailey and Bakos 1997	Bradlow and Schmittlein 2000; Dewan, Freimer, and Seidmann 2000; Beckert 2000	Balasubramanian 1998; Bakos 1997; Riggins 2001
Relationships	Chau, Au, and Tam 2000 ; Bakos 1997; Malone, Yates, and Benjamin 1987; Bailey and Bakos 1997	Grover and Ramanlal 1999; Ansari, Essegaier, and Kohli 2000; Kenney and Marshall 2000	Katz and Shapiro 1994, 1986; Grover and Ramanlal 1999
Interaction	Haubl and Trifts 2000	Chau, Au, and Tam 2000; Shapiro and Varian 1998	Armstrong and Hagel 1996; Stepanek 2000
Product	Haubl and Trifts 2000; West et al. 2000; Nelson et al. 2000; Copler 1996; Peterson 1996	Todd and Benbasat 1999; Sharda and Steiger 1996; Kalakota, Stallaert, and Whinston 1996; Haubl and Trifts 2000	Lim,Benbasat,and Ward 2000; Bakos and Brynjolfsson 1999

Table 1. Relevant Literature for E-Business and E-Commerce Functionality

in real time, users find that they can gather news information faster on this site than they could anywhere else. The site engages in personalization by allowing users to customize their own news home pages and by making suggestions about other related news stories. Using a sophisticated proprietary intelligent software agent, the site e-mails registered users when breaking news occurs that would be of interest to the users. Breaking financial news is fed into online decision support tools that advises individual users about investment options they should consider. Finally, by making use of its highly rated cable television news channel, the news site makes use of rich multimedia capabilities by providing live video streaming feeds of news reports, live press conferences, and archives of interviews with today's news makers. While much of this functionality could be duplicated by other sites, the combined effect of utilizing many information source applications creates a news site that is superior to competitors – thereby locking-in users to the Web site. Of course, many of the information sources in Figure 4 are also enabled by the functionality in other cells. This creates a cascading effect whereby a particular functionality could simultaneously be an information sink and source. By using this graphical notation within and across the grids, an entire e-business strategy can be mapped.

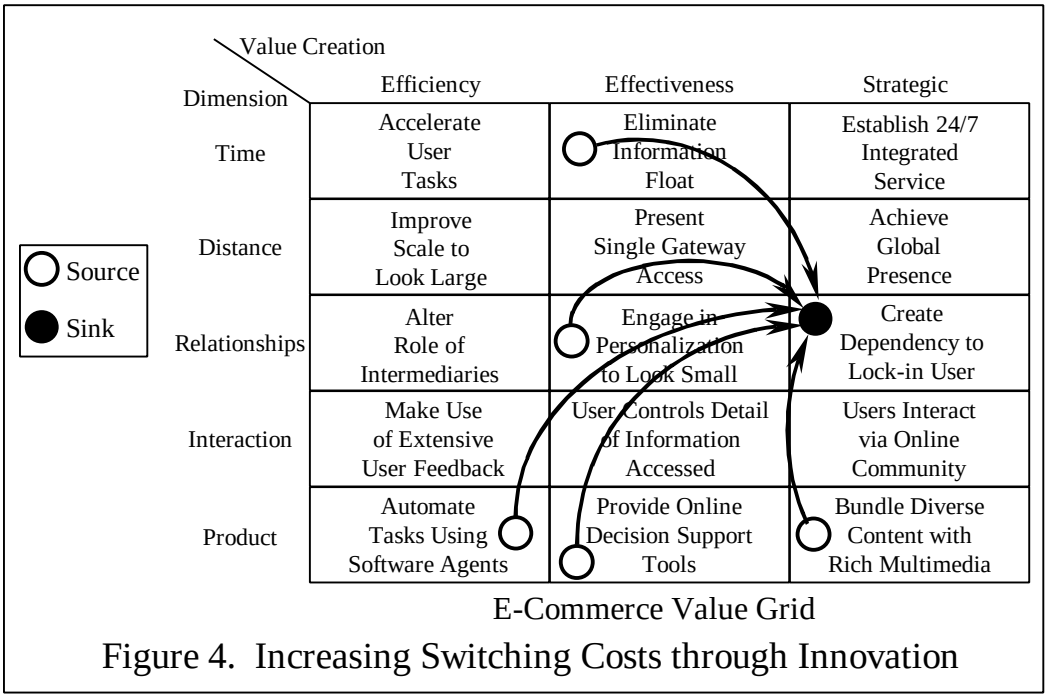

Figure 4. Increasing Switching Costs through Innovation

Let's consider a more far-reaching example of functionality interaction. Dell Computer Corporation has been one of the most innovative established companies to take advantage of the unique features of Web-based commerce (Dell Online 1998; Dell 1999). Outlining all of the Web-based applications available on Dell.com is certainly beyond the scope of this paper. Instead, let's consider one important aspect of their Web-based strategy – their ability to take advantage of the continuous price drops inherent in the personal computer industry. By incorporating a unique build-to-order manufacturing process and their strategy of allowing end consumers to order directly off their Dell.com Web site, Dell is able to pass on price drops to their customers much faster than their competitors. This ability to eliminate information float by continuously updating their prices is illustrated in Figure 5.

By altering the role of intermediaries and going directly to consumers, Dell has disintermediated the marketplace, allowing them to the pass price cuts immediately to customers. Dell provides a type of online decision support tool where users can configure their own PC. Potential customers can do what-if scenarios by altering the monitor size or processing speed to determine the impact on the total price. Also, by providing a fast, convenient online storefront, Dell accelerates other user tasks such as receiving price quotes related computer equipment. By tracking the user activities and changes in considered configuration, Dell is able to amass considerable detail about user price sensitivity. This information is used to determine what prices should be updated as soon as possible. Also, Dell achieves a legitimate global presence by making the Dell.com Web site available in country-specific versions taking into account local language, currency, and delivery capabilities.

However, Dell's success is not simply due to its successful front-end Web site. The company's primary competitive advantage is found in the smooth integration of its back-end manufacturing system with its front-end ordering storefront. By integrating the back-end with the Dell.com front-end, Dell has created a fully integrated 24/7 customer service site that is able to deliver on quickly discounted merchandise. In terms of process integration, Dell has created a seamlessly integrated virtual organization linking their manufacturing facilities with suppliers, which minimizes on-hand inventory. Also, suppliers have complete visibility of Dell's customer order status and are responsible for

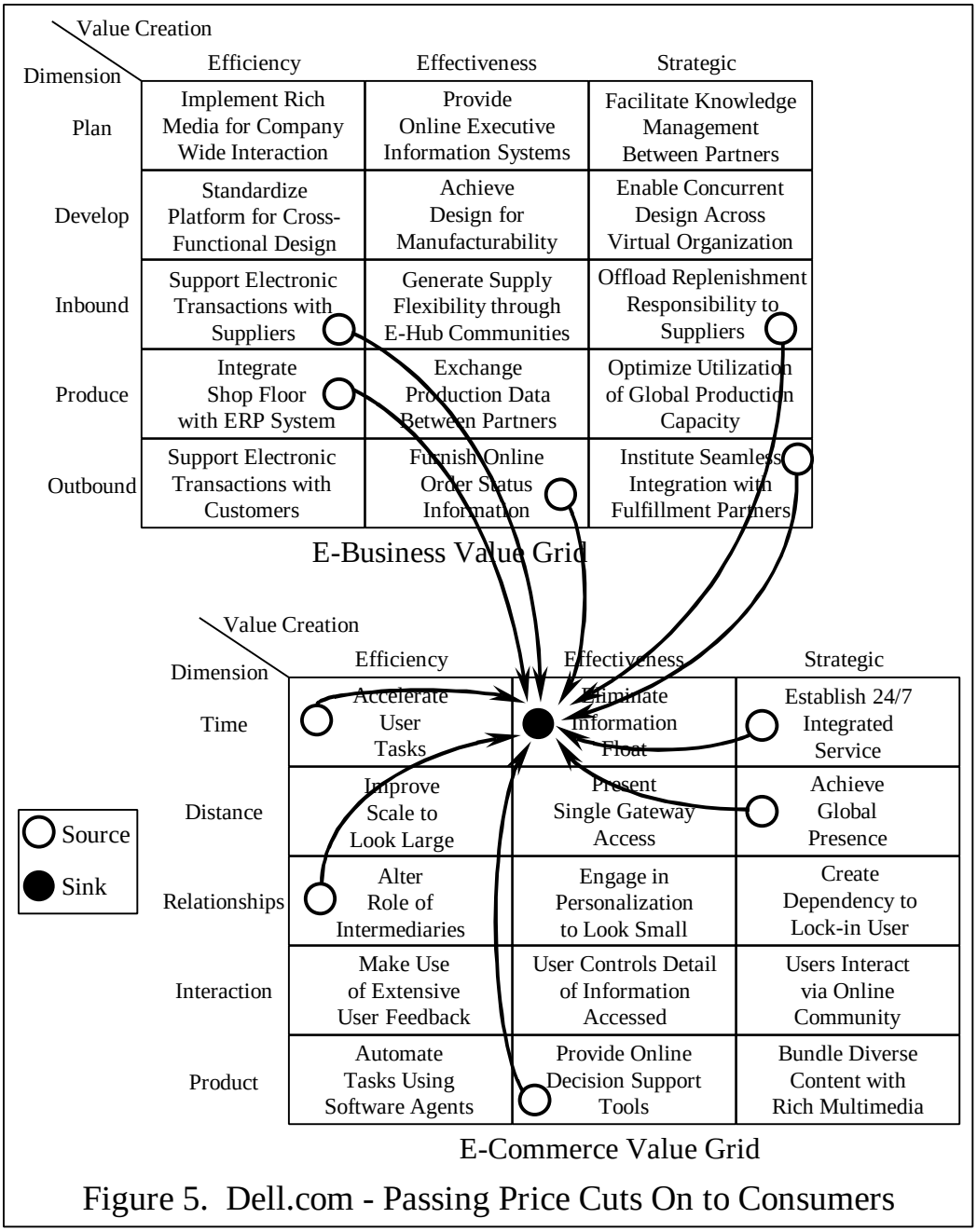

Figure 5. Dell.com - Passing Price Cuts On to Consumers

inventory management up to the point of assembly. In terms of manufacturing the PC, build-to-order systems integrate the order process directly to the factory floor. In addition, computer accessories, such as monitors, are shipped directly from the trading partner's facility, whereby the logistics carrier is responsible for assembling the entire order at the customer's doorstep regardless of origination point. Customers are able to

download up-to-the-minute order status and delivery information. All of these innovations are due to a tightly coupled, Internet-based information system that uses server-to-server linkages on the back-end and the Dell.com storefront on the front-end.

By using the two frameworks in tandem and taking into account that the E-Commerce Value Grid can be applied to external users or internal intranet "customers", an organization's overall e-business strategy can be mapped using functionality interaction. This mapping identifies the primary e-business and e-commerce applications for the organization (information sinks), and the secondary applications that can enable the primary applications (information sources). By developing a series of mappings similar to Figure 5, an organization's entire e-business strategy can be mapped into a visual representation. However, what applications are critical to a particular type of e-business? How can the strategist know where her organization should focus its attention within these frameworks? In the next section, we develop an e-business classification scheme based on three different criteria: customer target, value chain position, and type of good. Each of the resulting eight categories of e-businesses should focus their attention on different applications within the E-Commerce Value Grid and the E-Business Value Grid.

6. A Classification Scheme Identifying Categories of E-Businesses

Hoffman, et al. (1995) categorized different types of Web sites as either destination sites or Web traffic control sites. Peterson, et al. (1997) categorize eight different types of products and services and discuss their suitability for Web-based commerce. Hackbarth and Kettinger (2000) outline how organizations can be transformed into e-businesses using SWOT analysis. While these classification schemes are useful within their particular domain, the derivation of e-metrics requires a high-level classification of different types of e-businesses. E-businesses can be classified along numerous dimensions, such as the degree to which they are virtual versus physical, the type of product produced or sold, traditional versus dot-com start-ups, type of customer targeted, entertainment versus industrial, degree to which they control the marketplace, etc. In an effort to be parsimonious, we limit ourselves to categorizing e-businesses along three high-level dimensions.

The most generic classification of e-businesses is whether they are primarily B2B versus B2C in terms of their customer focus (Applegate, et al. 1996; Riggins and Rhee 1998). For our purposes, B2B companies are companies whose primary customers are other businesses. These e-businesses have little, if any, contact with end consumers, often deal in industrial manufacturing and more traditional settings, and provide the infrastructure that allows other companies to serve end consumers. These companies may focus on nurturing tightly coupled relationships with a limited number of customers, such as an airplane manufacturer, or may produce and create brand awareness for products aimed at end consumers, but choose to allow other companies to sell and distribute their products, such as Proctor and Gamble. These companies are normally more concerned with back-end e-business issues such as new product development and integration, manufacturing and production capabilities, and back-end supply chain management. On the other hand, B2C companies are more focused on e-commerce issues such as developing user-friendly online storefronts, providing prepurchase and postpurchase customer service, providing up-to-date information, maximizing Web site traffic, and entertaining their users. While not being exclusive to one or the other, B2B companies will be more focused on activities within the E-Business Value Grid, while B2C companies will more often develop applications found in the E-Commerce Value Grid.

While the first dimension has to do with customer focus, the second dimension has to with the company's relative position within the value chain. Specifically, firms can be primarily producers of goods and services or resellers of the same. Producers are typically higher up the value chain, and can often have a B2B customer focus such as first and second tier automotive suppliers, management consulting companies, and suppliers of office and industrial supplies. However, the Web allows producers of goods to bypass intermediaries and sell directly to end consumers creating a B2C customer focus, such as several major airlines, personal computer manufacturers, and many news organizations. Producers have a greater need to generate output from knowledge workers for new product development, integration of components into corporate systems solutions, and generation of new ideas, patents, and copyrights. Resellers are usually in a more competitive selling environment requiring customer service differentiation and

sophisticated customer relationship management efforts such as decision support systems, personalized service, and brand creation. Because they deal with end consumers, resellers must also focus on delivery logistics and timely order fulfillment.

Finally, companies vary widely in the type of product or service they provide. Peterson, et al. (1997) characterize three dimensions: frequency and expense of purchase, differentiation potential, and physical versus informational. Low outlay, frequently purchased items are usually B2C oriented, while high outlay, infrequently purchased items are more often associated with B2B transactions. The need for differentiation is in part captured by the seller's position in the value chain. Resellers need to focus on marketing and customer service for differentiation, while producers can differentiate their products in terms of quality or uniqueness of the good itself. While these dimensions are useful, many "products" in the e-commerce setting are informational goods that often end up being provided for free – forcing the organization to seek revenues from other business models. The opportunity to download copyrighted material from peer-to-peer Internet services threatens to make copyright law irrelevant. Therefore, in the online setting, the most important product characteristic is whether the good is physical or informational in nature. Information producers must be concerned with enabling their knowledge workers with sophisticated intranet and collaboration applications. Producers of physical goods need to make use of computer-aided-design and computer-aided-manufacturing tools and other product design applications. On the other hand, information resellers need to find a way to maximize site traffic using non-proprietary information that often generates little direct revenue. These B2B and B2C portal sites must find a way to integrate content, commerce, and community to attract initial site traffic, lock-in repeat traffic, and generate productive traffic that provides revenues.

Although these three dimensions are actually continuous, we treat them as dichotomous to derive the eight different categories of e-businesses shown in Figure 6. The figure also includes examples of each e-business type, their primary focus based on the discussion in this section, and the resulting critical applications for each category. While each category can be broken down further into more sub-categories, we briefly describe each category below:

Figure 6. E-Business Classification Grid

Target	Position	Good	E-Business Type	Examples	Primary Focus	Critical Applications
B2B	Producer	Physical	Traditional Manufacturer	Dow Chemical Boeing Millipore Air Products	Cost control, product innovation, customer service	CAD/CAM, ERP systems, flexible manufacturing systems, factory automation, online brochureware, online decision support tools, online after-sale service
		Information	Knowledge Vendor	McKinsey Accenture Forrester Razorfish	Employee Retention, Knowledge Creation	Intranet for collaboration and knowledge management, executive information systems, access to external databases, branding/image site, online delivery to clients
	Reseller	Physical	Value Added Service Provider	OfficeDepot Grainger American Express Ingram Micro	Customer Loyalty, Efficient Fulfillment	Systems integration, online service support, integrated logistic systems, company-specific storefront
		Information	E-Hub	Orbitz e-Steel Covisint VerticalNet	Maximize Site Traffic, Efficiency as Market-maker	B2B exchange, auctions, industry-specific information portal, industry/topic-specific discussion forums
B2C	Producer	Physical	Manufacturer Selling Direct	Dell L.L.Bean Delta Air Lines Avon	Supply Chain Management, Differentiation	Online storefront, decision support tools, integrated build-to-order inter-ERP system, online after-sales service
		Information	Online Information Service	CNN.com BusinessWeek WSJ Interactive Fuqua School	Personalization, differentiation, fast global delivery	Personalized front-end, accelerate user tasks, global presence, multimedia presentations, portal to affiliated storefronts, intranet for collaboration
	Reseller	Physical	Retailer	Amazon Webvan Walmart.com ToyRUs.com	Personalization, order fulfillment, customer service	Personalization marketing, global fulfillment capabilities, decision support tools, intelligent agents
		Information	Community Portal	AOL Yahoo eBay NBCi	Personalization, network effect, differentiation, customer loyalty	Personalized front-end, wide assortment of user services (e-mail, financial services), multimedia applications, chat, discussions

- *Traditional Manufacturers* produce physical goods that are generally sold to other corporate customers. While we use the term "manufacturer", we do not necessarily limit ourselves to industrial settings. Controlling development and manufacturing costs, developing new innovative products, and providing strong customer service are key focus areas for these companies.

- *Knowledge Vendors* include management consulting services, corporate educational services, and online databases and news services targeted mainly at corporate clients. These companies produce products and services that are direct result of intellectual capital in the organization. Therefore, retaining employees and empowering them for collaborative knowledge creation are critical focus areas. Firms that produce original information goods like new software programs aimed at corporate clients also fit into this category.

- *Value Added Service Providers* act as intermediaries to sell products and services to other businesses. These organizations find innovative ways to integrate products and services to create value such as travel agents and office solutions companies. Critical focus areas include creating and maintaining customer loyalty and efficient order fulfillment to minimize time and costs for their clients.

- *E-Hubs* as discussed by Kaplan and Sawhney (2000) are industry-specific, vertical portals that generate revenues via B2B exchanges. While some e-hubs are created by new entrants into an industry, more recent hubs have been created by a consortium of major industry participants, resulting in close scrutiny by the Justice Department (FTC 2000). E-hubs need to focus on maximizing traffic by aggregating useful content, create loyalty and lock-in using community features, and generating significant efficiencies as a market-maker within the B2B exchange.

- *Manufacturers Selling Direct* are similar to traditional manufacturers except that they utilize the unique features of the Web to bypass intermediaries and sell direct to consumers. These manufacturers must be careful to avoid or minimize channel conflict if they sell in traditional channels as well. By carefully combining supply chain management and a highly differentiated customer service via the online storefront, several of these manufacturers have been very successful online.

- *Online Information Services* provide unique information that is either original in its development or provides a unique editorial perspective. Also included in this category are online educational offerings such as the Fuqua School of Business at Duke University that has been a leader in developing original, high quality online educational courses. Personalized customer service, differentiation through content originality, packaging and delivery, and timely online delivery are critical applications.

- *Retailers* can include new dot-com e-tailer start-ups and more traditional retailers moving into the e-commerce space. Gulati and Garino (2000) discuss the challenges associated with integrating the online offering with the traditional brick-and-mortar

stores versus separating the online storefront into a separate brand identity. Important areas to focus on include personalization, order fulfillment and delivery, and prepurchase and postpurchase customer service.

- *Community Portals* are those that seek to aggregate many different online information services into an integrated customer experience. These portals typically provide services such as aggregation of personalized news stories, e-mail services, links to shopping sites, online bill payment, and a wide range of community discussion features. The goal is to create lock-in often fueled by network effects as the size of the community grows past critical mass.

Clearly, developing a set of e-business metrics will depend on what type of e-business is under consideration. Further, within each e-business category, the strategic thrust of the enterprise, and consequently that of its electronic applications, will play a major role in the definition of the e-metrics. For example, a retailer such as Wal-Mart focuses on providing customers with products at the lowest possible price, while Home Depot focuses on providing superior customer service to do-it-yourself homeowners. Clearly, the focus of their electronic applications will be significantly different, although they belong to the same e-business category in Figure 6. In the following subsections, we define the major strategic thrusts of e-businesses, and explain the linkage between these strategic thrusts and their relevant applications in the E-Business and E-Commerce Value Grids. As we explain later, this drives the selection of the appropriate e-metrics to monitor.

5.1 Competitive Strategy Classification for E-Businesses

Porter (1980) argues that firms use three competitive strategies for above average performance. These generic strategies include cost leadership, product differentiation and focus (or niche). Cost leadership refers to the lowest operating cost per unit of output within an industry. Product differentiation refers to the perception by customers of unique and desirable features in products. The focus strategy is an attempt to tailor the firm's products and services to a narrow target group, segment, or market niche. Such a strategy pays strict attention to the needs of the target segment and uses either cost leadership or product differentiation within that segment. Several researchers have found empirical support for Porter's typology and its core constructs seem robust.

Mintzberg (1988) proposes an alternative typology that desegregates the product differentiation strategy into differentiation through *Quality, Image, Design, Price, Support, and Undifferentiated.* Mintzberg's typology does not include *Focus* because he argues that the focus strategy addresses the scope of the market domain, while Porter's other strategies reflect how a firm competes within its chosen domain. Further, he labels Porter's cost leadership strategy as differentiation by price. Recent empirical evidence suggests that Mintzberg's typology better explains the strategic behavior of firms (Kotha and Vadlamani 1995).

Miller and Roth (1994) develop a typology of manufacturing strategies based on a cluster analysis of survey data from 195 firms about their competitive capabilities. The authors identify three manufacturing strategic groups – *caretakers, marketeers* and *innovators.* Caretakers compete on the basis of price. Marketeers distinguish themselves through various market-oriented competitive capabilities such as dependable service, high quality, broad distribution and broad product lines. Innovators are differentiated by their emphasis on introducing new products quickly and making frequent changes in design.

With this as background, the competitive strategy constructs used in this research are shown in Figure 7. It is based on a synthesis of the above three typologies by selecting those constructs that are related to the possible strategic thrusts of Internet based applications. We divide cost leaders into those that achieve *Cost Leadership through Manufacturing Efficiency* and those that achieve *Cost Leadership through Supply Chain Efficiency*. Product differentiators are classified into those that achieve *Differentiation through Product and Service Innovation*, those that achieve *Differentiation through Customer Service Excellence,* and those that achieve *Differentiation through Brand and Image Superiority.*

5.2 Mapping the Competitive Strategies to the E-Business Classification

The top half of Figure 7 shows the mapping of e-business categories to the strategic thrusts of their e-business and e-commerce applications. Two important issues must be emphasized. First, the figure is not intended to show all possible strategic thrusts of applications for each e-business category. Its purpose is to highlight the strategic

thrusts that are primary to a typical member of the category. Second, while the figure shows the possible primary strategic thrusts for each type of e-business, a specific organization may decide on even fewer critical areas based on their overall corporate strategy.

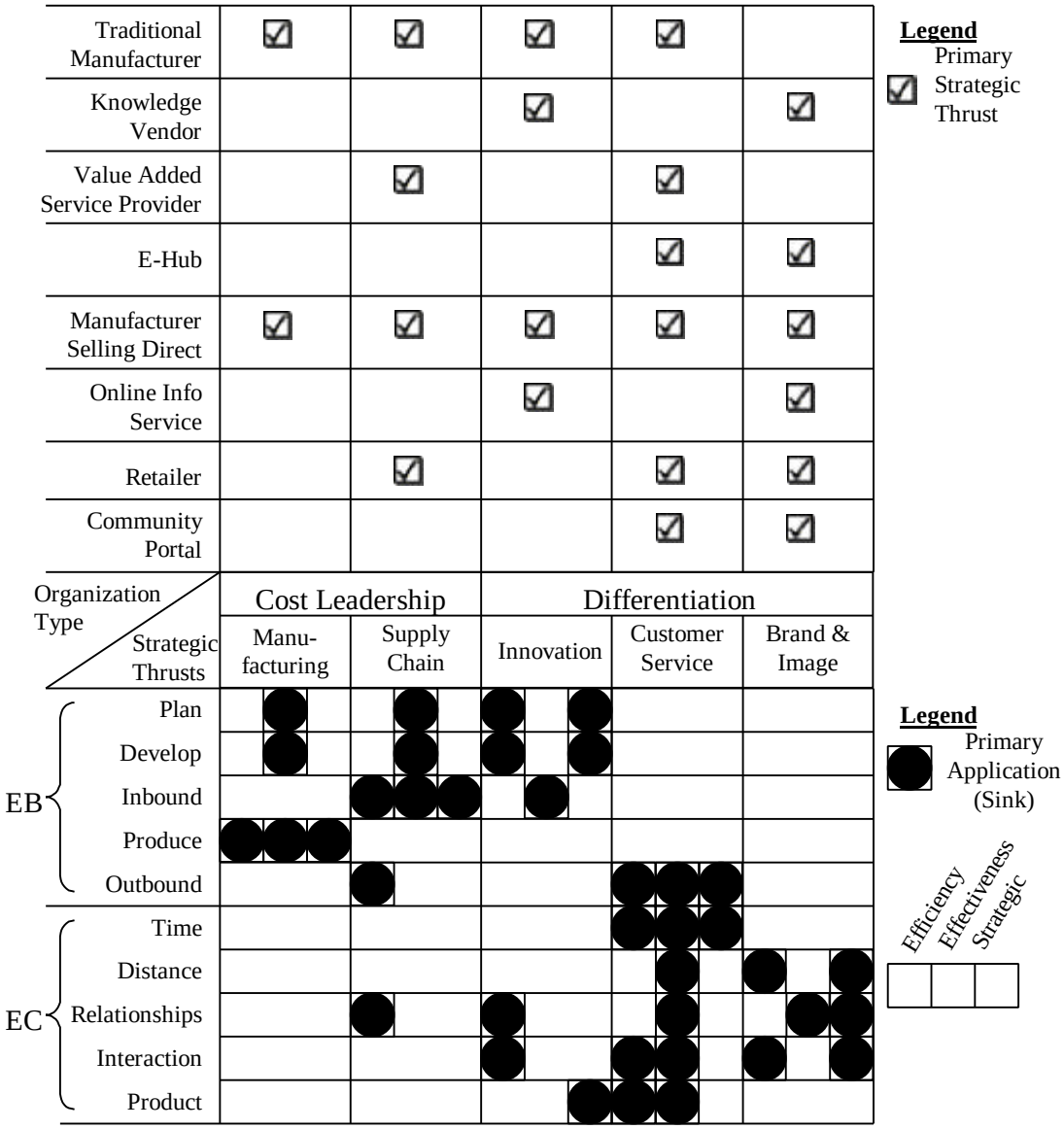

Figure 7. Mapping Application to E-Business Categories via Strategic Thrust Construct

Traditional manufacturers who produce and sell physical goods to other businesses can use the Internet for reducing manufacturing and supply chain costs through better coordination with their suppliers and better control of their shop floor

processes. Other key focus areas include product innovation through Web-enabled support of cross-functional design teams, and superior customer service through Web access to order and product information. Creating a superior brand through their Web site is of lower importance for this category because they do not sell primarily to consumers. *Knowledge Vendors* do not produce a physical good. Consequently, their primary Web-based applications will focus on using their Web site to disseminate knowledge to the user to build a superior brand, and developing innovative knowledge products using internal Intranet applications for knowledge worker collaboration. *Value Added Service Providers* resell physical goods to other businesses. Their competitive advantage comes from their ability to lower their supply chain costs and provide superior customer service. *E-Hubs* are resellers of information goods that they do not produce. Their competitive advantage comes from a superior Web brand that locks-in users and from their ability to provide superior customer service. A *Manufacturer Selling Direct* to consumers can use the Internet to address the entire gamut of strategic thrusts in the figure. An organization in this category, such as Dell Computers, will typically have a wide range of e-applications that help it to achieve lower costs, build superior Web presence, develop innovative information enhanced physical products, and provide superior service (Dell Online 1998). *Online Information Service Providers* provide information and knowledge goods to consumers. While Web technology may positively impact their knowledge supply chain, the primary focus of their applications will be on innovative Web-based information delivery mechanisms and building a strong brand on the Web. *Retailers* resell physical goods to consumers. The primary focus of their Web based applications will be on lowering their supply chain costs, building a strong brand name on the Web to attract customers, and providing superior customer service through the Web interface. *Community Portals* provide access to other sites on the Web to consumers. They neither produce nor sell any goods directly. Thus, the primary strategic thrust of their applications will be on building a sustainable brand on the Web and providing superior customer service.

The lower part of Figure 7 shows the primary applications that can be used to support the competitive thrusts described above. This part of the figure must be read in conjunction with the E-Commerce and E-Business Value Grids in Figures 2 and 3.

While the set of applications for each strategic thrust are too numerous to describe in the text, a few observations should be made about the figure. The primary applications are clustered along the diagonal of the figure. Thus, the primary enablers of achieving cost leadership are the back-end e-business applications described in Figure 3, while the primary enablers of product differentiation are the front-end e-commerce applications described in Figure 2. Product innovation requires both e-business and e-commerce primary applications. It is also important to note that the figure does not show the secondary applications (information sources) that enable the primary applications highlighted in the figure. Such enabling information sources are too numerous and often too company-specific to include in the diagram. However, their presence cannot be ignored. Thus, for example, while superior customer service is achieved through the front-end applications in the E-Commerce Value Grid, the importance of back-end e-business supporting applications cannot be ignored. In the next section, we define three different types of e-metrics and show how this functionality interaction mapping can be used to generate metrics for each of the eight categories of e-businesses.

7. Three Types of E-Metrics

We now turn our attention to how functionality interaction using the two grids allows us to develop specific e-business metrics. By mapping an organization's e-business strategy into a series of functionality interaction maps as shown in Figure 4, we can consider three different types of metrics.

Type I – Metrics within Sink Applications

Type I metrics are those that measure the success of a single sink application in either grid. Until now, most e-commerce or e-business activities have been considered in isolation. For example, managers might inquire, "How successful are we at establishing an online community among our users?" or "To what extent have we achieved a global presence using our Web-based interface?" Each cell the organization chooses to focus on represents a specific functionality that can be measured for success.

For example, for an online retailer focusing on personalization, specific metrics could include the number of times a cross-promoted item based on predicted interest is

inquired about and/or purchased, or the number of registered users who customize the company home page for their personal use. Metrics related to offloading replenishment responsibilities to partners could include the percentage of suppliers that have been delegated replenishment responsibilities, or the duration of manufacturing downtime due to out-of-stock conditions for both delegated and non-delegated suppliers. If a critical goal is to accelerate user tasks regarding postpurchase support activities, metrics could include the number of troubleshooting solutions to frequently asked questions available on the site, or the percentage of user inquiries answered via the Web interface with and without employee intervention, versus those answered via the phone center.

Type II – Metrics of Interaction Between Cells Within Grids

Type II metrics measure the functionality interaction between two cells within the same grid. Specifically, Type II metrics measure the degree to which an information source succeeds in enabling an information sink within the same grid. For example, in Figure 4, five applications in the EC Value Grid are information sources feeding information into one information sink to create dependency. Each of the five arrows represents an information flow that should be measured using specific metrics. Continuing with the example in Figure 4, eliminating information float to create dependency could be measured by the frequency with which information is updated on the Web site, relative to competitors, or the frequency with which pricing is updated on the Web site, relative to competitors. Creating dependency by engaging in personalization could be measured by the number of times a customer makes a repeat purchase due to a cross-promoted item based on predicted interest, or the frequency of registered customers' visits due to click-throughs of e-mail reminders versus visits due to other mechanisms. Dependency via software agents or online decision support tools could be measured by the number of unique, proprietary software agents or DSS tools available on the Web site, relative to competitors, or the frequency with which a customer employs a software agent or DSS tool on the Web site. Finally, using rich multimedia to create dependency could be measured by the number of times a customer accesses streaming media on the Web site, or the number of unique multimedia files available on the site that are hit at a minimum threshold limit.

Type III – Metrics of Interaction Between Cells Across Grids

Finally, integration of back-end e-business applications with front-end e-commerce applications is important developing a comprehensive e-business strategy. Type III metrics measure the degree to which an information source succeeds in enabling an information sink in *another* grid. For example, in Figure 5, five applications in the E-Business Value Grid are information sources feeding information into one information sink in the EC Value Grid to eliminate information float. As with Type II metrics, each of these five arrows represents an information flow that should be measured using specific metrics. Metrics for measuring the elimination of information float due to supporting electronic transactions with suppliers and offloading replenishment responsibilities to suppliers could include the reduction in inventory of on-hand materials. This then allows supplier price cuts to be passed on quickly. Clearly, Type III metrics are much more involved and measure impact at a much finer level of detail than Types I and II. Eliminating information float using information from the integrated shop floor and ERP systems could include the speed with which new product configurations can be made available to customers due to flexible manufacturing systems. The ability to eliminate information float using a customized order status page could include the percentage of user inquiries about order delivery status answered via the Web interface with and without employee intervention, versus those answered via the phone center. Finally, the impact on float by instituting direct fulfillment via a logistics partner could be measured by the reduction in average delivery time due to shipments originating at trading partner facilities going directly to customers.

The functionality interaction map in Figure 5 then indicates at least one group of Type I metrics for the information sink application, five groups of Type II metrics measuring the functionality interaction within the EC Value Grid, and five groups of Type III metrics measuring the functionality interaction across grids. Clearly, managers must carefully pick which items to measure and should employ automated data collection and analysis methods when possible.

As explained in Section 6, the choice of e-metrics will be dictated by the strategic thrusts of the e-business. By applying Figure 7 to a particular type of e-business, the

strategic thrusts indicate which applications in which grids should become the primary focus of that organization. For each cell identified, the manager should then develop firm-specific Type I metrics to measure the success of each activity. This is then followed with the identification of appropriate enabling information sources for each information sink, the functionality interactions that should take place, and the appropriate firm-specific Type II and Type III metrics that should be measured.

8. Conclusions and Implications

In this paper, we have proposed a new framework for identifying e-business metrics. The framework identifies a set of e-commerce (front-end) and e-business (back-end) applications that firms can utilize to generate value from their investments in Internet technology. A typology of e-businesses and their strategic thrusts identifies the key focus applications of a specific firm. Three types of e-metrics capture the efficacy of these primary applications (information sinks) and the functionality interactions with their enabling secondary applications (information sources). This framework has important implications for future research and practice in this emerging area.

8.1 Implications for Managers

Managers rely on established metrics to validate assumptions about their business environment and judge the results of managerial practice. The importance of metrics in any field of study can hardly be argued. This paper aids the e-business manager in developing a set of e-metrics in several ways. Practitioners have typically approached the emerging and fast-paced field of e-business with ad hoc metrics of firm success. The framework provides a disciplined approach to the development of e-metrics that is comprehensive in nature and focuses on all relevant areas of the firm's value chain. Often, e-metrics are limited to the front-end applications involving the firm's Web presence, ignoring the back-end applications that enable their functionality. By focusing on the front-end, companies ignore the value obtained from a more efficient, Web-enabled supply chain.

The choice of metrics is often made without establishing a clear link to the overall strategy of the firm. The framework achieves this through a classification of e-businesses

and their corresponding strategic thrusts. These strategic thrusts can then be supported through specific e-applications from the E-Commerce and E-Business Value Grids. The choice of these applications dictates the choice of primary and secondary metrics that measure their efficacy. Thus, the framework establishes a clear and logical sequence of steps that links a firm's overall strategy to the choice of e-metrics.

The E-commerce and E-Business Value Grids provide an exhaustive set of Internet-based applications that managers can systematically consider for their business environment, that encompass all aspects of their value chain. Separate from the overall framework, these grids can be used in isolation by managers for this purpose. Also, the E-Commerce and E-Business Value Grids, along with the notion of functionality interaction described in the framework, can be used in tandem to visually map the firm's overall e-business strategy. The Grids can also be used to evaluate gaps in the firm's current strategy and to focus their efforts along key dimensions. In addition, the e-metrics classification scheme ensures that both primary (often front-end) applications and enabling or secondary (often back-end) applications are carefully considered when evaluating success.

The authors hope that perhaps the most important, albeit indirect, contribution of this framework will be the increased emphasis in the future on those e-metrics that are related to the back-end applications in the E-Business Value Grid and their functionality interactions. As Internet commerce matures, it has become clear that a firm's Internet strategy involves more than its Web site and must incorporate every aspect of the value chain.

8.2 Implications for Researchers

In this early stage of research on e-metrics, the development of a comprehensive framework that is based on existing literature from related areas, serves an important purpose in directing future research. In this section, we outline future research ideas that can address the current gaps in the evolving literature in this area.

We have made no attempt in this paper to develop a set of metrics for each cell in the two Value Grids. However, the framework provides the basis for developing a set of precise metrics that are more comprehensive in nature. We envision that the

development of such metrics through future research will be an important consequence of the framework. Development of specific metrics for each cell of the two Value Grids will have considerable impact on IS practice.

The framework provides a scheme for classifying existing literature in electronic commerce. The extensive literature survey in Table 1 depicts existing literature for each cell of the two grids. Indeed, each cell of Table 1 represents a fertile area for future research. Two observations can be made in general about the literature classification in Table 1. First, while several case studies of specific organizations have been conducted, there are few studies that focus on empirically based analysis of e-commerce and e-business applications. Perhaps this has been due to the lack of publicly available data about such applications and their impact. Second, while the supply chain research community has focused on developing analytical models for the cells in the E-Business Value Grid, the IS literature has primarily focused on the cells of the E-Commerce Value Grid. Collaborative research across disciplines that examines the entire value chain is required. In addition, validating many of the existing analytical models with empirical studies is needed.

Other areas for further research include investigations to fully understand the functionality interactions between cells of the two grids. Understanding the true enablers of different applications and how to best measure this enabling mechanism will be valuable to practitioners developing e-business applications. Also, further research to refine the e-business categories and its linkages with e-business strategic thrusts, would aid practitioners in developing the right applications for their environment. Finally, the framework can also serve as a model for case-based research by highlighting the important issues that should be analyzed and providing a structure to conduct the analysis.

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