The Emerald Research Register for this journal is available at
www.emeraldinsight.com/researchregister

The current issue and full text archive of this journal is available at
www.emeraldinsight.com/0952-6862.htm

Value-added benefits of technology

E-procurement and e-commerce related to the health care industry

Alan D. Smith and Joseph Correa
Department of Management and Marketing, Robert Morris University, Pittsburgh, Pennsylvania, USA

Abstract

Purpose – To provide insights into the current supply chain for original equipment manufacturers (OEM) in the radiology diagnostic imaging equipment business. As is common in many manufacturing and service firms, the rationale of bridging suppliers of OEMs is the ability to leverage technology, software, and accessories pertaining to the various pieces of equipment.

Design/methodology/approach – Several models of e-procurement and e-commerce related to the health care industry are presented.

Findings – Although the radiology capital equipment market presents numerous idiosyncrasies that must be addressed to successfully implement an e-business strategy effectively, incredible opportunities exist all along the supply chain for e-business strategies to both eliminate costs and acquire strategic initiatives. Those firms that most successfully listen to their customers and address the barriers to efficiency (B2E) will help move the industry toward more effective utilization of the benefits e-business can create and also obtain first mover advantages.

Originality/value – Although the efficiencies that e-business provides are extremely important in the radiology capital equipment market, the main value of e-business in this industry of high-priced and relatively infrequently purchased equipment may well be the value-added benefits the technology brings to its customers, as illustrated in the modeling process. The OEMs that eventually market their finished product directly to hospital and imaging centers via a direct sales force can best take advantage of the connectivity and accessibility of e-commerce.

Keywords Health services, Process efficiency, Procurement, Radiology, Supply chain management, Capital equipment, Internet

Paper type Technical

Introduction

Economic nature of the health care market

The health care market is arguably the largest service industry in the USA. In 2001, health care amounted to over $1.3 trillion of the US economy. Health care spending continues to increase and now represents over 14 percent of GDP. Some estimates expect health care to consume over 16 percent of GDP by 2004. While other industries such as banking and retail use the internet and e-commerce to become more efficient and reduce costs, the health care industry supply chain has not embraced the internet to the same extent for many reasons. This article focuses on a high-technology and rapidly evolving subset of health care: the diagnostic imaging capital equipment market. Examples of this market's products include MRI scanners, CT scanners, nuclear medicine, PET scanners, ultrasound machines, and radiation therapy devices. This equipment ranges from several hundred thousand dollars to over $2 million, and

International Journal of Health Care Quality Assurance
Vol. 18 No. 6, 2005
pp. 458-473

0952-6862
DOI 10.1108/09526860510619444

consumes a significant portion of a hospital's capital budget. The major thrust of this study and article is to concentrate on the following issues:

- What is the current situation in the diagnostic imaging capital equipment supply chain with regard to e-commerce?
- In what areas could efficiencies be achieved by implementing e-business initiatives?
- Does strategic vision play a part in implementing e-business (or is cost reduction the only benefit)?
- What barriers to efficiencies exist in the radiology equipment market that makes it different from supply chains in other industries?
- Could a model be created to show the implementation of e-commerce in the radiology diagnostic imaging market?

Facilitating the internet in business-to-business transactions

The internet is perceived as the dominant facilitating technology for e-commerce by many academics and practitioners (Bartoccini, 2001; Carabello, 2001). However, the internet is only one of several IT-related technologies by which e-commerce is and will be conducted. For example, wireless transmissions (such as bluetooth), interactive TV, and smart card technologies are emerging as viable alternatives to pure internet interactions in both service and manufacturing industries. In fact, many industrial e-commerce applications rely on multiple technologies to fully implement a system. As people become increasingly dependent on data to do their jobs and as they increase the amount of work done outside the traditional office, a series of working models of data integration and automated data collection methods are needed in the strategic manufacturing IT literature. These models and methods are becoming more critical in an integrated technical project team environment as more suppliers and customers are looking deeper into a manufacturing firm's supply chain management systems. Accessibility to e-mail, work-in-process inventories and schedules, corporate databases – to mention a few – are made possible through an understanding of strategic manufacturing IT-related concepts. These strategic IT concepts, including controlling IT applications, are affecting the complexities of management, the role of new technologies and the benefits of project management to ensure the operational health of business applications. In addition, there is a growing need to develop working models from the modern manufacturing management literature to relate authentication, knowledge management and leadership strategies within the new product manufacturability and development processes in general, and specifically within the automatic identification and data capture systems industry (AIDC). This need is becoming more evident as world economy continues to be internet and information systems (IS) driven.

The development of internet and auto-identification technologies has created and enhanced business-to-business (B2B) and its supply chain management systems (Weddle and Bullukian, 2002). Despite the economic setback prior to and after the tragic destruction of the World Trade Center associated with September 11, 2001, the B2B market is quickly growing into a major market (Turban *et al.*, 2000), and is expected to account for 83 percent of online sales in 2002 and 88 percent by 2006 (*Ecommerce Times*, 2002). More applications that require user authentication and

transaction authorizations with a very high level of security will especially continue to increase. The smart card industry (combining microprocessor technology and credit-card portability) will probably emerge as a major player in the immediate future in new product development and project team innovation as increased web-enabled applications with similar security requirements will emerge as the volume of financial transactions conducted via the internet steadily increases. Hence, proper project management systems are needed to capitalize on this growing marketplace. Various market initiators, including buyers, suppliers, and third parties, are building e-marketplaces and participating in the electronic markets. Unfortunately, despite their popularity and potential for extensive growth, many B2Bs are struggling to survive because they failed to attract enough participants to properly leverage electronic markets and AIDC technologies (Whitaker *et al.*, 2001).

In fact, common case studies found in the practitioner literature cite examples of B2B marketplaces that failed because they did not reach critical mass. For example, Covisint reportedly attracted less than 100 of the 30,000 suppliers of Daimler-Chrysler, Ford, and General Motors for 14 months after they announced their plan to launch a single global B2B supplier exchange (Moozakis, 2001). Hence, to compete successfully in a global economy, a firm must measure and continuously improve the performance criteria of cost, quality, delivery, service, flexibility and reliability. These product features, generally associated with product manufacture, are usually determined during the product design stage. Therefore, product design/delivery and manufacturability must be considered vital elements in any manufacturing strategy formulation. The internet, with its near transparent AIDC system, has been the key enabler of these worldwide product design/delivery technologies. Consequently, a growing number of firms that manufacture and/or sell consumer products are testing technologies that could transform the way industries use the internet for tracking goods in their supply chains.

The AIDC and associated information technologies are more than just barcodes and smart cards. They are a variety of technologies that offer both strengths and limitations based on the jobs they are required to perform, and include magnetic stripes, radio frequency identification, biotechnology and voice data entry. The AIDC technologies are the terms used to describe the direct entry of data into a computer system, programmable logic controller (PLC) or other microprocessor-controlled device without using a keyboard via direct human input. In addition, AIDC technologies provide a reliable means to both identify and track items – characteristics that are the hallmarks of modern e-commerce. Through AIDC, it is possible to encode a wide range of information, from basic item/person identification to comprehensive details about the item/person in a read/write format. For example, a MIT Auto-ID project was recently spearheaded by some of the world's largest consumer packaged goods, retail and computer companies (International Paper, Procter and Gamble, Sun Microsystems, Unilever and Wal-Mart) and supported by the Uniform Code Council, a standards body that represents companies in 23 industries (Smith, 2003). This initiative illustrates the need for the integration of auto-ID strategies and techniques to be an essential component in a manufacturing firm's management of the overall supply chain. The management of supply chain information technology is all about promoting linking and connectivity in organizational structures. Hence, managers should be able to link

or track their products to orders and subsequently place orders to shipments and eventually shipments to payments.

The integration and use of the internet and AIDC systems serve as a foundation for the management of data flows for strategic manufacturing purposes, such as using barcodes in distribution warehouses' informational and material flows. Highly accurate information gathering through proper database management systems integration can be linked via the internet in any potential profitable combination to identify and track each product and shipping container moving throughout a supply chain to the database controlling it. Since "bar codes are demanded in industries such as manufacturing, health care and pharmaceuticals, distributors hesitant to risk getting involved in the bar code market should reconsider [their position]" (Kemler, 2001, p. 69). The process of replacing vast amounts of data normally processed by human workers, who are prone to errors, with scannable bar code symbologies enables end users to significantly reduce handling time and transposition errors. In addition, since the information is recorded and stored in a real-time fashion, end users will acquire a greatly enhanced and accurate tracking in the supply chain as compared with traditional manual methods.

Current situation

Figure 1 represents a snapshot of the current supply chain for original equipment manufacturers (OEMS) in the radiology diagnostic imaging equipment business, although it has applications to many suppliers in the health field. In essence, numerous suppliers provide the OEMs with technology, software, and accessories pertaining to the various pieces of equipment (Sganga, 2001; Tike, 2000). The OEMs then market the finished product directly to hospital and imaging center facilities via a direct sales

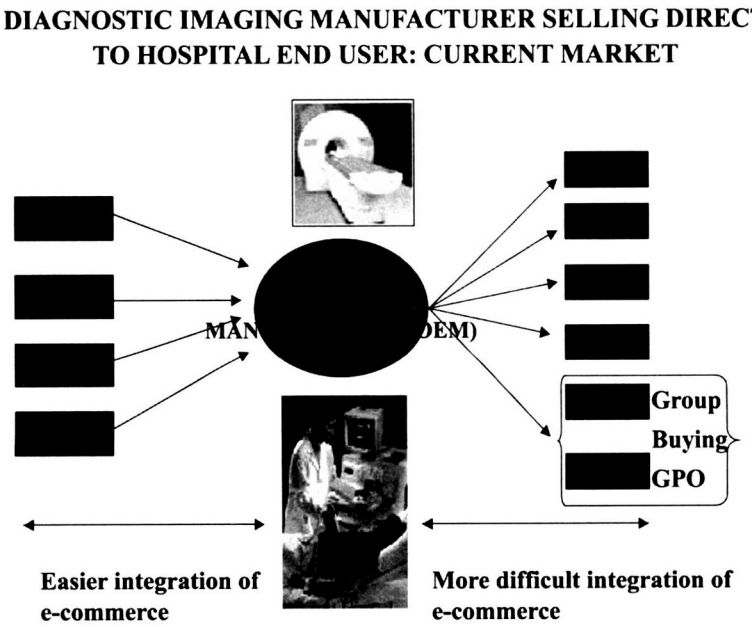

Figure 1.
The current supply chain for original equipment manufacturers (OEMs) in terns of the diagnostic imaging market

force. The market also includes groups of medical facilities that have banded together by business or for group purchasing known as group purchasing organizations (GPOs) or integrated delivery networks (IDNs).

The supplier channel to the OEMs most resembles the traditional supply chain in other industries, as indicated in Figure 2. These firms supply both commodity items such as semiconductors and also raw materials in addition to customized items such as software services and pre-designed parts. An example of e-business practices being employed on this channel is GE Medical Systems, which employs reverse auctions to drive down the cost of supplies. The GE Medical Systems company currently e-auctions about one-half of their $3bn in purchasing (GE.com, 2002). Vendors who want to do business with GE can get current Requests for Purchase (RFP) information from GE's website and participate in three-hour auctions similar to the e-Bay model (*Electronic Commerce News*, 2002). General Electric managers admit this practice works much better for commodity items as opposed to items that need to be customized. However, as the system becomes more mature, customized items will be sourced from this model as well. On the other end of the supply chain, Figure 3 depicts the typical decision process hospital managers would use to purchase equipment from an OEM.

The process (Figure 3) begins with the identification of a need or business opportunity in which the health care provider wishes to invest capital. The process could also begin as a requirement to replace aging or dysfunctional equipment. A clinical specialist in the radiology department determines which vendors in the industry offer goods that meet the hospital's needs, then does research. At the present time, this market relies heavily on vendor information to present both internal needs and feature/benefit analysis. This market also normally favors one or two vendors in a particular region, thus creating one of the barriers to efficiency for e-commerce in this market described later in this paper. Certain end-users create RFPs to try and standardize the procurement process and to attempt to put more materials management control over the process. In any event, whether from RFP or internal

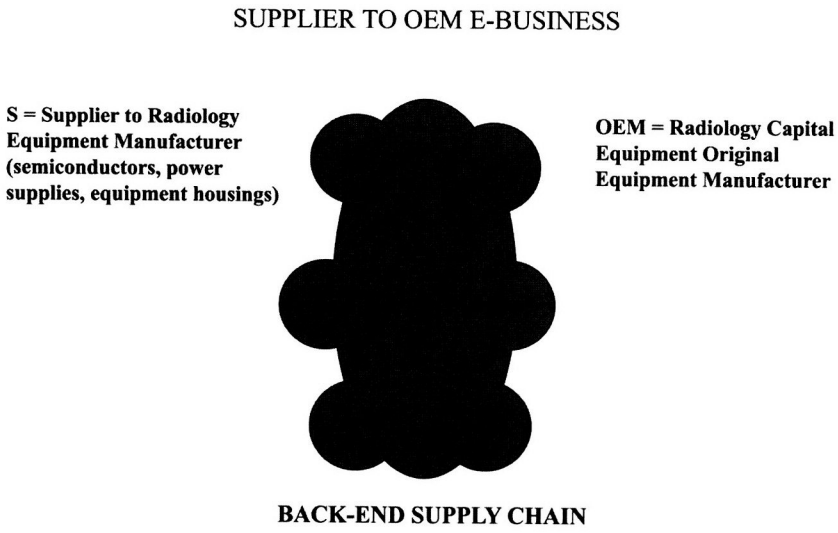

Figure 2.
The supplier channel to the OEM most resembles the traditional supply chain in other industries through interconnectivity via e-commerce supplying commodity items, raw materials, and customized items

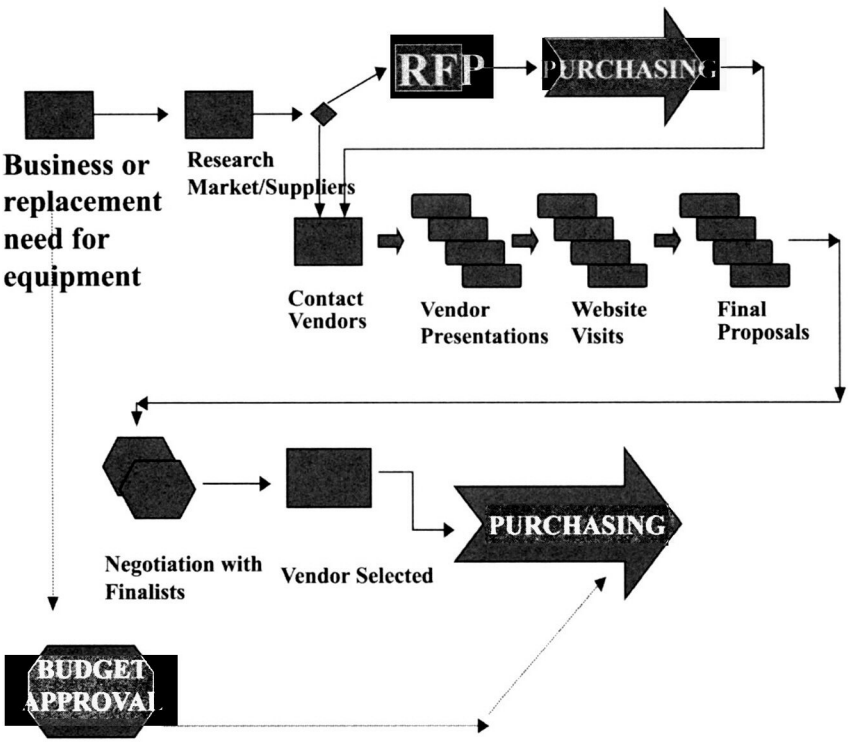

Figure 3.
Current front-end supply chain model for diagnostic imaging capital equipment

research, or perhaps from recommendations received by word of mouth from a trusted colleague at another health care organization, several vendors are manually contacted and invited to participate in the purchase process.

The next series of events involves the vendors. Typical OEM sales and marketing organizations are structured to employ both full-line general sales people and sales specialists (concentrating on only one product line) that team up to match equipment, services, and support to the particular customer. It is not a very efficient process and was not designed to be. Health care as a whole may not have participated in the re-engineering developments of the 1990s that drove operational efficiencies for many other industries. These vendors involved then perform detailed product or system presentations to both the clinical and administrative/executive personnel. Often, to appease the tastes of the clinical staff, site visits are necessary and may involve the expense of moving several clinical and executive staff to another facility where they can touch, feel, and see the equipment actually performing in a clinical fashion. The most important part of these visits is often the interaction that occurs between the physicians and administration of the two organizations. The need for these interactions to occur

presents a challenge to the implementation of e-business in the sales and marketing area. The e-business may or may not evolve to address or support these needs.

The process then continues as vendors match the needs and requirements of the health care provider with detailed proposals and pricing. Several meetings may occur between the vendor and the different decision makers in the hospital to facilitate the best proposal to meet the organization's needs and win the business. Often, a major challenge for the vendor is to determine who in the hospital hierarchy has the power to approve the purchase. Rarely, if at all, is this the actual purchasing department. Frustratingly, e-commerce does a poor job of identifying the organization's political structure. Finally, negotiations are held with one or two vendors that best meet the requirements of the facility and a vendor is selected. At this point the hospital material management personnel may be involved. However, in many cases hospital procurement and purchasing personnel are not involved except to draft the final purchase order and to ensure compliance with hospital budgeting and finance requirements as previously indicated in Figure 2.

Barriers to efficiency (B2E) of effective e-business in radiology equipment

Several pure play e-commerce ventures have been created to try and reduce inefficiencies along the health care supply chain. As discussed previously, companies such as GE Medical Systems have begun to implement e-commerce and paperless e-business along their back-end supply chain. In addition, companies such as Commerce One and Freemarkets deal in commercial e-sourcing. On the front end of the supply chain, dealing directly with the radiology equipment end user, companies such as Neoforma.com and Global Healthcare Exchange (GHX) offer clearinghouses that try to match equipment buyers and sellers (GHX.com, 2003; Verespej, 2002). However, in the diagnostic imaging equipment market these solutions have so far been less than successful. However, the lack of effectiveness has not been because of technology limitations. Web-enabled interfaces now exist that allow e-business to occur with little up-front investment. Rather, there has been a lack of understanding by the end users of the value of e-commerce for these high-value purchases. The solutions provided by these companies currently do not add enough perceived value to address both the purchasing and clinical needs of the provider. In effect the benefits they offer concentrate on the actual material management process and are not in congruence with the real players involved in the purchasing process. Such solutions do not address the barriers to efficiency (B2E) as indicated by the model indicated in Figure 4. In general, B2Es relate to specific circumstances in the radiology equipment market that are unique and present problems to traditional supply chain e-commerce solutions. Some of the important characteristics associated with B2Es will be defined in the next section.

Widespread use of e-commerce solutions to purchase expensive radiology equipment would not be expected to occur until these needs are met. It also might be effective to approach these needs in an evolutionary manner versus an entirely encompassing solution to help move the market in small steps. In other words, focus on evolutionary improvements that pay for themselves versus revolutionary but risky gains. Such an e-marketplace could concentrate on reducing one or two of the B2Es and thus work in tandem with the current process in Figure 2 to create efficiencies for the buyers of the equipment. Little research has been done looking at radiology e-commerce in contrast to a traditional manufacturing-purchasing model. Since the

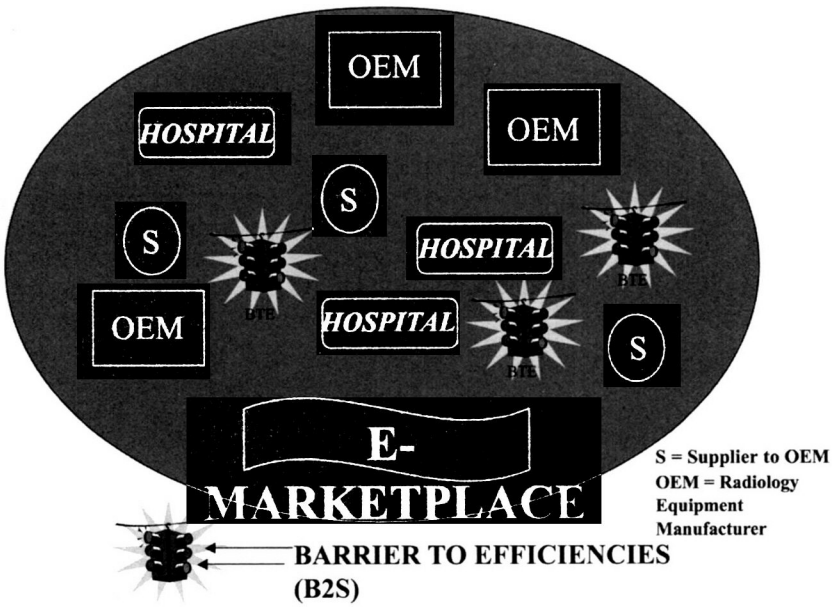

Figure 4.
Barriers to efficiency and circumstances in the radiology equipment market

hospital does not purchase capital imaging equipment in a traditional manner, factors must be examined to overcome the challenges and exploit the opportunities for e-business to occur in the radiology equipment market. The specific factors that make radiology equipment unique will be discussed later.

Supplier to OEM to hospital model for e-business

The future model for e-business in radiology equipment as depicted in Figure 4 may be dependent on the industry's ability to meet the health provider's needs and idiosyncrasies and/or associated B2Es. Several important B2Es that need to be addressed for successful e-business are depicted in Figure 5, the most important being the clinical needs and support of the health care provider as indicated by physician support and preference.

In fact, few business and health care management and marketing literature exists that even mention the physician as part of the power base in health care procurement. However, health care often resembles an inverted business structure as shown in Figure 6, and meeting the physician's needs can be a major catalyst to either help or hinder the potential for cost savings or other advantages as it relates to purchasing large ticket imaging equipment.

Quinn *et al.* (1996) discussed the concepts of managing the professional intellect, which is directly linked to the inverted organization as demonstrated in Figure 6. Managing the professional intellect involves four levels:

(1) cognitive knowledge;

(2) advanced skills;

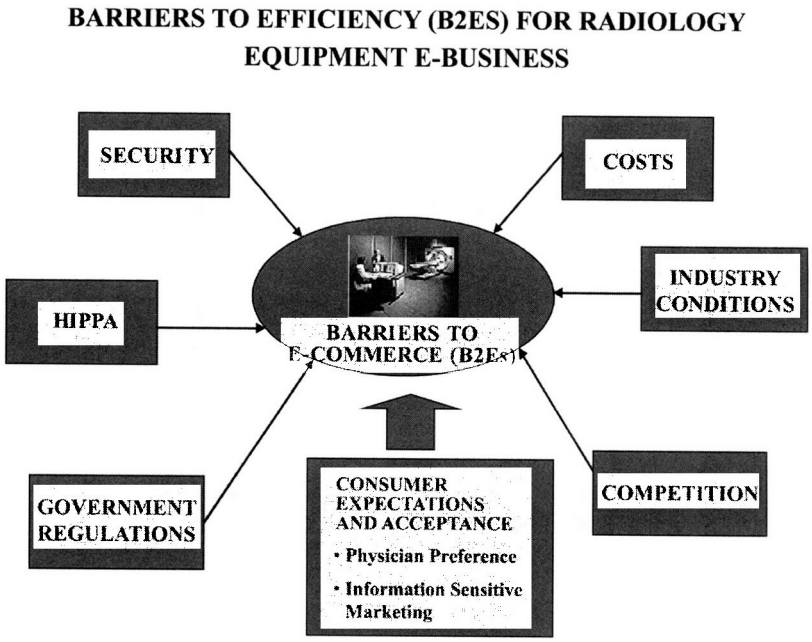

Figure 5.
Important issues associated with B2Es that need to be addressed for successful e-business

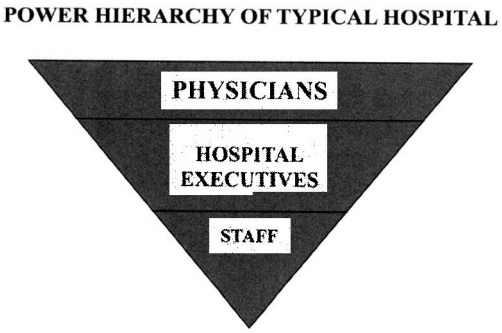

Figure 6.
Health care often resembles an inverted business structure

(3) systems understanding; and

(4) self-motivated creativity.

Levels one through three may be taught and are seen as knowing levels, while the fourth level takes time to develop because it is seen as a caring level and deals with emotions. It is important to develop the professional intellect within the health care industry, especially when the intention is to foster and strategically leverage professional intellect in inverted organizations. Inverted organizations are one way to develop and grow the professional intellect. When addressing the typical empowered employee health care institution, many characteristics exist that reflect an inverted organization. For example, the emergency medical team is constantly doing field work

and is connected into a computer network that allows them professional input from physicians and other professions with the discretion to implement that input. The technicians as well as the physician are empowered to follow their clients' progress whenever they choose to and in real time. Since they are only guided on what to do, the medical team is free to go about and make their relationships with their customers in the way that they know best. This type of relationship may be considered a classic example of the fourth professional intellect tool, namely self-motivated creativity. This idea of "free to do what and how you want" is a way for a person to be creative and choose a direction that works best for them, their customers, and the organization. Although they have goals to meet, they are able to choose their own way of doing. It is this ability to create relationships with customers that provides the strength and eventual sustainable competitive advantage for the health care industry. These relationships need not only be forged in B2C (business to customer) relationships, but also throughout the organizations' supply chain in B2B operations. Of course, the superficial flaw in an inverted organization is the sense of chaos that might develop without sufficient leadership. If health care managers and practitioners can develop an organizational structure that permits the creativeness to shine through its employees, they will have a better relationship, which can lead to better productivity, which is always the end result for organizations and their customers.

Discussion of barriers to efficiency to radiology capital equipment e-commerce

Customer expectations and acceptance

As indicated in Figure 5, the customer must perceive value from e-business or it will not be used. Customer reluctance is a major obstacle to overcome to move toward e-business benefits. Customers have not been put in a position where they feel confident deviating from the tried and true process outlined in Figure 2. Why? One reason is that it has not been demonstrated that e-commerce in this market leads to any effect on the bottom line. More importantly, customers have only begun to see and feel added value from the internet in their market. In a market that is slow to develop, a more incremental strategy might be attempted. For instance, GE Medical Systems now claims on its website to get over 40 percent of its service-related revenue from internet-based monitoring and support of equipment. General Electric managers claim to be able to monitor symptoms of possible failure and repair them before the outage affects the customer. Also, software can be easily downloaded from the GE web site to upgrade expensive equipment such as MRI scanners to perform improved functions. Regardless of the intended effect, efforts such as this serve to increase confidence amongst a risk-averse purchasing group that e-solutions work. General Electric Medical Systems is effectively "training" their customers to have confidence in e-business solutions while benefiting handsomely through the current growth in revenue the strategy is providing. This is a clear example of an evolutionary improvement that is paying for itself. The next step shows that internet equipment purchasing works. Developing a critical mass or mass acceptance of the appropriate technology will most certainly be slow to arrive in this area until information content and availability is regarded with as much confidence as personal representative contact with the vendor. That degree of e-business effectiveness may never occur in this market. However, the opportunities to increase effectiveness to a major extent exist

by supporting the sales representative with immediate access to information and technology and also by automating much of the sales representative's administrative functions to allow the sales representative to concentrate on filling the gaps that are difficult for e-commerce to fulfill: customer needs analysis and customer problem solving.

As discussed previously, although e-commerce drives efficiency in the supply chain, it does a poor job of identifying the organization's political structure. For example, although the purchasing department may issue a typical RFP, the power to evaluate and decide on a particular MRI scanner to purchase may rest upon one of the staff radiologists. Several administrative personnel that broker information back and forth from the vendor regarding particular features and benefits may additionally surround the staff radiologist. A typical transaction-based e-commerce solution would be ideal to provide the purchasing manager with price and technical specifications on a product, but would be less than ideal to match the OEM's capability to support the needs of the true power broker: the physician. In addition, how can an e-commerce site convey emotional intelligence to the buyer of such an expensive piece of equipment? Industry interviews support the premise that e-commerce holds its greatest value by supporting and not replacing human contact (and its associated inefficiencies) in the sales and marketing process (GE Medical Systems, 2003; Hospital Material Management, 2001). Examples will be discussed under the competition issue associated with B2E.

Government regulation. Medical equipment may not resemble the traditional supply chain as government regulation influences numerous aspects of the sale, installation and use. Reporting requirements cover the actual approval to sell the equipment and also the certification of the purchaser as lawfully able to use the equipment. Handling these inefficiencies in the e-business processes without inducing other problems is an important ingredient to successful e-business in this market.

Health Insurance Portability and Accounting Act (HIPPA). The HIPPA is a government regulation that deserves its own category as an influence on health care e-initiatives at the present time. It addresses the adoption of technology and administrative processes to ensure the security and confidentiality of health data. President Bush signed into law on December 27, 2001 a one-year extension for compliance with the HIPPA transactional code because many health care facilities are still not compliant. It is expected that spending to comply with HIPPA may exceed Y2K (i.e. the year 2000 and the fear that computer programs would not function properly owing to date formatting problems) and may deflect spending that otherwise could be directed toward e-business initiatives. Another problem is the perception in the industry that increased e-business just creates additional HIPPA issues to be addressed requiring the perceived benefit of any e-commerce initiative to be quite large in order to be implemented at this time.

Security. Along with meeting customer expectations, security may well be a major obstacle to advancing more e-business purchases. Traditionally, hospitals have been skeptical about giving private information to third party e-commerce portals, many owned in part by the equipment vendors (Global Healthcare Exchange, 2003).

Costs. One radiology OEM advertises equipment 15 percent below market prices for online purchasers. However, the link to the e-commerce area is not available and the customer must call and be interviewed by a sales representative. Customers are skeptical of cost claims for good reason. Radiology equipment service costs can exceed

six figures annually, not to mention the costs of equipment downtime and building renovation. In addition, price inelasticity often exists among the clinical decision makers.

Industrial considerations. The fragmented nature of health care, regional in nature, presents additional challenges to a unified e-business strategy. How to handle these differences as an OEM and adjust pricing and strategy accordingly without alienating the existing customers will be necessary for maximum potential of an e-business initiative. For example, certain areas of the US are dominated by powerful integrated delivery networks (IDNs) that demand steep price discounts in return for a negotiated bulk purchase. Any e-commerce solutions would be required to integrate tiered pricing and also be able to meet the administrating requirements of an IDN in contrast to an independent community hospital.

Competition considerations. Although the industry usually does not make references to competitors, the opportunity exists to respond quicker to moves by the competition to gain market share. This information can be quickly changed and available to sales representatives or customers offering an additional tool to the marketing mix. This area is already in operation. Sales representatives in the field now have access to up-to-the-minute changes in product features as well as the capability to perform quotations and presentations customized for the individual customer. Sales and marketing executives interviewed for this article feel confident that e-commerce will end up eliminating much of the administrative burden and provide them with more tools to be even more effective. Rather than eliminate the need for human sales activity, in the radiology capital equipment market sales representatives and management seem to be embracing the efficiencies of e-business processes to help them become more efficient and spend more time customer problem solving or prospecting.

Social theory affecting e-commerce in radiology capital equipment

Rogers (1995) suggested that most customers take distinct steps toward accepting innovation in the marketplace. One of the first stages to accepting innovation is to gain more and more knowledge of how the particular innovation affects the process of interest. This appears to be the situation in diagnostic radiology equipment as customers react to the innovations presented by e-business initiatives at the present. Customers are studying the financial benefits along with process changes that have would have to be made in order to implement e-commerce. Many current operational processes in health care facilities are firmly entrenched. Thus, vendors must be careful not to push their customers toward a more complicated buying decision. In addition, empirical evidence suggests the medical community in general is not an early adopter of business process changes although they are very aggressive adopters of clinical innovations (Weddle and Bullukian, 2002; Surry, 2002). This translates into careful analysis and study of e-business solutions before adoption while clinical e-medicine and online medicine move aggressively forward even with no proven financial benefits. As indicated in Figure 7, the bell-shaped analysis of categories of innovativeness, representing portions or numbers of adopters, may suggest that e-business adoption in diagnostic radiology equipment might fall in the laggard area, while adoption of clinical e-medicine to treat patients in rural areas, for example, might fall into the early innovation areas.

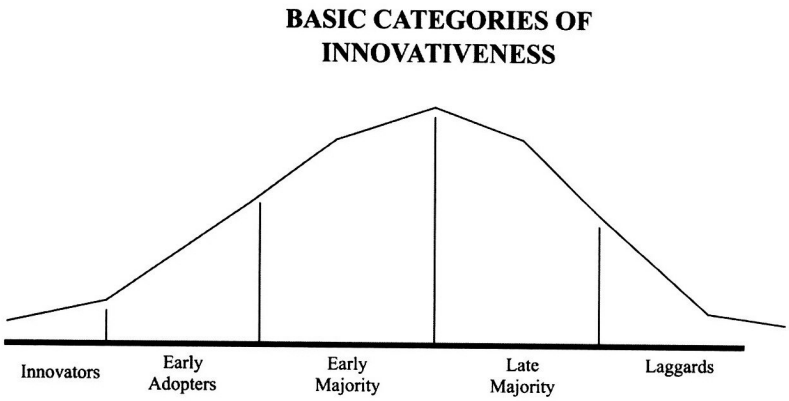

Figure 7.
Bell-shaped analysis of categories of innovativeness in e-business adoption in diagnostic radiology equipment

Source: Adapted from Rogers (1995)

Also related to social theory and pertinent to the adoption of e-business solutions for diagnostic imaging equipment is another widely used concept, namely Rogers' (1995) diffusion theory. An application of the theory may suggest a point in which the rate of adoption of the innovation dramatically accelerates, as indicated in Figure 8.

Hence, as the medical community continues to acquire more knowledge of how e-business could benefit the slow rate of adoption as indicated by the beginning of the S-curve (as shown in Figure 8) will continue. Evolution of current technology and continued persuasion of the market could possibly lead sometime in the future to a dramatic increase in adoption. However, it is not possible to predict if this event will ever occur. Empirical evidence suggests the contrary with current technology and customer perceptions unless they are changed.

Yet another theory that possibly relates to the adoption of e-business for capital imaging equipment is the theory of perceived attributes (Rogers, 1995). For example, a

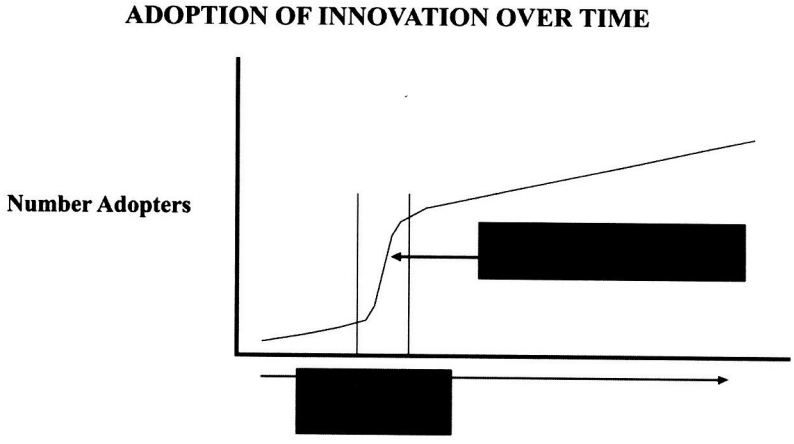

Figure 8.
Application of Rogers' (1995) diffusion theory and its rate of adoption of an innovation

Source: Adapted from Rogers (1995)

question to consider is whether the sale of expensive and complicated radiology machines by e-business practices can conform to what Rogers calls the perceptions customers will evaluate. These are trialability, observability, relative advantage, complexity, and capability. Without a complete review of Rogers' theory, which is beyond this article's scope, it is evident that none of these traits can be easily adopted for e-business solutions for multi-ton, multi-million dollar, seldom-purchased imaging equipment purchases. Thus, social theory seems to suggest numerous obstacles to adoption of e-business in capital imaging equipment in addition to the barriers to efficiency faced in the market. Vendors and innovators of e-business solutions must keep social theory in mind to properly implement adoption in this market.

Potential obstacles

The authors' contention is that there is positive evidence for developing the market potential for PACS-type systems. There are counter-views arguing that markets develop where they develop in an emergent strategy, so if they do not develop, there is little or no call for the product. For example, Rigby (1998, p. 163) astutely makes the observation that "as business conditions change over time, the richness of information about management tools will continue to grow". In the highly competitive radiology-related OEM marketplace, many managers might only want to give a tool or strategy a few years to prove its value. These years might not run the gamut from good times to bad times, so the new approaches may not get the thorough test that they should. Managers should have a variety of measures and tools in place so that they can give the measures and tools the time and evaluation necessary to display their usefulness. The concepts discussed in this paper are not immune to the trials of market innovations and product development, which rarely succeed at best. The traditional view is that the success of companies depends upon quality management. The other view is that a firm's ultimate "fate is determined by forces outside management's control" (Hout, 1999, p. 161), that all companies will fail sooner or later, and that it is the system, not management, which dominates. Hout (1999) states that non-linearity, self-organization, and emergent strategy reveal limitations that indicate good management is still a primary requirement. The proper management of the information and value chains are still initiated by customer needs and maintained by good management, as illustrated in the previous conceptual models.

General conclusions and implication associated with the radiology market

Unfortunately, traditional leveraging e-commerce will not massively replace traditional sales and marketing efforts in the sale of capital imaging equipment to hospitals and imaging centers in the foreseeable future. Although some vendors such as GE Medical Systems have successfully implemented some e-business methods, such as remote monitoring of equipment and remote software installation and sale, there still exists a large gap to cross for customers to be comfortable with a true e-business model in this market. Perhaps as vendors continue to chip away at the many layers of inefficiency that exist in the market with innovative solutions that can save the customer both time and money, acceptance will follow. The most challenging part of an evolution to e-business in capital radiology equipment will be the social factors and entrenched processes in health care business practices.

However, even though a complete e-revolution in radiology equipment purchasing may not happen overnight, much potential exists for e-business practices to leverage both efficiency and effectiveness out of the existing system. Manufacturing, marketing, sales, and accounting are all poised to be streamlined by faster and more accurate information that will be available to decision makers and, most importantly, to customers. Efficiencies such as eliminating needless administrative burdens from customer representatives that allow them more time for customer problem solving is one example of both an effectiveness and efficiency gain. It is important to note that despite all the efficiency gains through e-commerce, the entire process can make the buying process more complex for the end user, which is counter-productive. In essence, some feel that they may be merely trading operational efficiencies for lost sales as customers seek comfort in their traditional buying patterns.

Other dynamic factors that will affect the diffusion of e-business in radiology equipment are social acceptance of the new processes involved and the continual reduction of B2Es as described previously in the paper. Most significant is the responsibility of radiology equipment vendors to facilitate solutions that reduce the amplitude of each B2E while allowing such social initiatives to facilitate acceptance such as trial periods to allow the user a chance to "test the water" before committing to full e-commerce. A further challenge by vendors is that although it is great to incorporate e-business strategies, the current landscape of the business requires e-business solutions to pay for themselves or be dropped. Unfortunately, the e-boom of the 1990s is over and ROI (return on investment) is a still a key attribute to sustain any e-business initiative.

As a result, these solutions most practically will be tried on smaller, less expensive equipment before reaching the level of capital imaging purchases. As stated previously, social factors relating to customer change, the political landscape of health care and e-solutions that realize the inverted structure of the health care organization will continue to be the main obstacles for true e-business in this market. Although the radiology capital equipment market presents numerous idiosyncrasies that must be addressed to successfully implement an e-business strategy effectively, opportunities exist all along the supply chain for e-business strategies to both eliminate costs and acquire strategic initiatives. Those firms that most successfully listen to their customers and address the B2Es will help move the industry toward more effective utilization of the benefits e-business can create and also obtain first mover advantages. Although the efficiencies that e-business provides are extremely important in the radiology capital equipment market, the main value of e-business in this industry of high priced and relatively infrequently purchased equipment may well be the value-added benefits the technology brings to its customers.

References

Bartoccini, W.V. (2001), "Beyond the buy-it button", *Health Management Technology*, Vol. 22 No. 1, pp. 22-4.

Carabello, L. (2001), "E-procurement can reduce expenses", *Healthcare Financial Management*, Vol. 55 No. 12, pp. 82-3.

Ecommerce Times (2002), "Data summaries", February 13, available at: www.EcommerceTimes.com

Electronic Commerce News (2002), "Health care firms move to broader e-commerce deployment", *Electronic Commerce News*, Vol. 7 No. 10, pp. 1-6.

GE.com (2002), "General Electric named e-business of the year by *Internetweek Magazine*", available at: www.ge.com/singapore/ge_article3.htm

GE Medical Systems (2003), available at: www.gemedicalsystems.com

GHX.com (2003), "End-to-end healthcare supply chain with GHX and CAPS purchasing management system EROS", available at: http://home.ghx.com/uk/news/press_release_details.asp?info_id = 389

Global Healthcare Exchange (2003), available at: www.ghx.com

Hospital Material Management (2001), "Novation, Allegiance begins three-year study of Internet's impact on supply chain", *Hospital Material Management*, Vol. 26 No. 5, p. 6.

Hout, T.M. (1999), "Are managers obsolete?", *Harvard Business Review*, Vol. 77 No. 2, pp. 161-8.

Kemler, A.M. (2001), "Bar codes: built for speed", *Business Forms, Labels & Systems*, Vol. 39 No. 11, pp. 69-70.

Moozakis, C. (2001), "Update: new CEO should shape up Covisint", InternetWeek.com, April 23, available at: www.internetweek.com

Quinn, J.B., Anderson, P. and Finkelstein, S. (1996), "Managing the professional intellect: making the most of the best", *Harvard Business Review*, Vol. 74 No. 2, pp. 71-80.

Rigby, D.K. (1998), "What's today's special at the consultants' cafe?", *Fortune*, Vol. 138, September 5, pp. 162-3.

Rogers, E.M. (1995), *Diffusion of Innovations*, 4th ed., The Free Press, New York, NY.

Sganga, J.P. (2001), "Online healthcare purchasing", *Healthcare Executive*, Vol. 16 No. 5, pp. 55-8.

Smith, A.D. (2003), "Applications and process strategies of bar coding technologies in the health care industry", *Journal of e-Business and Information Technology*, Vol. 3 No. 1, pp. 37-50.

Surry, D.W. (2002), "Diffusion theory and instructional technology", available at: http://into.base.org/docs/diffusion/

Tike, B. (2000), "Equipment vendors test the world of e-commerce", available at: www.diagnosticimaging.com/cgi-bin/webcast00/display_news.cgi?5

Turban, E., King, D., Lee, J., Warkentin, M. and Chung, H. (2000), *Electronic Commerce 2000*, Prentice-Hall, Upper Saddle River, NJ.

Weddle, R. and Bullukian, J.-M. (2002), "The promise of B2B", Center for Business Innovation, available at: www.cbi.cgey.com/journal/SpecialIssue/PromiseB2B.html

Whitaker, J.D., Stephens, J.A. and Trahan, C.P. (2001), "Successfully securing suppliers", *Supply Chain Excellence*, Vol. 4.

Verespej, M. (2002), "Say goodbye to distinct categories", *Frontline Solutions*, Vol. 3 No. 7, pp. 42-3.

Further reading

Medibuy.com (2002), "GE medical systems joins Medibuy marketplace", available at: www.medibuy.com/news/news_press_gemedical.asp