

# A contingency model of EDI's impact on industry sectors

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Electronic Data Interchange (EDI) has conventionally been discussed from the perspective of individual corporations. This view needs to be complemented by an appreciation of the relevant industry sector view. This paper proposes a contingency model incorporating an industry sector view. The notion of the industry value-chain is proposed as a valuable tool in analysing the potential of EDI. Key characteristics of industry sectors are discussed, and several factors are identified which must be considered when modelling any particular sector. A taxonomy is proposed whereby the differential impacts of EDI on various industry sectors may be explained and predicted. It is concluded that insufficient attention has been paid to the question of industry infrastructure. Opportunities for research into industry sectors on the basis of this framework are discussed, and several difficulties identified.

**Keywords:** EDI, industry sectors, industry value-chain, industry infrastructure

Inter- and multi-organizational systems have been the subject of considerable study in recent years<sup>1-10</sup>. In most studies, the perspective adopted has been that of the individual corporation. Thus, linkages between businesses have been viewed from the perspective of each partner.

In that sub-set of the literature dealing with alliances and 'value-added partnerships', the viewpoints of two members of an industry sector have been considered in a collaborative or 'win-win' context<sup>11-17</sup>. To date, few authors have adopted the industry sector perspective (for exceptions, see Refs 18 and 19).

Another characteristic of most prior studies is the dominance of the competitive ethos. In many industries, in many countries, however, competition is heavily constrained. The health-care, primary energy and social service industries are among those in which competition is subject to significant limitations, such as the creation or toleration of monopolies and cartels; the imposition of safety, consumer and environmental regulation; and, in the case of strategic industries, governmental stimulation and direction. A theory of strategic information systems that presumes active competition among the participants is inadequate for such industries. A global view of the sector is required, not so much in the context of a centrally planned economy, but rather as a linked set of enterprises whose freedom of action is constrained. Even where competition is important, the industry-sector view would provide a valuable complement to that of the single corporation.

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Electronic Data Interchange (EDI) is a specific form of multi-organizational system. It is widely understood as the replacement of paper-based purchase orders with electronic equivalents. EDI actually has much broader application than the acquisition process, and its impacts are far greater than the mere automation of manual processes. EDI offers the prospect of easy and inexpensive communication of structured information throughout the corporate community, and is capable of facilitating much closer integration among hitherto remote organizations.

As with other multi-organizational systems, studies of EDI have mostly adopted the individual corporation's perspective. EDI has been found to decrease labour, mail and telephone costs and reduce the elapsed time of routine business communications, through quicker document preparation and transmission, and decreased clerical error rates and exception-handling<sup>20-22</sup>. It has also been established that organizations are only likely to reap the benefits of EDI if they adapt their organizational processes and structure<sup>23, 24</sup>. Second-order impacts of EDI have been variously detected and proposed in such areas as procurement and operations, inventory and cash management.

The purpose of this paper is to consider EDI from the global perspective of the industry sector and propose a contingency model of EDI's impact. The paper commences by reviewing two popular industry sector models from the management literature.

## A conventional model of industry sectors

Various industry sector models exist, many of them based on microeconomic theory. A widely employed

and cited model from the marketing discipline is that popularized by Porter<sup>25</sup>, and reproduced as Figure 1.

This model deals with the context of a corporation's strategic planning. The perspective it adopts is emphatically that of the single enterprise, and it appears to be less relevant to vertically integrated corporations than to companies which focus their efforts on an activity in which they believe they have comparative advantage. It is even less applicable to those industries in which a significant role is played by enterprises once-removed from the focal corporation (e.g., suppliers to the corporation's suppliers, customers of the corporation's customers, or regulatory agencies). A further weakness of the model for the purposes of this paper is its implicit assumption of competitive supply of products and services. In many sectors, particularly in the services industries, monopoly supplier or consumer organizations are legislated by government, and frequently are government agencies. EDI is increasingly being applied in sectors of this kind, such as public libraries, taxation, the regulation of corporations, land information, and national statistical collections<sup>26, 27</sup>.

In order to assess the impact of EDI on industry sectors as a whole, a broader framework is needed. The next section considers another conventional model, and proposes a further development of it.

### EDI in value chains

The motivations for corporations to implement EDI vary. In some cases the firm seeks to lower the labour costs of data transmissions. This can be achieved through the rationalization of purchasing activities, reduction in the volume of paper-handling, and a decreased incidence of transcription errors. EDI is especially attractive in countries with high inflation and interest rates, where organizations seek to decrease the lags in the order-placement process, and so reduce buffer stocks and increase control over cash flows.

Beyond these essentially defensive purposes, much more proactive motivations are also evident. In Trade EDI Systems, for example, both the companies concerned and the exporting country stand to gain

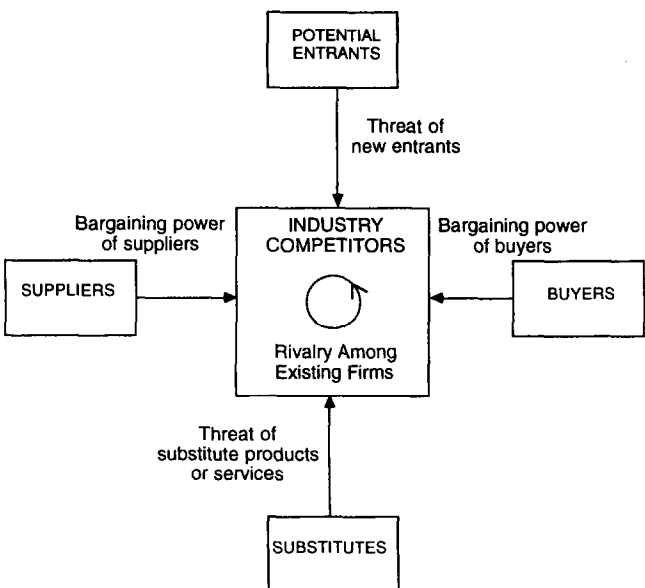


Figure 1. The Porter Model of industry sector dynamics

from quicker handling of cargo. EDI has been seen in several countries as a means of improving the efficiency of waterfront industries, by speedier, less redundant and less error-prone data flows, and by using changes in data-handling as an opportunity for reform of operational practices as well. In Japan, an important stimulus has been the trend towards more frequent orders for smaller quantities, which is associated with increased product diversity, emphasis on Just In Time (JIT) manufacturing inventory systems, and the shifting of the burden of buffer stocks back up the production chain. In retail sectors such as fashion clothing, the primary motivator has been the facilitation of Quick Response to customer demand by electronically integrating the successive stages of the production process<sup>28</sup>.

In order to fully understand EDI applications, it is inadequate to restrict the focus to individual corporations. Inter-organizational information systems such as EDI need to be examined in their industry context. The 'value chain' concept (e.g., Porter<sup>25</sup>) reproduced in Figure 2, identifies the succession of activities by which a single corporation adds value to its raw materials and delivers its product to customers. Extending the value chain notion beyond the individual enterprise to the level of the industry sector provides a basis for evaluating EDI's potential contributions. Figure 3 provides an example of the form an industry-specific model might take. It shows the succession of organizations involved, together with key supporting organizations. At successive points along the chain, the flow of materials between the participants is enabled through electronic trading and electronic logistics support.

The enterprises in an industry value chain are most easily conceived as separate companies, with EDI being a means of providing value to organizations in the chain (e.g., wheat-grower, miller, bread manufacturer and foodstuffs retailer). The enterprises may, however, be separate profit-centres within the same conglomerate, or cost-centres within the same division of a single conglomerate. Hence, as EDI services mature, they may also have much to offer to vertically integrated corporations, by providing an efficient means of linking their own point-of-sale operations with inventory, purchasing, materials-handling, manufacturing and accounting systems.

In many industries, the unary, un-branching chain shown in Figure 3 would be an inadequate representation of real-world complexities. It is normal for each link in the chain to comprise a number of alternative enterprises, and each enterprise at one level generally

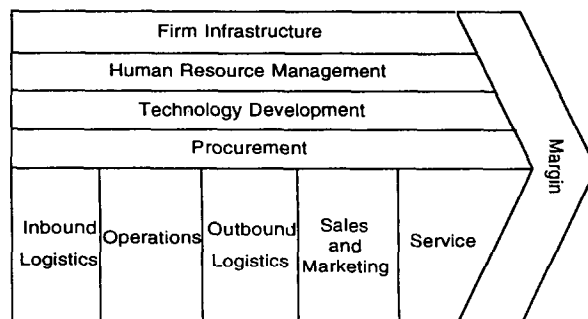


Figure 2. The corporate value chain

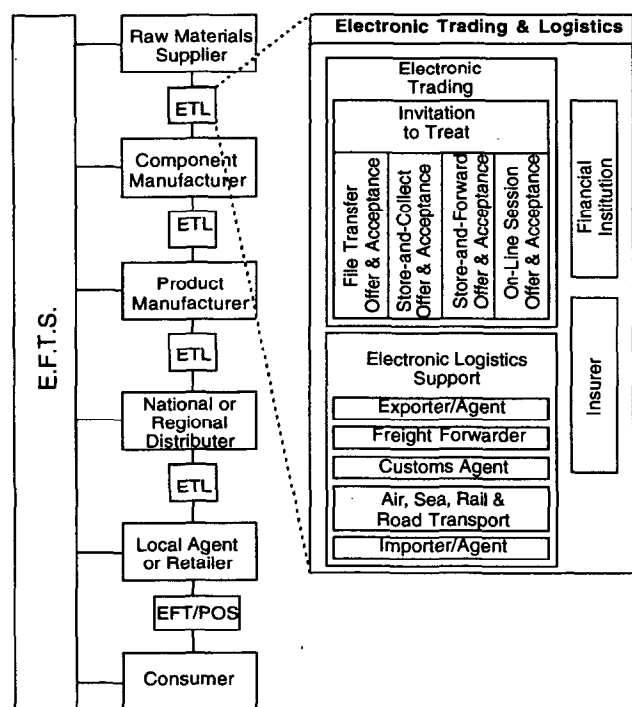


Figure 3. An example of EDI in an industry value chain

maintains relationships with more than one enterprise in each of the adjacent levels; for example, to ensure multiple sourcing of critical components. In addition, many enterprises have close associations with other industries, such as common raw materials, manufacturing processes, products, or distribution mechanisms. A model of the industry chain must identify such connections, and hence model templates of sufficient richness are needed in order that industry models reflecting common patterns can be readily constructed.

From the preceding discussion, it is apparent that focusing strictly on EDI is inadequate. In its most narrow form, EDI is no more than the transmission of messages in 'store-and-collect' mode, with electronic mail-boxes providing a buffer between sender and receiver. Less restrictive usage of the term includes 'store-and-forward' mode, with forced delivery of messages, and on-line or 'interactive EDI'. For many people, it would require a substantial expansion of the term to also include invitations to treat (such as those which use videotex or electronic yellow pages services) and electronic funds transfer. In assessing IT's impact on industry sectors, it is important to consider EDI as a member of a broader class of multi-organizational systems, and not to study it in isolation<sup>29</sup>.

The model in Figure 3 does not purport to be generally applicable. This is because EDI is a broad class of service that must be specialized in order to provide direct benefits to participants in particular industries. For example, SWIFT in the international banking sector, Just In Time systems in manufacturing and several service sectors, and Quick Response systems in the retail sector, can be regarded as implementations of EDI principles in particular contexts. The following section identifies and discusses several important considerations that are relevant to the development of models for particular industry sectors.

## Key factors in industry sector modelling

### *Characteristics of the goods and services being traded*

The example model in Figure 3 is oriented toward goods-related industries. A quite different model structure is necessary for services-related EDI in such areas as banking, insurance, stock exchange trading and settlement, travel and tourism, libraries, taxation returns, statistical collection and market research.

Even within goods-related industries, considerable differences in the potential of EDI exist, depending on the nature of the goods. EDI in its pure form seems unlikely to bring about drastic change to the purchase and sale of 'once-off', fully custom-built goods, because these require a considerable amount of human contact. On the other hand, EDI seems particularly well-suited to trading in commodities, by which is meant goods that are directly substitutable for one another, e.g., stocks and shares, minerals, agricultural and pastoral products with long shelf-lives (such as coffee, wheat and wool) and international currencies. Between the two extremes, customized goods may be effectively supported, provided that the range of options is fully structured, or the base product is standardized and the options are dealt with through a formalized process involving relatively unstructured messages (such as guaranteed-delivery email).

Another category of product for which EDI appears ill-suited is specialty and luxury goods where the handshake with the highly regarded supplier, or the artist's personal signature, are of psychic value to the purchaser. Similarly, buyers of goods whose value is heavily dependent on after-sales services may not be satisfied with electronically mediated trading since their purchase-decision is strongly influenced by their assessment of the seller's appreciation of their needs and the seller's commitment and ability to provide the services over the relevant period<sup>30</sup>.

Categorization of goods according to the extent to which they are goods or services; commodity-like, customized or custom-built; and the nature and importance of the after-sales service-content, is therefore a necessary feature of any analysis of EDI's impact on an industry sector. These factors do not, however, greatly affect EDI's applicability to logistics support.

### *Internationalization of industry*

There are many industries in which at least some of the steps in the value chain involve the flow of information and goods across national borders, and hence customs, quarantine, banking, insurance and other procedures are important. The model in Figure 3 incorporates some of these elements. The lessons currently being learnt in Europe in this respect may prove highly valuable to countries throughout the world. International trade is one of the most difficult industries to deal with because it essentially overlays other industry sectors rather than being a sector in its own right. International Trade EDI is further complicated by the existence of some systems which operate for a single industry (e.g., crude oil, iron ore and coal), others which operate at the level of a single port (e.g., at Felixstowe, Rotterdam and Singapore), and still others which operate at a national level (e.g., Tradegate in Australia).

Some regions and countries are actively looking to EDI to assist them in providing a superior service to international customers<sup>31</sup>. Efficient communications are an important factor in international trade. This is partly because of their direct costs, which various studies have suggested average about 7% of the value of the goods themselves. An additional important consideration is that poor communications can give rise to considerable indirect costs, including delays in the delivery of goods, increased investment in buffer stocks, and disruptions in manufacturing processes. Of course, the differential abilities of countries to participate in advanced telecommunications-based technologies is a further important factor.

The ongoing globalization of business and hence of industry sectors is also pertinent. From the viewpoint of transnational corporations, national borders are historical relics which create unnatural barriers to business. It is more appropriate to think in terms of world-wide industry sectors for aluminium and wool than of a large number of national aluminium and wool sectors linked via international trade. In Western Europe, whose nations have significant lingual, cultural and political differences, and in which warfare raged less than 50 years ago, economic considerations are leading to rationalization of trade arrangements. It is important that EDI be seen not as an inert factor in international trade, but as a potential stimulant<sup>32</sup>.

#### *Impacts of regulatory bodies*

The regulation of industry sectors and their EDI systems is an important consideration. In some cases, an industry association may play a significant role, and in all cases supra-national, national and regional governments, and international, national and local laws will affect the process. For example, Governments may encourage the emergence of rationalization of third-party networks, or act to restrict the degree of market power exercised by one or more companies in the sector.

Governments in some countries may unintentionally retard the development of EDI, for example due to sheer bureaucratic sluggishness and unimaginativeness, or because investment in telecommunications infrastructure is perceived to be a relatively low priority for the country's limited capital resources. In some cases, EDI may be intentionally retarded for ideological, religious, strategic or political reasons, because the government seeks to maintain distance from the rest of the world. Circumstances may also exist in which a government would retard EDI for economic reasons, e.g., to protect domestic producers<sup>28, 33, 34</sup>.

#### *Summary*

This section has identified factors which require consideration if an industry-specific model is to be developed in order to analyse the impact of EDI. Such models need to reflect not only the industry's current structure and processes, but also industry trends. In many cases, industry sector models will be unavoidably complex.

The next two sections move from the essentially static modelling approach adopted above, to consider the dynamics of EDI impact. First, circumstances are

dealt with in which the participants see little strategic significance in EDI. The subsequent section addresses change resulting from positive steps taken by corporations to apply EDI strategically.

#### **Passive implementation of EDI**

Many early systems which were later dubbed 'strategic applications of IT' evolved with at least some degree of serendipity, rather than having been embarked upon from the start as strategic measures. There is, moreover, a growing degree of scepticism apparent in the literature about the possibility of sustainable competitive advantage from IT in general<sup>4, 35-40</sup>, and EDI in particular<sup>41</sup>.

It therefore seems appropriate first to consider industries in which EDI has 'happened' rather than having been championed by one or more major players. This is typical of supply-driven, rather than demand-driven, diffusion and of stable 'cash cow' industries in which cost-management is a primary motivation. Here, technology is used largely as a tool for reducing costs or improving the effectiveness of existing functions, rather than as a means of bringing about change.

In some industries, EDI's impact may be limited to modifications to structure and processes within individual companies. For the most part, these appear likely to be industries which are stable and large-scale, and product- rather than service-oriented. In those industries in which change occurs beyond organizational boundaries, varying degrees of impact may arise. The following classification is proposed:

- 'functional reallocation', in which functions are transferred among corporations;
- architectural re-structuring, in which some organizations are destroyed and perhaps new ones created; and
- industry redefinition, in which the entire industry undergoes major change.

Each of these classifications is dealt with below, commencing with the most dramatic, industry re-definition.

#### *Industry re-definition*

There may be circumstances in which IT affects an industry so dramatically that the whole sector is re-defined. Industries which are undergoing major IT-led revolutions include printing (being challenged by low-cost laser-printers) and publishing (as a result of desk-top publishing software, network access to databases, and the proliferation of LAN-connected PCs and CD-ROMs). In the case of EDI, such revolutions appear most likely to occur in service industries, especially in what are sometimes referred to as 'pure information industries', such as finance, insurance, travel and tourism reservations and public access databases.

A common manner in which such a revolution occurs is for the barriers to entry to be lowered in such a way that a substitute service can be offered through entirely different channels. For example:

- a third-party information services supplier may extend its offerings to include reservations, and

- thereby compete with ticketing agencies, travel agents and car-hire companies;
- an organization with close contacts with consumers, such as a 'mail-order' house which has converted its clients to electronic communications, might compete with travel agencies and insurance agents; and
  - organizations which maintain large numbers of branch offices, such as financial institutions, post offices, car-hire companies and retailers, have the opportunity to provide consumers with convenient access to EDI networks.

In such circumstances, it is conceivable that entire segments of industries may disappear, with the same function being performed by another existing industry which has re-structured itself and re-defined the function it performs.

#### *Architectural change*

In other circumstances, the existing industry may survive, but in a substantially modified form, with some links in long-standing chains broken or re-forged. The most readily appreciated example is the potential disappearance of 'middle-men', such as wholesalers and stockbrokers. The economic justification for wholesalers has rested on the logistics of product distribution, investment in local inventory, maintenance of contact with customers in a restricted regional or functional market, and the management of transaction information flows.

Changes have occurred, independent of IT, in the logistics and economics of product distribution. An increasingly sophisticated land, sea and air transport industry is enabling manufacturers in some industries to distribute their products themselves, either directly to regional agents, or, in some cases, directly to the ultimate consumer. EDI further accentuates this tendency, because it provides the environment within which sales- and logistics-related documents can be cheaply and reliably transmitted between the manufacturer and large numbers of remote agents. As a result, some organizations will encroach on territory traditionally the preserve of intermediaries; for example, by establishing direct communication links with the next-but-one enterprise in the chain or directly with the ultimate consumer. Such 'disintermediation' is already occurring in the holiday and insurance markets<sup>42</sup>.

The roles of some enterprises may be reduced to such an extent that they will not survive unless they significantly enhance or alter their services. There are many opportunities for innovation in an economy based on electronic networking including: data collection and analysis services; trading in derivative 'securities' such as options and futures and gambling on movements in economic and other indices; the customization of standard goods and services; consumer intermediary services to find the most satisfactory supplier of required goods and services; and of course services relating to electronic trading hardware, software and people-ware.

The situation in commodity trading is particularly interesting. An organization wishing to buy or sell commodities such as stocks and shares, coffee, or minerals used to face difficulties in finding a seller or buyer of the same commodity. Specialized service enterprises arose, generally referred to as 'brokers', to

assist such organizations to find one another. As markets became larger and more sophisticated, brokers collaborated to form 'exchanges', such that high volumes of transactions could be conducted rapidly but in an orderly fashion. A common form of exchange involved a trading 'floor', on which brokers physically met to conduct transactions on behalf of their principals.

As IT is applied to commodity trading, trading floors are replaced by electronic networks and the role of the exchange is re-defined. Systems are very easily devised in which principals can locate one another without the assistance of a middle-man and hence survival of the brokerage role may be threatened<sup>43</sup>. A paradoxical situation arises in which existing exchanges are forced to automate in order to resist intrusions into their market, but thereby threaten the existence of the brokerage firms which own them.

#### *Functional re-allocation within industries*

Many organizations can be expected to adapt to EDI in order to survive, resulting in intermediate, less dramatic EDI-induced change. If developments in logistics and IT undermine their *raison d'être*, wholesalers can act to prevent their demise by offering value-added services; for example by undertaking pre-sales consulting and/or after-sales service on behalf of the manufacturer. Similarly, local agents may construct a marketing advantage by carefully assembling a portfolio of different products from different manufacturers. Either and/or both distributors and agents may add value in the forms of 'localness', close appreciation of client needs, 'one-stop shopping', system integration, and problem- rather than product-orientation.

Moreover, it may not be in the interests of the large manufacturers and service companies to use EDI to bring about the demise of enterprises which mediate between them and the ultimate consumers. Many large corporations are adopting the strategic approach of reducing the activities under their direct control to the minimum set of 'core functions' which they perform better than their competitors, and 'out-sourcing' all other functions by contracting them to enterprises specializing in that particular activity. Such 'vertical disintegration' is facilitated by EDI, because it enables independent companies to maintain close links, effectively substituting electronic transaction-based communications for hierarchical or centrally planned coordination<sup>18, 41, 42, 44</sup>.

Large corporations may prefer to take advantage of the large amount of local knowledge involved in wholesale and local agency work, particularly when it is coupled with the relatively cheap labour of owner-managers, provided that those enterprises become sufficiently sophisticated in their use of telecommunications-based information systems.

#### *Summary*

The nature of passive change arising from the application of EDI will differ among industries. Some sectors will change their shape, largely as a result of EDI. Others will change as a result of EDI in conjunction with other forces at work within the industry. In some industry sectors, whole segments of the industry value-chain may disappear. In other cases, the membership of the

industry may not change significantly, but the pattern of work performed by the various enterprises within the industry value-chain will. The changes may take place in an orderly manner, or they may be dramatic. In some cases, the changes may be internal to corporations only. The discussion in this section suggests, however, that there may be relatively few such sectors, and even in these cases, EDI may be a factor in subsequent changes in the sector.

The following section suggests a classification which is intended to be of assistance in analysing sectors in which one or more players consciously use EDI as a tool of corporate strategy.

### Strategic implementation of EDI

After a decade of discussion of strategic systems, and with the high degree of competition which characterizes the beginning of the 1990s, many corporations are now aware of the potential of IT in general, and EDI in particular, to assist in the implementation of corporate strategy. This section considers three forms of proactive use of EDI: (i) as a defence against intruders; (ii) as a threat to competitors; and (iii) as a facilitator of improvements within an entire industry.

#### Defence

In Porter's terms<sup>25, 31</sup>, EDI may be used to raise the barriers to entry and thereby protect existing players in an industry against the threat of new entrants. This involves the establishment of a 'closed user group' form of EDI, whose rules enable the existing association to preclude new members from joining. Technical, economic, legal and/or political constraints are needed to establish and sustain such an arrangement. For the strategy to be effective, it must not be possible for an external party or alliance of parties to substitute an alternative product or service for that offered by the existing association.

Such a cartel must survive against attempts by competitors and anti-monopoly authorities to disband it. Possible measures are the gaining of official or at least tacit approval for the closed user group (e.g., by convincing government of the importance of stability and of ongoing investment by the cartel's members, perhaps in conjunction with assurances of increased competitiveness in other areas), by operating internationally such that the anti-trust agencies of national governments are constrained by their jurisdictional limitations, or by the exercise of economic power over national governments.

Examples of EDI applications which might fit this category are the Society for Worldwide Interbank Financial Telecommunications (SWIFT), and ODETTE, the European car manufacturing application. SWIFT has largely operated in the international rather than national arenas, and has therefore operated to some extent beyond the jurisdiction of national regulatory authorities. Within some countries, banks have retained control of the national funds clearing system and have thereby restrained the impact of non-bank financial institutions on their businesses. One reason governments and central banks have approved such restrictive trade practices has been the importance of stability in banking services. Attempts by bank cartels to establish

control over multi-organizational systems such as ATM and EFT/POS services, and EFTS-related EDI have tended to meet with somewhat less success.

#### Threat

As part of the general literature on IT and business, EDI has been discussed as a basis for strategic and competitive advantage<sup>5, 23, 41</sup>. There are two main ways in which EDI may be used to attack competitors within an industry.

The first, which can only be used effectively by companies dominant in their industry, is for an organization to establish a proprietary EDI scheme, and require that its business partners use the system. This is associated with the catch-cry of 'Trade via EDI, or don't trade with us!'<sup>45</sup>. This may be practicable for some government-owned or -sanctioned monopolies, and government purchasing agencies. It has already proven possible for several industrial giants which dominate an industry or an economic region, and for some very large retail chains. The primary competitive advantages arise from the establishment or reinforcement of switching costs and barriers to entry, and at least to some extent from a beneficial effect on the enterprise's cost function. In addition, both suppliers and customers may be contractually 'locked in' to the corporation, or may at least tend to become habituated respectively to selling and buying along the line of least resistance.

The second approach is where an alliance is formed between a number of corporations, generally vertically, i.e., along the industry value-chain, in such a way that the group-members achieve a competitive advantage over other corporations in the industry<sup>14</sup>. Examples include the Quick Response systems of Levi-Strauss and Benetton. Such alliances (sometimes referred to in the USA as 'partnering') may have deleterious effects on some upstream suppliers, since the supply-links between partners are now more reliable, and the downstream corporation may reduce the number of sources from which it orders (a phenomenon referred to in the USA as 'de-sourcing'<sup>46</sup>).

Competitive advantage derived from IT in general and EDI in particular, may be difficult to sustain, and may in principle not be sustainable<sup>4, 24</sup>. Even though the actual difference may be neutralized within a few years, however, some of the aggressor's gains may be retained over a longer period, in particular, improvements in market share.

#### Facilitation

The early tendency to regard EDI as a basis for competition is giving way to an appreciation that collaboration within an industry is essential in order for industry-wide savings to be made. Major examples of deliberate use of EDI are to be found in automotive industries (e.g., Hill<sup>20</sup> and Hollands<sup>47</sup>), in specific retail sectors in various countries such as hardware products and consumer pharmaceuticals, and in international trade. The ultimate outcome may be a greater degree of efficiency in the industry value chain, with the primary beneficiaries being the consumers of the industry's product. Some empirical studies suggest that this may

be the most common form of strategic implementation of EDI (e.g., Pfeiffer<sup>48</sup>).

Where the facilitative approach is adopted, the emphasis is significantly different from competitively aggressive applications of EDI. Companies tacitly agree to suspend competition in specific areas, and take part in careful negotiations with other companies and associations in the industry. Competition generally does not disappear altogether but becomes covert, in such forms as: manoeuvring to ensure that the benefits fall disproportionately in the company's direction and the costs disproportionately on other participants; and preparing to leverage on the scheme as soon as it is implemented. Organizations tend to gain differentially, depending on the extent to which they adapt themselves to take advantage of EDI.

From the viewpoint of regulatory authorities, the long-term effect does not appear to be likely to threaten the degree of competitiveness within industry sectors. This is because there are many other bases upon which competition can be gainfully conducted, and indeed some new ones are likely to arise as a result of EDI. For example, some suppliers may use links which were established for purchasing purposes, to provide superior after-sales services.

### Summary

In industry sectors where one or more participants recognize EDI as a potential contributor to corporate strategy, the approach taken to analysing the impact of the technology on the industry must reflect those intentions. In practice, one player in an industry may use EDI aggressively at the same time as other players implement EDI in a passive or collaborative manner. Hence a blending of the patterns discussed in the foregoing sections may be appropriate in many industries.

### Importance of infrastructure

There are many instances in which EDI's rate of development has not lived up to expectations. For example, a longitudinal survey of government use of EDI in Australia has shown that intentions of early implementation have largely not been realized<sup>26, 27</sup>. Schemes with much promise but very low growth rates have been described as 'perpetual pilot schemes'<sup>49</sup>. This has been particularly marked in smaller economies, i.e., other than in North America, Japan and integrated Europe.

One important reason for slow penetration has been the scale of investment in infrastructure, and the small volume of transactions over which to amortise it. It is therefore of critical importance that a sufficient proportion, or 'critical mass', of industry participants commit to a scheme in order that the infrastructure can be established with the confidence that a sufficient return on investment will be achieved.

In the normal manner in which innovations spread, three primary factors are causing a fall in the scale of investment needed in infrastructure:

- as the number of participants increases, and as transaction volumes rise, economies of scale apply;
- as interfaces are standardized, they are converted from relatively expensive and uncertain services to

relatively inexpensive and reliable products, and implementation becomes more straightforward; and

- as the implementation of EDI becomes perceived to be commonplace, more companies join relevant schemes.

The question remains, however, as to whether government stimulation or intervention may be necessary in order to ensure that the early hurdles are overcome, and the potential benefits are gained at an early stage rather than being deferred, or even stunted. Industries in which such public investment may be particularly appropriate include strategic industries (e.g., defence-related, major exporting industries, and international trade), those in which government is already a large player (e.g., health-care, taxation and statistics), and those which are already subject to major distortions as a result of governmental regulation.

Whereas in some nations investment in EDI infrastructure will occur in any event, other countries will need to assess carefully the need for stimulation, and seek high-return policy measures to ensure that they do not suffer international competitive disadvantage through EDI.

### Research questions

A wide range of EDI-related matters in need of research is identified in Gricar<sup>50</sup>, Wrigley<sup>51</sup> and Clarke *et al.*<sup>33</sup>. The contingency model proposed in this paper provides a basis for research into particular industry sectors. Of special importance are studies of particular industries which have already made significant progress in installing EDI, such as the automotive and retail industries. Such studies will need to distinguish 'early-adopter' industries from those which wait for the technology to mature<sup>52</sup>.

There would be value for industry if these studies were to assess the benefits gained against the expectations, and to identify delay factors and barriers such as legal constraints, infrastructural and training requirements, and costs arising from connection to multiple EDI systems and conformance with multiple standards. There is also a need for studies of the integration of EDI with other IT applications, such as pre-purchasing systems, Just In Time (JIT) manufacturing and service systems, EFT/POS and Quick Response systems in the retail sector and Electronic Funds Transfer Systems.

Another area of special interest is the differential impact on organizations within the same industry sector. Factors which may be relevant include firm-size (large corporations may move much more slowly than smaller ones, but may undergo a more significant modification to their structures and processes when the change eventually occurs); firm-size in relation to other participants in the industry; firm position in the industry (upstream raw materials and components companies may have significantly different experiences from downstream assembly and distribution companies); and IT infrastructure, including telecommunications facilities, the sophistication of the software and software services industry, and the computing skills level of key classes of employees.

Longitudinal studies of particular industry sectors are needed in order to trace the development of EDI's

contributions. For example, the early systems were closed networks using industry-specific protocols. As the quality of third-party services has improved, and with developments in standards, there has been an increasing tendency for networks to be open, to be operated by specialist third parties, and to use national and international standards. There may be, in due course, a contraction in third-party services, as EDI capabilities become a mainstream requirement. Studies have suggested that only a small proportion of network services suppliers will survive in the medium term<sup>53</sup>.

Another fruitful area for research is comparative studies between apparently similar industry sectors and between corresponding sectors within different countries. It appears that proprietary and industry-sector standards may remain dominant for some time in Japan and that third-party networks may not make a significant impact until they are able to offer conversion among industry and national protocols, and gateways out to international EDI networks. On the other hand, Japan is highly internationally oriented through its trading houses, its enormously successful manufacturing industries, and more recently its overseas investments and the tendency of some of its corporations towards internationalization. The need to adopt international standards when dealing internationally may bring about more rapid change in Japan's domestic systems than is currently foreseeable.

A variety of difficulties must be confronted in undertaking research into EDI. One is the recognition of other forces for change operating within the industry, such as new manufacturing technologies, and enhanced logistical technologies such as packaging, warehousing and transportation. If, as was argued earlier in this paper, EDI is only one of a family of IT applications which are having significant impact on industry sector structures and processes, then it is important that research projects also take into account the effect of other inter-organizational systems, such as on-line trading and the various forms of electronic funds transfer. There may also be detectably different experiences based upon the nature of the standards on which the system is based, and the type of system supplier (i.e., dominant-participant, collective or third-party).

Other difficulties include the need for suitable measures of costs and benefits, the subjectivity of many of the important variables (such as organizational change, and the role of EDI in re-negotiating organizational relationships), the need for longitudinal studies to assess the technology adoption process, and the question of comparability of studies undertaken in different countries.

## Conclusions

An understanding of EDI's impact on organizations is incomplete if the perspective of the researcher is restricted to the organization and its links with its immediate business partners. This paper has proposed a taxonomy whereby the impact of EDI on an industry sector can be explained. The model would appear to have predictive power.

It has been further argued that progress in many industries is dependent on clarification of the respective roles of industrial organizations, associations and

governments in establishing and developing the infrastructure on which the industry depends. Attention has also been drawn to the need for techniques to address the serious difficulties confronting researchers in this area.

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