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## Competing in the digital economy? The dynamics and impacts of B2B E-commerce on the South African manufacturing sector

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Discussion Paper No. 2002/79

## **Competing in the Digital Economy?**

The Dynamics and Impacts of B2B  
E-commerce on the South African  
Manufacturing Sector

Sagren Moodley \*

August 2002

### **Abstract**

This paper explores the current state of play and likely future direction of business-to-business electronic commerce in the South African manufacturing sector. The empirical evidence presented draws on 120 firm-level interviews, and 31 personal interviews with industry experts. The research findings highlight the fact that B2B e-commerce is in an inchoate stage of development in the South African manufacturing sector, with sociotechnical factors and contemporary market dynamics heavily influencing its evolutionary trajectory. Overly optimistic and technicist approaches to e-commerce do not take into account the real world of global trade and production networks and the position of South African manufacturing firms within it. The paper concludes that e-commerce development in the South African manufacturing sector is likely to be a cumulative, incremental and path-dependent process, that takes the form of the steady accumulation of tacit capability, rather than a sequence of discrete acts of technology building. Note that in the context of this paper, 'digital economy' refers to economic transactions and economic functions that are governed and executed digitally, i.e. through the convergence of digital computing and telecommunications

Keywords: ICTs, B2B e-commerce, manufacturing sector, South Africa

JEL classification: O3, O14, L1

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## 1 Introduction

Dosi *et al.* (1988), Freeman and Soete (1997), Perez (1983) and Schumpeter (1934) argue that technical change is a fundamental force in shaping the patterns of transformation of a country's manufacturing sector. Emerging patterns in innovation systems suggest that firms are forced to adapt to technological innovation and change in order to become or remain internationally competitive (Archibugi and Michie 1997; Archibugi, Howells and Michie 1999; Pohjola 2001). Today, advanced microelectronics-based information and communication technologies (ICTs) are at the heart of recent economic transformations in both the industrialized and many developing economies (Mansell and Wehn 1998). It must be stressed, however, that the diffusion of ICTs throughout the developing world has been extremely uneven, both within and between countries. Moreover, the least developed countries risk exclusion from global markets because they often lack the economic and social capabilities needed to take advantage of innovations in ICTs, such as business-to-business (B2B) electronic commerce.

With astonishing speed, media sentiment on B2B e-commerce has swung like a pendulum from overly optimistic assumptions about potential profit gains and cost savings, to predictions of doom and gloom in the wake of the dot.com crash and the shakeout of B2B trade exchanges (Bührmann 2001). As with the advent of any new technology that may be widely diffused, there are overly optimistic and pessimistic predictions, which are generally inaccurate (Cohen, DeLong and Zysman 2000; Graham 2001; Morgan Stanley Dean Witter 2000; *The Economist*, 23 September 2000). One of the grand myths of B2B e-commerce is that it offers a 'friction-free' environment for transacting business that will lead to a reduction in the role of intermediaries (Benjamin and Wigand 1995; Garcia 1995; Leebaert 1998; Malone, Yates and Benjamin 1987; Malone and Laubacher 1998). However, a more sober analysis suggests that, owing to the new costs associated with establishing trust and reducing the risks inherent in this type of activity, new types of intermediaries will be required. Therefore, B2B e-commerce represents an enormous challenge for developing country firms, and its impact is likely to be experienced in rather different ways, and perhaps at a different pace, than many analysts originally anticipated (Mansell 2001). The intoxicating discourse of revolutionary business models that proliferated during the days of Internet fever are giving way to a renewed focus on how best to apply the potential of e-commerce to *existing* intra and inter-firm operations (Lucking-Reiley and Spulber 2001).

The use of the Internet and World Wide Web to coordinate production through domestic and cross-border, inter-firm networks is likely to have a significant impact on the competitiveness of South African manufacturing firms. The critical importance of B2B e-commerce in shaping the performance of manufacturing firms in the global, networked economy has recently come under the domestic policy-making spotlight (Department of Communication 2000; Department of Trade and Industry 2001). Notwithstanding this, the linkages between the Internet and global market structures are far from clear. Does e-commerce make it easier for developing country producers to break into high-value segments and compete on a global scale, or, on the contrary, does e-commerce increase 'commoditization' and strengthen the bargaining power of global buyers, mostly based in the north?

Debates about the new global economy point to the need for an assessment of the baseline state of e-commerce in South Africa's manufacturing sector. To date, there is a paucity of empirical research in this field. In light of this situation, the goal of this study was to assess the dynamics, and impacts, of B2B e-commerce at a sectoral level so that a new light may be shed on the ways in which e-commerce is transforming the organization and operation of value chains. In order to develop appropriate policies, decisionmakers need to be aware of the sectoral implications of this transformative process.

The objective of this paper is twofold: first, to explore the current state, and likely future direction, of B2B e-commerce development in the South African manufacturing sector. Second, to identify the key factors/elements that policymakers should focus on in order to create an environment that successfully promotes the growth and development of e-commerce in the manufacturing sector. Although this research agenda is still in its preliminary stages and is far from exhaustive, the hope is that it will provide an initial analytical foundation that helps to focus the ongoing policy debates regarding this matter in South Africa. Therefore, this study was primarily concerned with developing an empirical base that may be used to help guide governmental actions in this domain, rather than with developing business strategy proposals and management or implementation guidelines.

The paper is organized into seven sections. Section 2 explains the research methodology that was used for undertaking this study. Section 3 examines the concept of B2B e-commerce, and sets out the analytical framework adopted for this study. Section 4 starts off with a snapshot of the current state of the South African manufacturing sector, and then provides a brief 'e-readiness' assessment vis-à-vis the embedded sociotechnical base that exists in South Africa. Since access to ICTs is the most basic pre-requisite for e-commerce, it is important to gauge the capacity of the national ICT infrastructure to support e-commerce for the South African manufacturing sector. The results of the e-commerce study of the SA manufacturing sector are presented in section 5. Section 6 sets out the policy challenges for government. The conclusions of this research are presented in section 7.

## **2 Methodology**

Recognizing that manufacturing is not a homogenous sector, this study focused on three 'typical' manufacturing subsectors, namely, apparel (a technology follower), automotive components (a technology leader) and wood furniture (a technology laggard). It seems plausible that when taken together these three subsectors may be seen as illustrative of the South African manufacturing sector more broadly. It should be noted from the outset that, because of limited resources available, statistical random criteria for selecting potential participants were not used for this pilot study. However, every effort was made to capture the full range of user experiences within the three sectors examined.

The empirical research undertaken for this study was based on 120 firm-level interviews, and 31 personal interviews with industry experts. A semi-structured interview schedule was used for the firm interviews. The interviews were conducted by the author between January 2001 and February 2002, and the duration of each interview

ranged between one and two hours. The firms selected were medium and large enterprises, and were more or less evenly distributed among the three subsectors. Firms were selected for inclusion in the study on the basis of interviews with key informants who were recognized as being likely to have a relatively detailed understanding of the state of e-commerce implementation and development in the selected subsectors. The interviewees in the firms were either managing directors or chief executive officers, marketing directors, purchasing directors, financial directors, and wherever possible IT directors. On the basis of the interviewees' position in the organizations represented, they were likely to have a good understanding of the scale and scope of e-commerce implementation in their respective firms. In order to further extend the range of potential respondents, the snow-balling technique was employed. In addition, some of the companies interviewed were identified from the University of Natal, School of Development Studies database of firm profiles, which has been compiled over the last seven years.

The panel of industry experts included senior personnel from academia, government, trade unions, employers' associations, the sectoral export councils, business and IT consultancies, and providers of B2B e-commerce support services. The experts were identified by the researchers either through colleagues, sector specialists or based on prior contacts made during industrial research for other projects. The key informants were selected on the basis of their expert knowledge about what is going on in terms of e-commerce implementation in the manufacturing sector as a whole, or in one or more manufacturing subsectors. In total, 31 personal interviews with industry experts were conducted between January 2001 and March 2002. Unlike the firm interviews, a more open-ended, exploratory approach was adopted in these instances. The objective being to allow the key informants to speak unhindered about e-commerce developments in the industries concerned, i.e. apparel, automotive components and wood furniture.

The analysis presented below should be seen as an initial attempt to propose future directions of analysis on the evolution of e-commerce in the South African manufacturing sector. The preliminary findings and broad policy implications reported here constitute an initial analytical basis for identifying areas for future research. The sectoral specificity of organizational impacts has been reported elsewhere (Moodley 2001; 2002a-g). This paper concentrates on synthesizing those findings and observations that can be discussed at more generic levels. The emphasis throughout is upon findings that indicate characteristics and behaviours that appear to be common, or potentially common, across the three industry subsectors.

### **3 B2B e-commerce: towards an understanding**

Lundvall (1992: 1) asserts that 'the most fundamental resource in the modern economy is knowledge and, accordingly, ... the most important process (of economic development) is learning'. E-commerce is an important contributor to the learning process (which shapes economic performance) because it provides improved access to structured business information and it offers opportunities for innovation when it is embedded in manufacturing processes. A comparative advantage stemming from the generation and application of knowledge is the desired outcome.

E-commerce, and ICTs in general, are likely to play a pivotal role in the integration and coordination of globally dispersed production and distribution systems (Gereffi and Kaplinsky 2001). E-commerce has the potential to become a necessary, albeit insufficient, ingredient for competing in global value chains underpinning high-tech information-driven capitalism.<sup>1</sup> According to Gereffi (2001), e-commerce has the potential to reconfigure global value chains and the inter-firm relationships along them. The emergence of the Internet holds the potential to undermine traditional models of commodity chain organization, substituting one in which new 'infomediaries' (e.g., owners of B2B portals) provide the main impetus to the organization of transactions. Gereffi (2001) argues that by making markets, these new infomediaries may erode the market power of traditionally dominant commodity chain participants (buyers or sellers). He points towards a future where the lead firms in existing commodity chains, whether producer-driven or buyer-driven, largely capture the e-commerce benefits. This scenario calls into question the scale and scope of the 'benefits' of e-commerce for developing country producers.

The issue of engaging more openly in global value chains has become central to debates about how formerly inwardly-oriented industrial sectors restructure themselves to maintain competitiveness in a more open, trade-liberalized environment (Nadvi 1999; Schmitz 2000; Sturgeon 2000). The public Internet and World Wide Web offers a standardized linkage mechanism which has the potential to facilitate the entry and participation of developing country manufacturers into global value chains. Although inequalities of access to information have been shown to adversely affect market performance in less developed countries (Stiglitz 1989), the Internet, by virtue of its relatively low investment and configuration costs, and interactive global reach, potentially could play a pivotal role in enabling increasing *connectivity* and *visibility* in national, regional and global-scale value chains. For example, one way to increase the flow of rich, up-to-date information throughout the value chain is through promoting transparent processes via the Internet. Transparency potentially reduces information asymmetries and creates expectations which reduce uncertainty. The need to increase the speed and quality of information, as well as reducing the costs of sending and receiving information may be an important incentive for the adoption of e-commerce in developing countries.

There is no standard or uniform definition of e-commerce in the literature. We are, however, cognisant of Anderson's (1998) critique of analysts who narrowly define e-commerce in terms of actual transactions carried out on the Internet. Therefore, for the purposes of this study, B2B e-commerce was broadly defined as *any form of commercial transaction or structured information exchange that takes place between firms within industry value chains via an ICT-based, computer-mediated network*. B2B e-commerce can be divided into two categories: (i) open marketplace-based trade that occurs in public Internet-based environments using the TCP/IP protocol suite,<sup>2</sup> and (ii) direct trade between business partners that occurs through either public Internet-based platforms, proprietary computer networks, or both. The former generally takes

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<sup>1</sup> The 'value chain' approach provides a coherent heuristic device for examining the forms of global integration of production and trade in manufactured commodities. In a seminal paper, Gereffi (1999) lays out the main elements of global value chain analysis.

<sup>2</sup> These marketplaces were originally designed to reduce bid-ask spreads and to bring down transaction costs by matching buyers with suppliers and enabling suppliers to trade with one another.

place at various World Wide Web-based auctions or exchange sites (information and/or transaction-oriented; open or restricted; horizontal or vertical; independent or industry sponsored, etc.). In contrast, the latter tends to occur either through a firm's extranet, or website which has an online purchasing function, or an electronic data interchange network.

The understanding of the firm as a monolith was problematized in Coase's (1937) seminal paper, 'The Nature of the Firm'. The theory of transaction cost economics that emerged from this work helped to clearly delineate the boundary of the firm as defined by the equilibrium between the advantages of the lower transaction costs of internal production on the one hand, and the lower agency costs and economies of scale and scope of outside procurement on the other (Williamson 1975). The costs of conducting marketplace transactions, i.e. information seeking, negotiating the terms, and settlement, define to a large extent what a firm will buy instead of making it (Williamson 1975). Since these coordination costs are lowered in e-commerce, a general agreement exists that an increase in outsourcing is likely to take place (Malone, Benjamin and Yates 1987).

Drawing on the transaction cost paradigm, Garicano and Kaplan (2000), Humphrey (2002) and Paré (2001) argue that e-commerce has the potential to substantially reduce coordination costs and increase efficiency in inter-firm trade.<sup>3</sup> The efficiency gains that they highlight can be classified into three broad categories: (i) *process improvements*—a substantial reduction in overall transaction costs; (ii) *direct information improvements*—minimizing information search costs, and a reduction in information asymmetries; and (iii) *indirect benefits*—better information processing (e.g., about future demand, about existing and future supply, etc.) as a result of greater transparency and improved connectivity, and more efficient 'make or buy' decisions as a result of a substantial reduction in transaction costs in inter-firm trade. It must be borne in mind, however, that the existence of a network technology infrastructure is not in itself a sufficient condition for the emergence of a durable trade network; that depends on repeated interactions through which parties build reputations for trustworthiness and gain confidence in one another.

To date, the 'promise' of the standard e-commerce model has been largely based on untested extrapolation from the experiences of the industrialized countries that are themselves only beginning to be examined systematically. This has led, among other things, to a substantial gap in our understanding of e-commerce and its implications for firms in developing economies, and points to the need for an empirical examination of the actual benefits experienced by firms in developing countries. It also highlights the need for a critical analysis of perspectives that are rooted in derivative description and technological determinism. Specifically, the views of those analysts who proclaim that international B2B e-commerce will create a 'level playing field' in which developing countries will be able to compete on equal terms with the highly industrialized countries of the north (UNCTAD 2001), and that ICTs provide developing country firms with the means to 'leapfrog' stages of industrial development (Panagariya 2000).<sup>4</sup> Conventional

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<sup>3</sup> In contrast to Garicano and Kaplan (2000), however, both Humphrey (2002) and Paré (2001) suggest that the potential reduction in coordination fostered by e-commerce may not be sufficiently large enough to decrease the overall transaction costs incurred by firms seeking to trade in international markets.

<sup>4</sup> This uncritical e-commerce 'fetishism' is steeped in a modernization discourse of development.



wisdom also dictates that as multinational corporations integrate the Internet into their cross-border business operations, firms from developing countries run the risk of exclusion from global value chains if they cannot establish electronic ties with their major business partners (Castells 2001). Proponents of such views appear to transform e-commerce into an end in itself rather than a means to achieving broader industrial development goals.

E-commerce optimists (e.g., April and Cradock 2000; Cronin 1996) often appear to overestimate the scope for international trading, while underestimating the new costs that developing country firms face when participating in electronic trading. In the 1990s, business process re-engineering (BPR) and enterprise resource planning (ERP) were enthusiastically, and in some cases even evangelically advanced by consultants and the popular business press and were tried by a substantial number of large firms, despite high costs and a high failure rate (Bashein, Markus and Riley 1994). Today, there remains considerable confusion about what BPR means in practice and how to change firms to take advantage of its insights. The large number of failures with complex IT systems such as ERP and BPR highlights the need for being cautious about the so-called ease with which developing country producers will be able to effectively implement e-commerce strategies.

In much of the contemporary literature, B2B e-commerce has tended to be narrowly equated with online commercial transactions and open, transaction-based trading hubs/e-marketplaces (Downes and Mui 1998; Raisch 2001; Sculley, Woods and Woods 2001; Timmers 1999).<sup>5</sup> Yet, the much vaunted purchasing and transaction-processing benefits of B2B trading exchanges have proved to be largely unfounded (Agrawal and Pak 2001; Berryman and Heck 2001). This reductionist approach seems to be counterproductive because it overlooks other more immediate (and potentially profound) benefits that may be accrued for developing country producer firms that engage in some form of B2B e-commerce. In contrast to these latter approaches, both Humphrey (2002) and Paré (2001) emphasize the importance (and prevalence) of information-oriented e-marketplaces, electronic bulletin boards and trade directories for developing country producers, which enable firms to search for buyers and sellers, but leave the actual 'trade negotiation' up to the firms themselves. They point out that although these platforms enable firms to search for buyers and sellers, the actual 'trade negotiation' aspect of transactions is left to the firms themselves. In other words, the electronic marketplace may merely bring buyers and sellers together (like a 'matchmaking' service). In these cases, it is up to the firms to communicate with each other, either online or offline, and to decide on the terms of the contract (if indeed there is to be one) and the transaction protocol to be followed.

Paralleling the findings of Humphrey (2002) and Paré (2001), Berryman and Heck (2001) argue that 'the real gains from online B2B e-commerce will come not from trading but from better access to and the sharing of information'. The fundamental impact that email has on substantially decreasing the cost of communication in the value chain provides support for Berryman and Heck's (2001) claim. In her study of B2B e-commerce in Tanzania, Maitland (2001) underscores the importance of email messaging and information exchange for developing country firms. If the financial

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<sup>5</sup> For a taxonomy of web-based trading platforms see Kaplan and Sawhney (2000), Mahadevan (2000) and Timmers (1999).

aspects of transactions are not really the key benefit of B2B e-commerce, then we may need to reconsider what B2B e-commerce actually means for developing country firms. It may well be that a semantically enriched, open Internet-based EDI platform that facilitates bilateral and multilateral 'information-based' interactions, might be a better approach to follow.<sup>6</sup> Research by Duncombe and Heeks (1999) in Botswana found that ICT adoption is a function of information practices and needs of firms. Based on their findings it can be argued that e-commerce will most likely be adopted by firms that require regular access to high quality information across borders, both regionally and worldwide.

The nature of the product that is traded is critically important in influencing the benefits that accrue from electronic trading hubs (Mariotti and Sgobbi 2001). A useful distinction is one between companies purchasing simple, standardized, commodity-like products, and companies making highly specialized purchases. The liquidity, transparency and the price orientation of an online bourse might well suit the former. The proliferation of online exchanges for maintenance, repair and operating (MRO) type activities is a case in point. The latter, however, is more likely to value the traditional bilateral relationship between buyer and seller, especially the possibilities for customization that such a channel offers. Thus, purchases of more complex products will continue to involve information-rich bilateral relationships. Therefore the focus, at least in the short term, on the potential for online trading to leverage price efficiencies and purchase process savings is misplaced.

The buyers in global value chains are increasingly placing greater emphasis on the need for developing country suppliers to meet stringent production, quality and management requirements and to comply with strict labour, environmental and safety standards (Humphrey 2002). This would appear to mitigate against the likelihood that the buyers from the north will source manufactured products directly through public Internet-based B2B trading hubs and/or public online auctions hosted on the World Wide Web. Having said that, it may well be that e-commerce is suited to certain types of products, and it may pose different challenges and opportunities for different types of value chains operating across and/or within national boundaries. The extent to which this is so, would appear to be dependent, in part, on the nature of the inter-firm relationships (i.e., the complexity of interaction among channel partners; the difficulty of specifying products, capabilities and quality on the Web; the degree of interdependence; the degree of fragmentation of the industry, etc.) that exist in the value chain.<sup>7</sup> This would help to explain why some firms find e-commerce technologies essential, while others use them very little, or not at all. It may well be that some manufacturing firms have less need and fewer incentives to use e-commerce technologies, by the very nature of their industry, their clientele and their inter-organizational relationships.

The lack of coordination between firms within global-scale value chains can create considerable inefficiencies. Typical examples include large amounts of tied-up inventory, slowed product innovation (due to the time required to push old stock

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<sup>6</sup> Open Internet-based EDI enables trading partners to interact without a prior agreement on a common protocol of interaction.

<sup>7</sup> The question is whether personalized (rich) networks can be replicated in virtual space, or are they too heavily dependent on relationships of trust and the intensive personal interactions permitted by physical (and cultural) proximity.

through the chain), loss in revenue for inventory that has aged, inability to respond to unforeseen demand fluctuations, stock-outs and over-supplies (Flaherty 1995). In their study, Gausch and Kogan (2001) found that the costs of raw materials inventories in manufacturing are two to five times higher in developing countries than in the United States. Hence, streamlining inter-firm linkages (i.e., exploiting systemic efficiencies) and improving the quality and flow of information in the value chain is of critical importance for competitiveness and growth. The e-commerce literature often underplays the impact that e-commerce can make on improving the speed, accuracy and cost of transferring data between channel partners, and improving visibility in the supply chain, thereby improving order fulfilment, inventory management, forecasting capability and customer service. Greater transparency of the supply chain could potentially mean less waste, rework and troubleshooting. Moreover, e-commerce technologies offer the potential to minimize costly paperwork by enabling firms to submit and track documentation online.

## 4 The South African context

### 4.1 The manufacturing sector

The inward-orientation of the South African manufacturing sector has been fostered by a history of state protectionism and import-substitution industrialization (ISI) during the apartheid era (Joffe *et al.* 1995). This inward focus was reinforced by trade isolation, disinvestment and the imposition of economic sanctions during the 1980s and early 1990s. As a result, nationally-based producers were for a long time insulated from the cut and thrust of international competition. Since the transition period (post 1994), however, the South African manufacturing industry landscape has been substantially altered by the twin pressures of globalization and the rapid liberalization of the trade policy regime. Moreover, these pressures have been reinforced by a major shift in state policy to open markets, a rapid erosion of both tariff and non-tariff barriers and the implementation of an export-oriented industrial policy (Habib and Padayachee 2000).

Table 1  
A sectoral profile of the South African economy

Sector	% Share in total value added		% Share in total exports	
	1996-2000	1991-95	1996-2000	1991-95
Government/community services	20.6	22.0	0.3	0.3
Manufacturing	20.5	21.2	50.7	38.5
Business services	17.3	15.6	3.3	2.4
Trade	13.8	14.0	5.5	4.3
Transport	10.2	8.3	6.1	5.1
Mining	6.4	7.4	29.1	45.0
Agriculture	4.5	4.8	4.8	4.2
Electricity	3.6	3.4	0.1	0.1
Construction	3.0	3.3	0.0	0.0
All Industries	100.0	100.0	100.0	100.0

Source: TIPS South African Standardized Industry Database.

Notwithstanding these changes in policy orientation, growth in South Africa has remained modest. Real GDP grew annually by approximately 1.4 per cent between 1988 and 2000. This has been compounded by an estimated 500,000 job losses since 1994. Exports, however, have been growing in real terms at a rate of 3 per cent over the last five years (TIPS database). Based on 1995 constant prices, the manufacturing sector's share in GDP has remained constant at around 20 per cent between 1996-2000, and its share in total exports during 1996-2000 was 50.7 per cent (Table 1).<sup>8</sup> The predicament of low growth in South Africa has raised important questions about the types of policies that need to be introduced to inject more efficiency and dynamism into the economy.

#### **4.2 The information and communication technologies (ICTs) terrain**

South Africa has experienced rapid growth in Internet use, and is placed at number 35 by the Economist Intelligence Unit's (EIU) 'E-Business Readiness Rankings' of 60 countries.<sup>9</sup> The number of dial-up subscribers has grown at an average annual rate of 80 per cent since 1994. By 1998, the number of Internet users had surpassed the one million mark (Worthington-Smith 2001). According to EIU's Pyramid Research, South Africa had 540,000 Internet dial-up accounts in 1999, and was forecast to reach 1.1 million by 2002 (Pieterse 2001). Of the estimated three million Internet users in Africa, two million are in South Africa, and they account for more than 90 per cent of Africa's total Internet traffic (BMI-TechKnowledge 2001).

The virtual private network (VPN) sector in South Africa is growing rapidly with over 140 licensed VPNs already operating in the country.<sup>10</sup> Major providers of business connectivity over VPNs include Omnilink, FirstNet, AT&T, BCS Net, Internet Solutions and UUNet. The Internet service provider (ISP) market also is increasingly becoming competitive, with over 150 ISPs already operating in the country. The three main ISPs in South Africa (viz., UUNet, Telkom's SAIX and Internet Solutions) have always targeted large firms. At this end of the market, bandwidth demand and usage have, to an extent, levelled off. However, once the first tier ISPs begin to more aggressively target small and medium-size firms, the demand for bandwidth will increase because of the pent-up demand that exists. For the time being, however, it is the pricing of bandwidth that appears to be the key problem rather than network capacity.

BMI-TechKnowledge (2001) estimated that in 1998 South Africa spent US\$936 million on computer hardware, and in 2000 the amount spent on software (packaged applications software, operating systems, networking software and software development tools) was estimated to be in the range of US\$498 million. After financial services, insurance and real estate, the next biggest purchaser of hardware and software products was manufacturing. As in the case of hardware, South Africa imports almost

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<sup>8</sup> Calculations based on data from the TIPS website.

<sup>9</sup> E-readiness refers to the extent to which a country's business environment is conducive to Internet-based commercial opportunities. Available at [www.ebusinessforum.com/index.asp?layout=rich\\_story&doc\\_id=367&country\\_id=MX&country](http://www.ebusinessforum.com/index.asp?layout=rich_story&doc_id=367&country_id=MX&country).

<sup>10</sup> An Internet-based virtual private network (VPN) uses the open, distributed infrastructure of the Internet to transmit data between corporate sites/connected nodes. These systems use encryption and other security mechanisms to ensure that only authorized users can access the network and that the data cannot be intercepted.

all generic software, which is then marketed and distributed domestically. Domestically, the bulk of software development is limited to the reworking or local integration of international products.<sup>11</sup>

South Africa has produced some very successful IT companies based on e-commerce. Examples include Ariel Technologies, Dimension Data, Johnnic, Ixchange, McCarthys, Nedbank and Super Group. In line with global trends, B2B e-commerce procurement hubs (such as Motoronline, Autris, Miraculum, Commerce One and ProcureTrade) also have been developed. South Africa now ranks in the world's top 20 countries in terms of number of World Wide Web sites (BMI-TechKnowledge 2001). With the rapid growth in Internet use forecast in South Africa, the potential for the growth of e-commerce looks promising. BMI-TechKnowledge predicts that the B2B e-commerce market in South Africa will increase from US\$2.3 billion in 2000 to US\$9.7 billion in 2002 (F&Tnet 2000). A BMI-TechKnowledge survey conducted in 2000 put the percentage of large companies generating sales from electronic networks at 25 per cent, and for medium-sized firms at 20 per cent (F&Tnet 2000). The B2C market in South Africa is presently very small. The total value of Internet retail shopping reached US\$26.4 million in 2000, which was equivalent to 1 per cent of total retail turnover (Worthington-Smith 2001).

According to earlier research conducted by the International Data Corporation (IDC), it was estimated that by the end of 2001, nine countries (including Argentina, Australia, the Netherlands, Norway and South Africa) would be likely to generate more than 8 per cent of their revenue from online sales (Pieterse 2001). The IDC cites the use of electronic B2B exchanges and the large number of in-house computers connected to the Internet as possible reasons for the success that these countries were experiencing. With a well developed telecommunication infrastructure and deep integration into global economic networks, South Africa is better positioned than any other African nation to take advantage of the potential growth opportunities that e-commerce can help to foster. Telkom, the state-owned telecommunications company, has made significant progress in terms of modernization and rollout of fixed lines in order to meet its obligations vis-à-vis the Telecommunications Act of 1996. By April 2000, for example, all of the fixed lines were switched via digital exchanges (James, Esselaar and Miller 2001). South Africa has a well developed Internet infrastructure in business and academia, and its degree of connectivity places it in the top 25 in the world (Giovannetti 2001). South Africa has an advanced telecom network in the commercial centres, but this contrasts with very low penetration of services in rural and remote locations, especially in the previously 'independent' black homelands. While the costs of access are generally affordable in most cities because of the existence of local points of presence (POPs), there is no low-cost method of access outside of these areas.

That said, South Africa's e-commerce development is weak in two critical areas: (i) a deficient IT skills base, and (ii) limited access to low-cost, high bandwidth Internet. Training and indeed basic education of the black majority were largely neglected during the apartheid era. As a result, companies tend to rely heavily on a small nucleus of skilled white and Indian workers for their IT requirements. This is obviously an unsustainable policy in the long term. In a recent report, Internet networking

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<sup>11</sup> There are two notable exceptions, namely the Internet security and verification software developed by Thawte Consulting, and the software developed by Mosaic that services the banking industry.

consultancy Cisco Systems forecasted that the shortage of skilled IT professionals in South Africa will be among the most severe in Europe, the Middle East and Africa (Bureau of Market Research 2001). The local skills shortfall is forecast to rise from 33 per cent in 1999 to 62 per cent in 2003. This is likely to have an adverse effect on growth of e-commerce in the country.

The other critical concern is the need for establishing access to high bandwidth ICT infrastructures at an affordable cost. In 2001, large South African firms were paying on average US\$22,222 per month for a dedicated 1.5Mbps leased line. In the US the same capacity costs US\$1,795. During the same period in time, a 128Kbps line in South Africa cost US\$1,222 per month, while in Britain it cost approximately US\$842.1. In the US, firms were able to get six times this capacity for just US\$768 (Els 2001). Network bandwidth in South Africa is leased from Telkom, and this is likely to continue until some time after Telkom's monopoly comes to an end in May 2002. A second fixed-line operator is scheduled to become operational at that time, and a possible third operator will be appointed by 2005 depending on the results of a feasibility study to be conducted by government.

Government's recent decision to license one additional full service network operator and one international-only operator has introduced competition into the fixed line voice market for the first time in South Africa's history (Department of Communication 2001). The key issue is whether this competition is likely to be sufficient to bring about improved efficiency in the market and lower prices for consumers. Concerns have been raised about the financial and human resource capacity of the telecoms regulator, i.e. the Independent Communications Authority of South Africa (ICASA), to ensure that a level playing field is maintained in the telecommunications sector (James, Esselaar and Miller 2001). It is of critical importance that ICASA has the resources and technical capacity to monitor and act decisively against any potentially anti-competitive actions by Telkom.<sup>12</sup>

Since 1999 government has spearheaded a wide-ranging consultation process on e-commerce policy, involving actors from academia, and the private and public sectors.<sup>13</sup> The product of this broad-based consultation process was the publication of the *Green Paper on Electronic Commerce* by the Department of Communication in 2000. The draft legislation was wide-ranging and covered many aspects of e-commerce, including privacy and security issues, domain name system management, electronic payment systems, regulatory issues, etc. The Electronic Communications and Transactions Bill has been accepted by the Cabinet in 2001, and government is hoping to have it passed by Parliament during the course of 2002. Finalizing e-commerce policy for South Africa is important since it is likely to create greater confidence in the medium on the part of firms.

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<sup>12</sup> This has been a problem in other developing and industrialized countries, with the most notable example being OFTEL in the UK.

<sup>13</sup> See [www.ecomm-debate.co.za](http://www.ecomm-debate.co.za) .

## 5 Preliminary findings

A substantial 87 per cent of the 120 manufacturing firms interviewed for this study indicated that they had access to the public Internet and World Wide Web. However, only 49 per cent reported to have a corporate website. Currently, the Internet and World Wide Web are used most extensively for intra- and inter-firm communication, marketing and lead generation, rather than for inter-business transactions and supply chain management. A post-interview review of the participants' websites revealed that these invariably consisted of little more than a front-end, and/or an online catalogue with orders being emailed, faxed in, and/or taken over the telephone. Customers using these sites generally were unable to check, for example, on production processes, service call status, order shipping status and delivery information via the Web. Approximately 22 per cent of firms were using their websites for order-taking, but have not yet added any capabilities such as customization or interactivity to distinguish the service from other types of direct selling. For the remaining 78 per cent we found no evidence of actual trading taking place via corporate websites. Overall, these findings suggest that a greater emphasis was being placed on establishing a Web presence rather than on developing mechanisms for online trading per se.

Most (96 per cent) of the firms interviewed were not registered with any public, third-party web-based trading hub or e-marketplace. A significant proportion of the firms were, however, registered with information-oriented 'matchmaking services' such as electronic bulletin boards (54 per cent), and/or trade directory portals (46 per cent). The firms claimed that they had received 'request for information' and 'request for quotes' type inquiries from prospective buyers through information-oriented e-marketplaces. A few firms (10 per cent) also mentioned that they belonged to private marketplaces, which connects customers with their own select group of suppliers. Private marketplaces were perceived as less risky than third-party marketplaces.

The overwhelming majority of the firms were unable to explicitly articulate specific e-commerce strategies and objectives. Our findings suggest that there was a dissonance between what the participating firms considered to be the expected benefits of B2B e-commerce and their own adoption, implementation, and use of e-commerce technologies. It would appear that while the participants generally were familiar with the obvious, and sometimes exaggerated, potential gains of B2B e-commerce, they did not seem to be in any hurry to actually implement business models that were heavily reliant upon e-commerce. The qualitative and quantitative data obtained from the interviews revealed that there were eight main reasons for this inaction on the part of the participating firms (Table 2).

E-commerce does not yet appear to be a strategic imperative among the research participants. The majority of the participants were unable to support e-commerce ventures as yet, because they did not have the integrated customer and supplier ICT interfaces in place. While the e-commerce optimists regard e-commerce as a 'revolutionary' technology which challenges the pre-existing ways of doing business, of collaborating, and of competing, we take the view that e-commerce is an evolutionary process. This is clearly reflected in Figure 1. Figure 1 provides a highly stylized structural overview of an evolutionary e-commerce flow model. Phase 1 is largely experimental and exploratory, with firms adopting basic e-commerce tools such as email and/or a website. Inter-firm electronic information flows, where they exist, are

Table 2  
Primary reasons for participants' inaction (N=120)

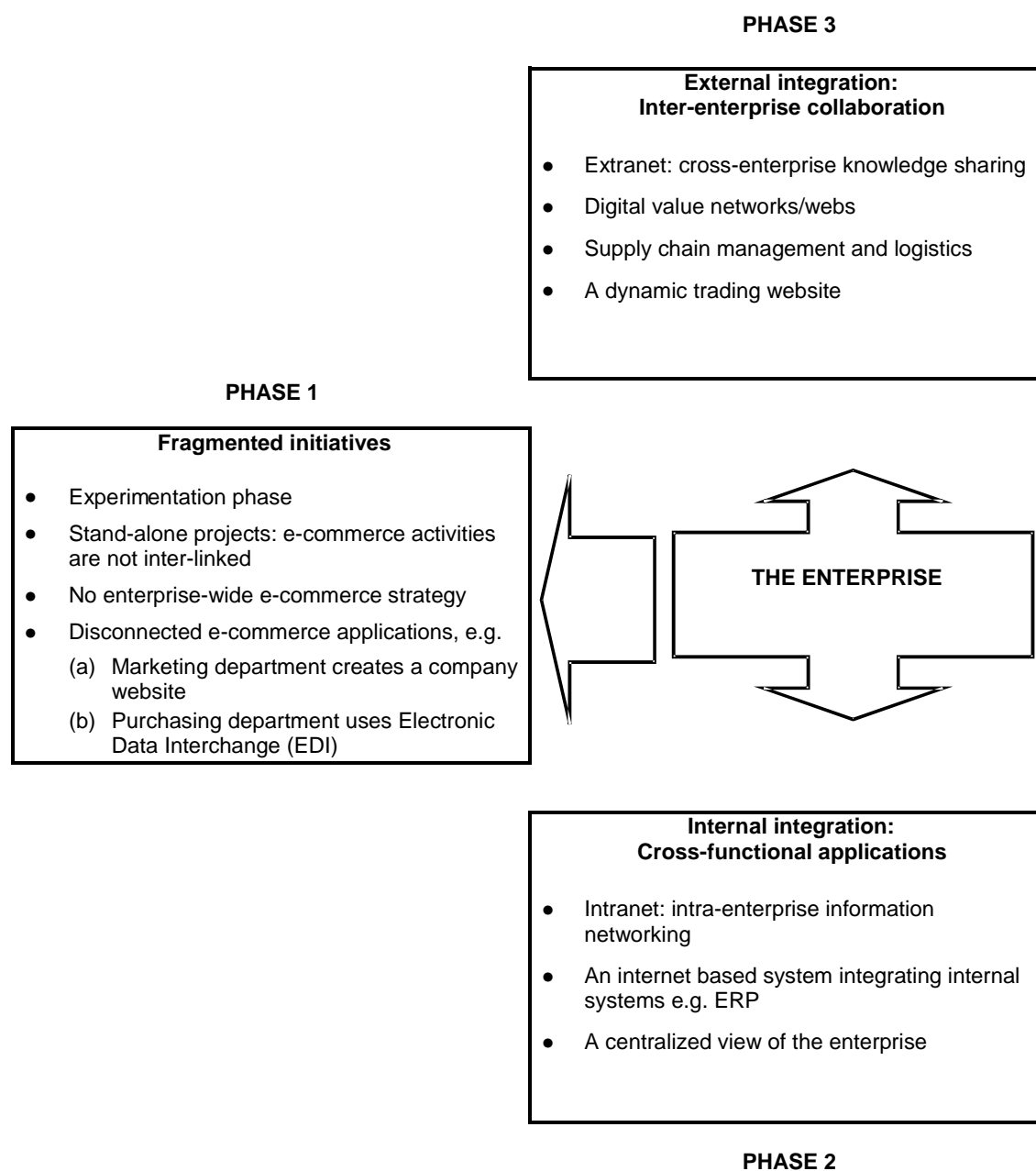
Reasons	%
A perception that IT companies, together with the media and the financial community, over-hyped the potential of e-commerce, and underestimated the time and resources it would take to implement Web-based applications and e-commerce servers	93
E-commerce is not yet a condition of trade for most firms in the manufacturing sector, and there is little or no pressure to adopt e-commerce systems by the governors of the respective value chains	85
The large, unanticipated barriers (such as problems with consolidation of technical standards, unexpectedly high implementation costs, and slower-than-expected adoption in many industries) impeding their progress to a functional e-commerce system	75
The inability of manufacturing firms to develop an apposite e-commerce model which is tightly integrated into their respective value chains	58
There is the fear that e-commerce will break or weaken a firm's long-standing relationships with existing buyers	52
A lack of critical mass of e-commerce enabled firms in the value chains within which the participating firms are located	52
The fact that most e-markets and trading hubs have not been able to achieve operational critical mass	38
Participants see e-marketplaces/trading hubs as barriers between them and their customers	22

still mainly centred on more traditional private networking technologies like EDI via direct lines or VAN applications. Phase 2 marks a shift to integration, with firms exploring the intra-organizational potential of e-commerce, to link different aspects of their business, from production to sales; the objective being to streamline internal processes (to reduce costs, or improve business process productivity). Phase 3 sees 'transforming' firms deploying e-commerce for inter-organizational networking, and aligning its benefits to strategic planning. E-commerce is used here to enhance traditional linkages between value chain participants, to build new business partnerships and to restructure existing business models.

Our findings suggest that the primary focus of most (93 per cent) of the manufacturing firms centred largely on a functional orientation (50 per cent) (Phase 1 in Figure 1), i.e. they do not form part of an enterprise-wide e-commerce or business strategy, or on operational efficiency across the enterprise (43 per cent) (Phase 2) where the focus is on using technology to improve efficiency and support existing business processes. Only a minority (8 per cent) of firms were using e-commerce to increase the organization's effectiveness outside the enterprise by linking across the Internet with suppliers and customers to create virtual supply chains (Phase 3).



Figure 1  
The e-commerce flow



In Table 3 the types of e-commerce models that the participating firms were planning to use and/or implement within the next three years are listed. The data suggest that the manufacturing firms remain fixated on a functional orientation, more specifically automation of their trading functions (i.e., purchasing and sales) (Phase 1, Figure 1). While only 16 per cent of firms were considering using e-commerce to network the different departments within the enterprise to reap cross-functional synergies (Phase 2), a significant 48 per cent indicated that they were planning a more ambitious application of e-commerce, i.e. interconnection with their suppliers and customers to exploit systemic efficiencies (Phase 3). This finding strongly suggests that a large number of the participating firms did not realize that systemic cross-enterprise networking is dependent on integrated intra-enterprise IT systems (i.e., both front and back-office applications).

Table 3  
Planned e-commerce models (N=120)

Individual supplier catalogues	73%
Internet-based extranet	48%
B2B trading hubs	48%
Internet-based electronic data interchange	43%
Open buying on the Internet (OBI) systems	32%
Aggregated multi-supplier catalogues	21%
Internet-based enterprise resource planning	16%
Internet auctions	16%

The findings clearly demonstrate that the implementation and adoption of B2B e-commerce applications in the South African manufacturing industry are in the early stages of its evolution. The main uses of the Internet and World Wide Web by the participating firms included accessing commercial databases or services (23 per cent); information searches (53 per cent); marketing and advertising (60 per cent); monitoring prices (23 per cent); keeping abreast of technology and market trends (51 per cent); using online catalogues for contracted parts (21 per cent); checking supplier financials (15.8 per cent); email applications (100 per cent); and, to a lesser extent, actual transactions between firms (24 per cent). The main advantages that the firms associate with e-commerce are strengthening customer relationships (54 per cent); reaching new markets (18 per cent); optimizing business processes (23 per cent); and reducing costs (39 per cent). The findings suggested that although the majority (73 per cent) of the respondents had positive expectations about the potential of B2B e-commerce, they generally were relatively unaware of how to maximize this potential.

The information collected from the interviews also reveal that only 16 per cent of the participating firms had a formal e-commerce policy, while 21 per cent of companies were attempting to generate sales through the Internet and World Wide Web. The evidence suggests that electronic procurement and electronic catalogue management systems geared to move corporate purchasing and selling online have not been widely adopted. The firms that were interviewed mentioned the following supply chain problems: high inventory levels; long lead times; poor inter-firm communication; lack of trust and obligational relationships; limited collaborative forecasting, planning and replenishment processes; little strategic supply chain thinking; and an imbalance between supply and demand. Thus it would appear that the participating companies have much to gain from an appropriate B2B e-commerce strategy geared towards advanced supply chain management. However, making the transition to B2B e-commerce will not be easy, as there are formidable obstacles that need to be overcome (Table 4).

There is little in the interview material to suggest any linear relationship between basic subsector characteristics and the level or sophistication of e-commerce use. Although one might expect the automotive components sector to lead by example, their performance in this respect is not as 'impressive' as one would expect vis-à-vis the other two subsectors. The automotive components sector is itself exploring the potential of e-commerce adoption in many areas of its own value chain. Finally, individual manufacturing firms investing in Internet-based networking technologies at this early

stage in the development of e-commerce might find the return on investment quite low. Over time, as more suppliers and customers use the Internet in their front-office and back-office systems, and to connect with their trading partners, the benefits of Internet-enabled collaboration will likely become more pronounced.

Table 4  
Barriers to adopting B2B e-commerce

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OBSTACLES
1. Limited understanding among firms of the opportunities, challenges and risks of e-commerce
2. Uncertainty about returns from e-commerce investments
3. Concerns that the price transparency that B2B e-commerce promotes could lead to a race to the 'profitless' bottom
4. Resistance to the idea of sharing inventory and capacity information for fear that it will cost them sales
5. Security concerns, i.e. fear of sharing information online
6. Incompatible IT infrastructures, and the lack of technical standards for sharing data
7. Firms spend little time developing a strategic view of their business. They are preoccupied with survival, i.e. a vision which is tightly focused on the short-term and on issues such as profit, tax, competition and regulations
8. Inertia, i.e. management's reluctance to change existing operating structures
9. Evolutionary path dependencies which focus on the reduction of labour and input costs as competitive advantage rather than pursuing a knowledge and innovation-intensive growth trajectory
10. Management's 'laager' mentality which have locked firms into an insular, inwardly-oriented way of thinking
11. The lack of adequate IT infrastructures, skills and capabilities
12. The relatively high initial investment costs involved in developing an integrated e-commerce infrastructure. The cost problems are compounded in many cases in that most companies have no assessment methodologies to gauge the costs of e-commerce relative to its performance

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## 6 The policy challenge

The implementation and adoption of e-commerce processes constitute a formidable challenge for technology policy. There appears to be two main views emanating from the current debate on the role that government policy can play in promoting technology modernization. On the one hand are those who argue that government policies aimed at reinforcing a country's technological competence are irrelevant, since resources employed would not necessarily lead to national advantage (Ohmae 1990). According to this view, globalization is eroding the significance of the state in promoting technological change (Chesnais 1994). These 'globalization of technology' advocates assert that private firms (or networks of firms) are the locus of technological capabilities and their development (Dunning 1992; Howells and Wood 1993). On the other hand,

there are those who argue that public sector intervention is necessary to better equip firms to face technological change and the pressures of globalization (Archibugi and Michie 1997; Archibugi, Howells and Michie 1999; Lundvall 1992). These advocates of 'national innovation systems' assert that the nation state is ultimately responsible for technology modernization (Archibugi and Michie 1997; Lundvall 1992; Nelson 1993). To this end, Pavitt and Patel (1999: 110) argue that the technological competitiveness of firms 'inevitably depends on national systems of innovation', which in turn depend on government policy.<sup>14</sup>

We take issue with the view that the globalization of technology is making national policy an anachronism. Lall (1997), for example, provides an interesting account of how governments might help to assist firms in confronting the difficulties of technological learning in a developing country context. His findings suggests that government can assist companies by putting in place a set of complementary institutions which encourage IT and knowledge diffusion, especially through the support of education, training and information infrastructure. Market mechanisms alone are unlikely to be sufficient to generate positive spin-offs throughout the economy. Government also has a role to play in supporting new forms of market facilitation, designing and implementing effective national ICT strategies, promoting 'stakeholder dialogues', constructing ICT infrastructures appropriate to local conditions, and building capabilities and skills for producing and using ICTs. In particular, the state will need to play a leading role in the modernization and extension of the national information infrastructure.

Based on the preceding discussion, it would be prudent for policymakers to adopt a cautious approach to assessing claims about the potential of Internet-based e-commerce to facilitate South African manufacturers' access to international markets. Simple, undifferentiated policy prescriptions are unlikely to succeed. The impact of e-commerce is likely to vary from market to market and from firm to firm. Therefore, 'a one-size fits all' approach is inappropriate. Government needs to understand that e-commerce is a complex concept, with many different facets, with each posing its own challenges. Policy-making is further complicated by the fact that e-commerce is a 'moving target' which is constantly evolving and changing.

The potential benefits of e-commerce are more likely to come to fruition if policymakers adopt a broader approach to e-commerce. Specifically, one that draws more actively on a deeper and more balanced understanding of this concept, its implications, and the relationship between e-commerce and development. This means that policymakers will need to move beyond the standard model of e-commerce which is fixated on online commercial transactions and transaction-oriented trading exchanges. Greater consideration will need to be given to creating and enhancing ICT links between South African manufacturing firms and geographically dispersed firms in global value chains; Internet-based communication and information exchange such as collaborative product design, joint problem solving and quick response to customer requirements; and streamlining tasks such as production planning, inventory control and scheduling that lie closer to the heart of supply chain management.

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<sup>14</sup> The national system of innovation is the network of institutions in the public and private sectors of each country that support the initiation, modification and diffusion of new technologies such as e-commerce (Freeman 1995).

Reliable, high-speed Internet connections are essential for these tasks. In addition, government will need to commit significant resources to training employees to exploit the new Internet-based technologies and systems. According to Lundvall (1992), in the new growth regime *knowledge, information and learning* are crucial for economic growth and competitiveness, and policies relating to ICTs are especially important. Therefore, government needs to take a leading role in the technology policy sphere, partly since its room to manoeuvre in the macroeconomic and labour market policy arenas are being curtailed. In this sense, industrial policy focuses on ‘empowering firms’ rather than ‘picking winners’.

Government intervention is justified in areas where it is foreseen that market forces will not be sufficient to ensure effective and more widely spread implementation of e-commerce in South Africa. State policy should, therefore, focus on enhancing infrastructure to support e-commerce, building trust in these new forms of business,<sup>15</sup> establishing the ground rules for B2B e-commerce, and maximizing the direct benefits that can be gained from B2B applications for manufacturing firms. Government should also explore the possibility of creating a time-limited tax incentive to raise e-commerce awareness and adoption by manufacturing companies. This incentive would be for investments in e-commerce technologies and would be in the form of accelerated depreciation.

The state should also take a leading role in providing advice on matters like technology choice, identify and disseminate information on best practice, provide a critical assessment of the available e-commerce technologies and approaches, develop meaningful industry benchmarks, set in motion programmes aimed at raising appreciation of the strategic impact of e-commerce, and invest in training and skills development. A policy priority is to liberalize the highly regulated and concentrated South African telecommunication market and promote competition in order to stimulate new investment, increase demand for communications access and services through falling prices, and promote greater efficiency and innovation in the provision of infrastructure and services. Policy initiatives to lower network infrastructure costs and Internet access charges for manufacturing firms are important. This is likely to provide a stimulus to the growth of e-commerce among South African firms. In the OECD (1999 and 2000) countries, for example, the availability of affordable access to high-speed telecommunication infrastructure is closely linked with firm migration to e-commerce.

The magnitude of the e-commerce challenge is such that there is a need for various public-private and multi-partnerships, alliances and consortia. There is an urgent need for the forging of partnerships to (i) assist firms to access capital for their e-commerce ventures; (ii) allay basic fears about the sharing of information; (iii) establish a standard format for conveying information and transaction standards; (iv) encourage firms to form networks in order to share knowledge, reduce the average costs of their input transactions, and increase their relative market power in e-commerce transactions; and (v) develop ICT capacities and skills through education and training, and counter skill

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<sup>15</sup> Trust implies confidence that electronically-based purchases, funds transfers, and business deals will be as valid as traditional activities; that personal information and finances will be secure; and that the world of online information and communication will be at least as accountable for the quality, reliability, and legality of products and services as in the physical world of paper-based documentation. Security and cryptography issues tie in with both privacy protection and certification, as well as with the technical options for creating and validating digital signatures.

shortages which are greatest in three areas, viz. managers capable of completing complex technology projects, local content creators aware of the network's potential and software and hardware engineers.

Policymakers should be especially wary of not slipping into an overly technocratic approach that ignores the priorities and needs of the firms in question, and broader industrial development goals. The biggest e-commerce challenge facing the South African manufacturing sector is not technical, since the technology is already available for information exchange, trade and financial transactions. Therefore, focusing primarily on the production or acquisition of e-commerce technologies is counterproductive. The challenge rather is for government to exercise a strategic vision and leadership. Government must focus on what manufacturing firms need, and on decisions about how e-commerce is to be incorporated into economic activities, at both the intra- and inter-firm levels. Ultimately, the policymakers must have a vision of the most important e-commerce applications for the South African manufacturing sector, and how such priorities are to be realized.

## 7 Conclusion

B2B e-commerce is in an inchoate stage of development in the South African manufacturing sector, and technology and market dynamics are still casting its basic shape. Internet platforms are being used mainly to supplement existing EDI and process management systems (like CAD and ERP), mainly through the use of websites and email to provide *general information and communication services*. The Internet and email are used mainly as a means of supporting existing business relationships, rather than exploiting opportunities for establishing new relationships. Moreover, there is a general lack of urgency on the part of most participants, for whom transactional-based e-commerce is simply not yet a strategic priority. The paper has argued that policy decisions will have a major impact on the kind of environment in which e-commerce will develop and should therefore be crafted with due recognition of its fragile and evolving nature.

E-commerce and the Internet offer South African manufacturing firms opportunities to break out of their current constrained, insular information systems. There is enormous scope for extending the use of e-commerce in the South African manufacturing sector, particularly in using the Internet as a channel for communication and the exchange of up-to-date structured business information between trading partners, and for improving the flow of scheduling information along the supply chain to help reduce inventories and improve production planning efficiencies at each stage. In the South African manufacturing sector there is an acute need for an effective business information system that is able to support (i) *information management* (which includes the activities associated with knowledge management, research and development, and marketing); (ii) *documentation* (which encompasses configuration management, maintenance, repair and overhaul activities); and (iii) *collaboration* (which encompasses design, planning activities, etc.).

E-commerce has a role to play in speeding up the flow of information in the value chain, and in making it more widely available. This alone can produce gains large enough to justify firms' investments in ICTs. As the lead times of early adopters shrink

and forecasts become more dependable, companies may be more willing to share their closely guarded information. E-commerce development in the South African manufacturing sector is likely to be a cumulative, incremental and path-dependent process (à la David 2000 and Rosenberg 1976 and 1994), which takes the form of the steady accumulation of tacit capability (which is acquired through a collective learning process within the firm), rather than a sequence of discrete acts of technology building. South Africa will need to take great care to avoid being taken-in by the promises of overly optimistic and technicist approaches to e-commerce which do not take into account the real world of global trade and production networks and the position of South African manufacturing firms within it.

E-commerce is not an end in itself, nor does it offer a quick technological fix. Importantly, the success of e-commerce is heavily dependent on complementary innovations in business and management processes, and organizational structure. At the very least, e-commerce provides the South African manufacturing sector with new opportunities and challenges. Government should therefore be careful not to overestimate the ease of implementing B2B e-commerce by substantially underestimating the complexity and time of the required organizational changes. An important lesson from business history is that innovation and the use of new 'systemic' technologies is a highly unpredictable and uncertain process (Archibugi and Michie 1997; Archibugi, Howells and Michie 1999). E-commerce is unlikely to be any different.

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