Globalization and E-Commerce: Growth and Impacts in Singapore

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Summary

This paper provides a broad overview of the likely global/regional contextual factors and unique national characteristics that influence e-commerce diffusion and innovation in Singapore. Our analysis suggests that:

- Singapore is likely to be a very fast adopter of e-commerce applications that have relatively proven economic value model in other advanced countries.
- In particular, advanced manufacturing industrial clusters in Singapore with strong global supply chain links to advanced countries (like electronics and aerospace), logistics and transportation industries, and other global market oriented, business-to-business industries are likely to be the most aggressive in adopting e-commerce applications.
- In contrast, we predict that Singapore will be less able to innovate new e-commerce technologies or pioneer revolutionary e-commerce applications with radical global impacts, due to the small local market and the inadequate development of an ICT entrepreneurial community with extensive networks in Silicon Valley and other hotspots like the wireless technology hubs in Sweden and Finland.
- Singapore is also unlikely to be a leader in large-scale business-to-consumer e-commerce applications and mass consumer contents publishing. The only possible exception is "e-Government" applications.
- Our review of government policy initiatives to promote e-commerce suggests that although they are by and large in the right direction, they are unlikely to have significant impact until proven e-commerce models have emerged and competitive pressure starts to be felt by companies.
- We have also identified a number of areas where government policy initiatives have been less effective, notably in making the telecommunications services sector more competitive and innovative, and in promoting regional cooperation.
- Our review of the available empirical evidence on recent e-commerce diffusion trends and patterns, although preliminary due to the lack of sufficient time-series data, appears to be consistent with the above analysis.
- A preliminary assessment of the likely socio-economic impacts of future e-commerce developments in Singapore is also provided, highlighting likely increasing industry consolidation in globally oriented industries, increasing social inequalities, and changing government-citizen relationships.

Introduction

As a major regional trading, manufacturing and services hub in Asia, Singapore's future competitiveness and economic development prospects are likely to be significantly affected by the development of e-commerce on a global scale. This paper aims to provide a broad overview of the likely global/regional environmental factors and the unique national characteristics that will facilitate or retard the readiness of the country for e-commerce innovation and diffusion. The paper also reviews the emerging policy initiatives of the government to promote e-commerce development. Synthesizing from these findings, the paper identifies likely patterns and trends of e-commerce diffusion in Singapore, and examines the extent to which available empirical evidence supports the hypothesized diffusion trends and patterns. The paper concludes by highlighting the salient policy issues and challenges facing Singapore as well as possible

lessons for other newly industrializing countries seeking to exploit e-commerce for economic development.

Although still at an early stage, the experience of Singapore in e-commerce development is of interest from an international comparative perspective for a number of reasons. Firstly, as one of the first countries in Asia to target IT as a strategic sector for promoting economic development in the early 1980s, Singapore had already developed a relatively advanced ICT infrastructure prior to the arrival of the Internet and e-commerce (Wong, 1996, 1998). It is thus interesting to see if this early investment in IT has facilitated the transition into e-commerce development or may have been a hindrance instead. The history of technological change is replete with examples where the incumbent leaders in an established technology are overtaken by new "attackers" when a new, disruptive technological change occurs. To what extent does e-commerce represent a "disruptive" radical technological change, where latecomers enjoy leapfrogging advantages over the early adopters? Or is it more an incremental extension of existing ICT infrastructure to new forms of business applications, which would strengthen the lead of the early adopters?

Secondly, Singapore's past economic success as a regional business hub in Southeast Asia has been based on a strategy of attracting direct foreign investment (DFI) by global multinational corporations and leveraging their presence to stimulate technology transfer and to promote the development of competitive local industries supplying components and services to these demanding customers (Wong, 1992**,** 1998, 2000). The strategic geographic location of Singapore in Southeast Asia and the excellent transportation infrastructure developed by the state have been key factors in attracting these DFI flows to Singapore. However, the Internet revolution is alleged to be driven by new start-ups, not incumbent large multinationals. Moreover, e-commerce is alleged to lead to the "death of geographic distance", rendering traditional advantages based on physical transportation economics obsolete. To what extent does the development of e-commerce necessitate a fundamental shift in economic development strategy, moving away from reliance on global MNCs to promoting new start-ups? And to what extent is e-commerce likely to strengthen or weaken traditional DFI locational advantages? Being so highly dependent on global MNCs and DFI, the experience of Singapore will provide valuable lessons for other developing countries.

Environmental Factors Affecting E-Commerce Readiness: Conceptual Framework

In line with other papers in this project, this paper adopts a broad analytical framework that recognizes the process of e-commerce adoption in a country as an evolutionary, path-dependent, diffusion process affected by a wide range of socio-economic environmental factors, rather than focusing narrowly on one or two causes. Some of these factors are likely to facilitate the diffusion process, while others will act as impediments. Some of them will exert their influence primarily on the demand side, some primarily on the supply side, while still others on both. Some will be uniquely local factors within the influence of national actors, including public policy interventions, while others represent global and regional contextual factors beyond the control of national actors. Some factors will take a long time to change, while others may change more quickly.

Among the global environmental factors that influence e-commerce development in a small country like Singapore, none is more critical than the fact that e-commerce as an innovation is

still at an early, immature stage. Despite the hype, the reality is that e-commerce is still in a state of flux globally, and there are great uncertainties as to the specific forms ("dominant designs" [Utterback, 1996]) that e-commerce applications will eventually take, and what their long-term impacts will be. Indeed, the recent bursting of the Internet bubble worldwide following the severe meltdown of Nasdaq and other high tech stock markets since Q1 2000 has resulted in a large number of failed e-commerce ventures. Some highly touted, well-funded e-commerce business models just two years ago have since proven to be not viable at all. At the same time, many global companies that have been leaders in e-commerce deployment have slowed down or drastically curtailed their investment. Although these recent adverse developments are likely to be over-reaction and e-commerce will undoubtedly continue its rapid growth in the longer term, they do acutely highlight the high risk and uncertainties still surrounding e-commerce investments and the lack of sufficient proven e-commerce business models at the current stage.

Such uncertainties notwithstanding, the extant literature on the factors influencing diffusion of new innovation does provide considerable guidance on the likely effects of various environmental factors on the pace and pattern of diffusion within and across countries over time (see e.g. Rogers (1995), Kraemer, King and Gurbaxani (1992), Musmann and Kennedy (1989) and Kautz and Priesheje (1996)).

Overview of Singapore's Global/Regional and National Environment for E-Commerce Development

Structure of Economy and its Implications for E-Commerce

Among developing nations, Singapore has achieved one of the most remarkable economic growth records over the last four decades. Between 1960-2000, Singapore's GDP grew by an average of 8.2 percent per annum in real terms (Table 1), with per capita GNP in current prices rising about 32 times in Singapore dollars. In terms of US dollars adjusted for purchasing power parity, the rise in GNP per capita is even more dramatic, by more than 60 times from US$435 in 1960 to US$27,000 in 1999, highest in Asia and globally ranked 7th in the world (World Bank, 2001). Like Hong Kong, the other successful metropolitan gateway economy in Asia, Singapore has evolved over the years into a major financial, transport, communications and business hub in the Asia-Pacific region. Just as Hong Kong has prospered as the commercial gateway to China in Northeast Asia, Singapore has benefited significantly as the central business hub for Southeast Asia. Unlike Hong Kong, however, Singapore has not experienced significant de-industrialization and "hollowing" out of manufacturing employment in recent years: Over 1960-2000, the manufacturing sector of Singapore grew even faster than the economy as a whole (9.4 percent vs. 8.3). Although manufacturing growth over the last decade has slowed appreciably to only 6.7% p.a., the manufacturing sector currently still accounts for about one-quarter of total GDP.

TABLE 1
Performance of Singapore's Economy, 1960-2000

(a) Aggregate Economic Growth Performance, 1960-2000

	% Real growth p.a								
	1960-70	1970-80	1980-90	1990-2000	1990-97	1997	1998	1999	2000
GDP	8.7	9.4	7.1	7.5	8.4	8.5	0.1	5.9	9.9
Labour productivity	n.a	4.3	4.8	3.4	3.6	2.3	-2.7	6.3	5.6 [p]
	(S$ at current prices)								
GNP per capita	1960	1970	1980	1990		1997	1998	1999	2000
	1,330	2,825	9,941	20,090		39,310	38,418	39,721	42,212[p]

Note: [p] Preliminary figures.
Source: Calculated from MTI (1990); Department of Statistics, *Yearbook of Statistics Singapore*, various years; Ministry of Trade and Industry, *Economic Survey of Singapore*, various years. Mid-year population estimate for 2000 obtained from Singstat website, http://www.singstat.gov.sg/FACT/KEYIND/keyind.html.

(b) Sectoral GDP growth rates
(In percentage growth per annum)

Sectoral Growth	1960-70	1970-80	1980-85	1985-90	1990-00
Manufacturing	13.7	12.7	1.6	12.5	6.7
Construction	15.8	6.0	15.2	-6.1	8.6
Commerce	8.0	6.1	4.0	9.2	8.6
Transport & Communication	6.5	11.6	5.8	7.7	6.2
Finance and Business Services	11.3	11.1	12.5	7.0	7.4
GDP Growth	9.1	9.0	6.2	8.1	7.5

Source: Calculated from MTI (1990); Department of Statistics, *Yearbook of Statistics Singapore*, various years; Ministry of Trade and Industry, *Economic Survey of Singapore*, various years.

As in Taiwan and Korea, manufacturing activities in Singapore have witnessed very rapid technological development, moving from labor-intensive, simple assembly industries to increasingly capital-intensive and technologically complex industries. However, unlike Taiwan and Korea, Singapore's strong manufacturing performance has relied heavily on direct foreign investment (DFI) by multinational corporations (MNCs). Foreign- and majority foreign-owned manufacturing firms consistently accounted for more than 70 percent of the total manufacturing output throughout the 1970s, 1980s and 1990s. This pattern of MNC-led manufacturing development stands in strong contrast to Taiwan and Korea, where indigenous manufacturing firms predominate over foreign firms – numerous SMEs in the case of Taiwan, large chaebols in the case of Korea.

Singapore's ability to sustain a large and technologically advanced manufacturing base as well as a sophisticated business, financial and communications services hub thus provides the country with a unique mix of both the manufacturing strengths of Taiwan and Korea and the trading/financial intermediary might of Hong Kong. Indeed, Singapore's trade openness, as measured by the ratio of total trade to GDP, is among the highest in the world, making the country a natural candidate for B-to-B e-commerce. Similarly, the significant presence of "high-velocity", export-oriented manufacturing activities makes Singapore an important node in the global production networks, thus offering potential scope for using the net to manage manufacturing supply chain and logistics. Finally, the presence of many world-class MNC operations in Singapore is likely to facilitate the diffusion of new technology usage to Singapore-

based subsidiaries, as well as serving as lead-user roles in stimulating new innovations by local suppliers and supporting industries.

These unique advantages of Singapore over her Northeast Asian rivals are however, offset by the limited size of the Southeast Asian markets within which the country is located. While Taiwan and Hong Kong have the huge markets of coastal China, not to mention Japan, in close proximity, the Southeast Asian hinterlands of Singapore is smaller in GDP size as well as economically more backward. In the aftermath of the 1997 financial crisis, the region is also growing much more slowly and suffers from greater political uncertainties.

Demographic Structure and its Implications for E-Commerce

Singapore's city-state nature gives it unique characteristics among our countries in terms of e-commerce environment. With a small population of around 4 million concentrated in a compact metropolitan city-island of only 640 square kilometers, Singapore enjoys significant economies of density in providing universal communications access, whether wired or wireless, to its entire national population. There is no sparsely distributed rural population to connect, and the "last-mile" access cost is relatively low. On the other hand, because of her geographic compactness and the excellent physical transportation and distribution infrastructure established in the past, the ease of access to highly developed commercial districts and the presence of numerous neighborhood convenience shops may limit the benefits of shopping online.

The high level of income and education of the Singapore population also carries both positive and negative implications for e-commerce. At US$27,000 (PPP-adjusted), Singapore GNP per capita in 1999 ranked among the highest in the world, surpassing even such advanced countries as Japan, UK and Canada. Relative to other NIEs, Singapore's income and wealth distribution is more equal than most, and the country has one of the highest household savings rates in the world. The population of Singapore therefore has relatively high disposable income, even though government policies enforcing compulsory retirement savings have a restrictive effect on consumer spending. Add to this the relatively high level of education and IT literacy especially among the younger generation, the large presence of expatriate professionals and managerial community, the universal usage of English as a medium of communication alongside the use of mother-tongue languages among the three largest ethnic communities (Chinese, Indian and Malay) in the population, and the general openness of the society to cultural influences from both the West and the East, Singapore's demographics appears to be very conducive for adoption of e-commerce. The highly open economy and the strong social ties of Singaporeans with the region (from which many of whom migrated) has pre-disposed Singaporeans to be accustomed to the use of telecommunications technologies to communicate with business partners and social kins and friends overseas, aided no doubt by the excellent and relatively low cost international telecommunications infrastructure put in place by the government.

Significantly offsetting against these advantageous factors, however, is the extremely small size of the domestic market. With a population of only 4 million, the market is too small to sustain most e-commerce applications by itself. No e-commerce innovation by a Singaporean entrepreneur has any hope of getting funded by venture capital by targeting the domestic market; it has to demonstrate ability to reach international markets from day one. The small domestic market size similarly deters businesses from adopting new e-commerce applications not already proven elsewhere in large advanced countries, out of fear that they may be locked in to

technological standards that become obsolete if these larger countries pursue a different standard. Even if proven viable nation-wide, an e-commerce innovation in Singapore is likely to carry too small a weight to influence global standards, unlike the example of, say, NTT Docomo in Japan.

Physical Infrastructure for E-Commerce

Among developing and even developed countries, Singapore has among the most advanced physical transportation and telecommunications infrastructure in place for supporting e-commerce. Indeed, successive yearly ranking of countries in terms of competitiveness of infrastructure by both the World Competitiveness Report and the Global Competitiveness Report have placed Singapore on top of the world (Table 2).

To the extent that e-commerce involving physical goods (as opposed to information goods) still requires complementary support of transport infrastructure to facilitate physical fulfillment, Singapore's world-class transport infrastructure gives the country a strong advantage. As can be seen from Table 2, Singapore's air- and seaports have been consistently ranked as the most efficient in the world. Singapore's logistics services industry, which includes the operations of many of the world's leading and technologically most advanced logistics players, have high rates of IT adoption, and their operational efficiencies are among the highest in the world (Wong, Toh and Hum, 1996).

TABLE 2
Ranking of Singapore's Transportation and Communications Infrastructure in the Global Competitiveness Report2000

(Total number of countries covered = 59)

Country	Overall Infrastructure	Road	Air Transport	Sea Ports
Singapore	1	1	1	1
Hong Kong	8	7	2	2
Malaysia	18	19	26	21
Thailand	32	30	32	32
Philippines	55	55	49	53
Indonesia	42	40	42	38
United States	*7*	*13*	*3*	*9*

Source: World Economic Forum, Global Competitiveness Report 2000

By most indicators, Singapore has also achieved among the highest rates of penetration of ICT and Internet usage in Asia, reaching levels comparable to the US and Scandinavian countries in some cases. Tables 3-8 provide information on some of these penetration indicators. For example, in terms of overall household PCs and household Internet penetration rates, Singapore's 59% and 42% in 1999 rank highest in Asia and are comparable to rates achieved in the US (Table 3). Although Singapore's number of Internet users per 1,000 population still ranks considerably below the Scandinavian countries which are the global leaders, it is still the third highest in Asia after Hong Kong and Australia but ahead of Japan, Taiwan and Korea. Moreover, an estimated one out of six internet subscribers in Singapore are on broadband connections (T1 or higher leased lines, cable modem or ADSL) (Table 5); while comparable international figures are not available, this is probably among the highest in the world. In terms of number of internet hosts per 1,000 population, Singapore is similarly still significantly behind the US and other advanced countries, but her ranking in Asia is still high, only behind Australia and New Zealand and ahead of Hong Kong, Japan, Taiwan and Korea. The high internet

penetration in Singapore is supported by a relatively high level of development of IT and telecommunications infrastructure: Singapore has the highest household penetration rates for fixed line telephone connections in Asia (Table 6), as well as the third highest ranking in terms of IT spending as a percentage of GDP (after Australia and New Zealand) (Table 7).

Singapore scores less well in terms of a number of other ICT adoption indicators, particularly wireless phone subscription and cable TV subscription. In the case of wireless phone subscription rate per 1000 population, Singapore ranks 5th in Asia, after Hong Kong, Korea, Taiwan and Japan in 1999 (Table 6); however, Singapore is still ahead of the US, and the growth since 1999 has been particularly rapid (Table 5). Singapore also ranked 5th in Asia in terms of cable TV subscription rate (Table 6).

Overall, according to an aggregated index of informatization developed by IDC, Singapore ranked number 2 in Asia (after Japan) and 11th in the world in 1999 (Table 4). The lower ranking of Singapore than Japan is due mainly to the inclusion of a number of social infrastructure indicators where Singapore scored less well, especially in higher educational enrolment, newspaper circulation and press freedom.

Singapore appears to have maintained a high pace of increase in diffusion of Internet and wireless telephony adoption over the last two years (Table 4). For example, the number of mobile phone subscribers increased 3-fold from the beginning of 1998 to the beginning of 2001, while the number of Internet subscribers increased more than 6-fold in the same 3-year period. Thus, while more recent international comparative data after 1999 are not yet available, it is likely that Singapore may have further moved up the ranking ladder in terms of Internet and wireless telephony penetration.

TABLE 3
Household PCs and Internet Penetration Ratios in Singapore

a) Ownership of computers in Singapore households

	1988[1]	1990[1]	1992[1]	1992	1996	1997[1]	1999
Percentage penetration	11.0	19.1	20.2	26.8	35.8	41.0	58.9

Source: IT Household Survey (NCB) 1999
[1] From DOS Household Expenditure Survey

b) Internet access in Singapore households

Year	Percentage Penetration
1996	8.6
1997[1]	14.0
1999	42.1

Source: IT Household Survey (NCB) 1999
[1] From DOS Household Expenditure Survey

TABLE 4
Information Society Index 2000 Rankings for Asian Countries

Rank	Country	Score
10	Japan	4,093
11	Singapore	4,014
14	Hong Kong	3,484
18	Taiwan	3,177
22	Korea	2,931
35	Malaysia	1,583
47	Philippines	1,012
48	Thailand	1,010
51	China	915
52	Indonesia	888
54	India	871

Source: ⟨http://www.worldpaper.com/ISI/intro.html⟩
Note: There are 23 variables in the ISI:[1]

TABLE 5
Growth in Telecommunications Services in Singapore, Jan 1998 – Jan 2001

	JAN 1998	JAN 1999	JAN 2000	JAN 2001
NO. OF FIXED TELEPHONE LINE	1,668,400	1,761,000	1,860,000	1,940,200
Penetration rate				48.3%
No. Of mobile phone subscribers	776,800	1,035,000	1,531,700	2,536,900
Penetration rate				63.1%
Internet dial-up	276,600	406,400	956,300	1,943,800
Penetration rate				48.3%
No. Of internet leased lines (T1 or higher)	N.A.	1,100	1,900	3,000
No. Of broadband internet subscribers (cable modem or ADSL)	N.A.	N.A.	N.A.	270,000
No. Of mobile data services subscribers	N.A.	10,800	11,200	11,900

Source: IDA

[1] *Computer Infrastructure:* 1) PCs installed/capita; 2) Home PCs shipped/household; 3) Government/ commercial PCs shipped/non-acric workforce; 4) Educational PCs shipped/students & faculty; 5) Networked PCs % installed total; and 6) Software/Hardware spending. *Information Infrastructure:* 7) Telephone lines /household; 8) Telephone faults/lines; 9) Cost of local phone call; 10) Television ownership/capita; 11) Radio ownership/capita; 12) Fax ownership/capita; 13) Cellular phones/capita; and 14) Cable/satellite TV coverage. *Internet Infrastructure:* 15) e-Commerce spending; 16) # Internet Home Users; 17) # Internet Business Users; and 18) # Internet Education User. *Social Infrastructure:* 19) Secondary school enrolment; 20) Tertiary school enrolment; 21) Newspaper readership; 22) Press freedom; and 23) Civil liberties.

TABLE 6
Indicators of Telecommunications Infrastructure, Singapore vs. Other Asian Countries, 1999

Telecommunications Infrastructure	Telecomm Investment as % of GDP [a]	Main phones lines per 1,000 population[a]	Cell phone subscribers per 1,000 population[a]	% Digital phone lines, 1999[a]	CATV subscribers per 1,000 population[a]
Australia	.94%	520.50	343.29	100.0%	30.36
China	1.93%	85.82	34.18	99.9%	47.36
Hong Kong	1.10%[b]	575.65	636.10	100.0%	67.97
India	.54%[b]	26.56	1.89	99.8%	37.07
Indonesia	.19%	29.06	10.61	100.0%	n.a.
Japan	.71%	557.53	449.35	100.0%	131.59
Korea	1.73%	437.88	500.29	73.9%	150.28
Malaysia	.90%	202.97	136.97	100.0%	5.18[b]
New Zealand	.57%[b]	495.71	366.07	100.0%	4.39
Philippines	1.24%	38.85	38.28	99.0%	9.40
Singapore	.55%	481.97	418.84	100.0%	53.16
Taiwan	1.12%	545.16	522.41	100.0%	201.02
Thailand	.29%	85.70	38.44	100.0%	2.40
United States	.28%	673.00	315.55	91.6%	251.34
Asia Pacific[c]	.94%	95.95	56.37	98.0%	44.53
OECD[d]	.54%	508.28	325.44	93.8%	140.02

[a]*Source:* International Telecommunication Union, World Telecommunication Indicators. Geneva: International Telecommunication Union, March 2001.
[b]Data for 1997 used

TABLE 7
Indicators of IT Infrastructure and IT Industry, Singapore vs. Other Asian Countries

IT Infrastructure	IT as % of GDP, 1999[a]	PCs per 1,000 population 1999[b]	IT Hardware Production, US$M 1999[c]	IT Hardware Exports, US$M 1998[c]
Australia	3.33%	469.97	$915.72	$849.06
China	1.13%	12.24	$17,750.00	$10,169.00
Hong Kong	1.32%	297.59	$1,703.45	$10,834.19
India	.53%	3.31	$730.27	$193.70
Indonesia	.35%	9.08	$980.00	$754.00
Japan	2.06%	286.94	$53,727.73	$26,753.25
Korea	1.61%	181.80	$6,982.50	$5,165.00
Malaysia	1.70%	68.71	$8,864.80	$9,566.33
New Zealand	3.81%	328.02	$123.66	$80.11
Philippines	.78%	16.92	$2,070.00	$2,800.00
Singapore	3.22%	436.61	$24,568.86	$29,937.13
Taiwan	1.34%	197.04	$20,903.10	$21,638.97
Thailand	.63%	22.71	$7937.20	$7,608.70
United States	4.14%	517.07	$85,085.21	$37,967.00
Asia Pacific	1.81%	30.72	$147,257.30	$126,349.40
OECD	3.09%	285.55	$221,159.20	$169,573.80

[a]*Source:* International Data Corporation, The 1999 IDC Worldwide Black Book, IT is defined as "the revenue paid to vendors (including channel mark-ups) for systems, software, and/or services:
[b]*Source:* International Telecommunication Union, World Telecommunication Indicators. Geneva: International Telecommunication Union, March 2001.
[c]*Source:* Reed Electronics Research, The Yearbook of World Electronics Data, 2000. Surrey, UK: Reed Electronics Research, 2000.

Human Resources for E-Commerce

As highlighted in Wong (1996), Singapore has a relatively well-developed ICT workforce, due to the significant public policy effort to promote the development of ICT skills since the establishment of the National Computer Board (NCB) in the early 1980s and the formulation of the National IT Plan in 1985. In addition to active public programs to train IT professionals and consistent public subsidies to private sectors to provide such training, the rapid growth of IT skills in Singapore also benefited from a generous labor immigration policy to attract IT talents from around the world, particularly India and China where the supply is abundant and the wages are much lower. According to two IT manpower surveys conducted in the mid-1990s, foreign IT manpower accounted for over 25% of the total stock of IT professionals in Singapore (Wong et al., 1997).

The significant size of the specialized IT professional labor force is complemented by relatively high levels of basic IT literacy among the general labor force, especially the younger cohorts. At the time of political independence, Singapore inherited a largely immigrant adult population with a relatively low level of education compared to Hong Kong and several other developing countries. Although the government has invested heavily in education since the 1970s, the average number of years of education among the adult working population remained below those of Hong Kong, Taiwan and Korea well into the 1990s due to the long gestation period for the older, less educated cohorts to retire from the labor force. However, such aggregate average statistics masked the very rapid pace of educational upgrading among the younger generation. In particular, the introduction of IT in primary and secondary educational institutions in Singapore in recent years has been among the most extensive in the world. In addition, extensive public programs to provide basic IT training to working adults has significantly raised the level of IT literacy among the general workforce, as evidenced by the very high ranking of Singapore workforce IT literacy by employers as reported in the World Competitiveness Report (IMD, 2000).

Financial and Legal Institutions

As part of its economic development strategy, Singapore has consistently pursued a prudent, conservative approach to financial system development, with emphasis on strong regulatory controls to ensure the integrity and trust-worthiness of the banking system. Although Singapore has steadily introduced new financial services in its financial system, the pace of change has been incremental and controlled, and with few exceptions, usually took the form of adopting proven practices from the advanced countries. Similarly, while foreign firms have been freely allowed into international financial services such as offshore money markets and merchant banking, foreign entry into the domestic consumer banking markets had remained tightly regulated. For example, while a shared ATM system was developed among the local banks, foreign banks were barred from joining in the same system. The issuance of credit and debit card by banks was also closely supervised, and until 1999, the listing requirements on the local stock exchange were relatively stringent. Reflecting the above, the rating of Singapore's financial system in the Global Competitiveness Report 2000 was mixed: While Singapore was ranked relatively high in terms of financial regulation and supervision (6^{th}) and financial risk rating (3^{rd}), her ranking was lower for overall sophistication of financial market (10^{th}), due partly to low rating on competition in domestic banking (37^{th}) and ease of raising money through the local stock market (26^{th}).

This cautious approach to financial system development in the past has both positive and negative implications for e-commerce development. On the one hand, the system's reputation for prudence and trust-worthiness will be a positive factor in encouraging companies worldwide to engage in e-commerce financial transactions mediated by Singapore-based financial institutions. On the other hand, the slow pace of financial deregulations in the past is likely to have discouraged new Internet-based financial innovations in Singapore. Although the pace of financial deregulation has quickened in the last two years, with the government actively encouraging the local banks to merge and internationalize, they have remained relatively conservative entities compared to the US and UK.

One area where rapid change has occurred recently is in the development of the venture capital industry. Although the venture capital industry started in Singapore in the mid-1980s, its growth over the years has been gradual until the late 1990s (Wong, forthcoming). Moreover, the VC funds tend to be invested in later-stage rather than early-stage ventures. The big change came in late 1999 when the government made a decision to imitate the Silicon Valley venture capital model by setting up a US$1 billion "Technopreneurship Fund" to attract and co-invest in new venture capital funds to be set up in Singapore. As a result, the venture capital industry in Singapore grew strongly in 1999 and 2000, with a significant proportion invested in IT- and Internet-related start-ups (Reynolds, Hay et. al. 2001). While this development should in principle have potentially significant positive impacts on stimulating e-commerce innovation, unfortunately, the meltdown of Nasdaq had made most venture capitalists cautious in funding new Internet-related ventures, notwithstanding the large amount of funds that have been raised.

Singapore has also developed a strong international reputation for its sound, trust-worthy legal system for commercial transactions. In contrast to the financial system, however, the legal system has been much more aggressive in embracing IT and promoting innovative use of the Internet to improve the efficiency and speed of operation of the legal system. While the well trusted legal system of Singapore is an unambiguous positive factor for e-commerce adoption, privacy concerns may become an issue in the future.

Summary of National Environment for E-Commerce Readiness

In summary, our review of the national environment for e-Commerce Readiness suggests that Singapore enjoys various favorable conditions for e-commerce development, including a highly open, competitive economy with a good mix of advanced manufacturing activities and sophisticated financial and business intermediary services, efficient transportation and telecommunications infrastructure, a compact, cosmopolitan and affluent population with multi-cultural regional links yet sharing the use of English as a common medium of communication, a relatively large pool of specialized IT talents and high penetration of IT literacy among the general population, and a transparent and well trusted financial and legal system.

At the same time, these varied positive factors are likely to be offset by a number of distinct disadvantages, chief amongst which are the very small domestic market, the lack of a critical mass of entrepreneurial ICT talents with deep links to Silicon Valley and other high-tech hot spots, and a relatively less developed geographic hinterlands with low e-commerce readiness, political uncertainties and potential economic rivalry and trade frictions.

In addition to these clearly negative factors, one can also question whether some of the supposedly positive historical factors identified above may turn out to be impediments as well, depending on our assessment of the likely directions of evolution of e-commerce activities and their consequent impacts. The literature on revolutionary technological change suggests that a strong position in an incumbent technological paradigm may be an impediment, rather than a facilitator, for successful performance in a new technological paradigm; core competence may turn into core rigidities, and established leaders may be subject to "creative destruction" or "leapfrogging" by new or later entrants. For example, Singapore Telecoms had been a relatively efficient telecommunications services operator in the past, contributing crucially to the development of Singapore as a regional telecommunications hub. However, there is a danger that the company, even with privatization, may be too wedded to its voice, circuit-switch technology and integrated carrier services business model to aggressively embrace new technological innovations (e.g. VOIP, SIP) and business models (e.g. NTT Docomo's business alliance/revenue sharing model with content providers), which in turn may stifle downstream innovations in new e-commerce applications. Similarly, a large pool of middle-aged IT professionals steeped in legacy systems and outdated software technologies may not be easily re-trained and re-deployed to develop the next generations of e-commerce innovations. Moreover, an advanced, mega transportation hub may be rendered less competitive if e-commerce enables smaller ports to improve their efficiencies to by-pass the mega-hubs.

The above concerns notwithstanding, our analysis above points a number of plausible prognosis on the likely trends and pattern of e-commerce diffusion in Singapore. Specifically, our analysis above suggests that Singapore is likely to be a very fast adopter of e-commerce applications that have relatively proven economic value model in other advanced countries, especially the US where e-commerce developments have been most advanced. In particular, advanced manufacturing industrial clusters in Singapore with strong global supply chain links to advanced countries (like electronics and aerospace), logistics and transportation industries, and other global market oriented, business-to-business industries are likely to be the most aggressive in adopting e-commerce applications. Not only are these sectors most likely to benefit from e-commerce applications given the global scale and highly complex nature of the production networks and transactions involved, they are also most likely to be subjected to pressure exerted by demanding, global customers.

In contrast, we predict that Singapore will be less able to innovate new e-commerce technologies or pioneer revolutionary e-commerce applications with radical global impacts, due to the small local market and the inadequate development of an ICT entrepreneurial community with extensive networks in the Silicon Valley and other hotspots like the wireless technology hubs in Sweden and Finland. The small, compact domestic market with efficient transportation also means that Singapore is unlikely to be a leader in large-scale business-to-consumer e-commerce applications, while the lack of a strong content publishing industry is likely to constrain Singapore's ability to innovate in e-commerce applications involving the mass consumer contents publishing or syndication model.

In summary, Singapore is likely to be a very fast-follower in the diffusion of e-commerce applications, which have relatively proven business models in the US and other advanced countries, but is less likely to pioneer radically new e-commerce technologies and business applications. The only possible exception is "e-Government" applications, where likelihood for the public sectors in Singapore to pioneer new internet-based public services may be greater due

to the long-term commitment of the government in exploiting IT to improve services efficiency, and the relative ability of the public sector to attract and keep IT talents due to the relatively lucrative career opportunities offered in public sector agencies, in contrast to their counterparts in most other countries.

Public Policy Initiatives on E-Commerce

As highlighted in Wong (1996, 1998), the Singapore government has played an active role in promoting ICT diffusion and industry development since the early 1980s. Indeed, Singapore was probably one of the few developing countries in the world that had taken a comprehensive approach to ICT diffusion promotion, which forms part of a larger integrated information economy strategy to leverage ICT for economic development. This larger strategy involves promoting the four components of a digital economy: the ICT goods manufacturing sector, the information content sector, the network infrastructure sector, and the "informatization" sector (Wong, 1998).

To the extent that e-commerce applications can be regarded as largely falling under the "informatization" component, e-commerce promotion appears to be a natural extension of the earlier government policy focus on promoting ICT usage by businesses and households, the main difference being that, while previous efforts were based on proprietary systems and networks, the new efforts are targeted at IT applications over the Internet. Indeed, it can be argued that the Singapore government has already embarked on promoting the development of e-commerce in a significant way prior to the arrival of the Internet, as can be witnessed from the early implementation of the widely known TradeNet system for automating trade document exchange using proprietary, closed EDI network technology. Similarly, the release of the "Intelligent Island Vision (IIV)" document in 1992 by the National Computer Board, which aimed to wire the entire country with a broadband national information infrastructure (NII), can also be interpreted as an attempt by the government to promote the use of pervasive information network to facilitate new services and applications, even before the emergence of the Internet. It is true that, because much of the NII design assumptions made in the IIV had been made outdated by the unanticipated explosive growth of the Internet, the public ICT policy in Singapore lost coherence and focus for a number of years, before a clear focus on promoting Internet-based applications finally emerged in late 1996. In what follows, we briefly outline the new policy initiatives targeted at Internet-based e-commerce applications.

Overall Policy Initiatives

The Singapore government's e-commerce policy initiatives went through a number of iterations. A tentative E-commerce Hotbed Programme was first introduced in 1996 with the aim to develop the e-commerce legal and technical infrastructure, and e-commerce services. In 1998, a more comprehensive Electronic Commerce Master Plan was published. This envisioned exploiting the Internet to develop Singapore into an international e-commerce hub by building upon its established strengths in international trade, international financial services, telecommunications and IT systems. The plan also aimed to create an e-commerce services sector, and to harmonize cross-border e-commerce laws and policies. The target of the 5-year plan was to have US$4 billion worth of products and services transacted electronically through Singapore, and 50 per cent of businesses to use some form of e-commerce by the year 2003.

To achieve these targets, the E-Commerce Master plan proposed five main policy thrusts:

- To develop an internationally linked e-commerce infrastructure
  An internationally linked e-commerce infrastructure is seen as vital for strengthening Singapore's position as a business hub in Asia. In particular, the financial and logistics sectors have been identified as playing a key role in driving this thrust. An efficient settlement system for Internet transactions between businesses, covering international trade payment and multi-currency payment, is proposed for deployment over the next two years. A well-connected logistics infrastructure was also proposed to support the requirements for the delivery of physical goods. The intent is to position Singapore as a centre of e-commerce infrastructure development, where international infrastructure players in areas such as trading platforms, trust management and rights management systems will develop and deploy their services using Singapore as a hub:
- To jump-start Singapore as an e-commerce hub
  This initiative focuses on the sectors in which Singapore has an inherent advantage as a hub, especially in business-to-business services. These advantages include a stable and excellent financial infrastructure, a transport and logistics infrastructure that is well known for its efficiency, and strong telecommunications connectivity and e-commerce infrastructures. Incentive schemes and other support programmes will be used to attract international and local companies to base their e-commerce hub activities in Singapore. An international publicity plan is to be developed, and trade shows will be used to promote Singapore as an e-commerce hub:
- To encourage businesses to use e-commerce strategically
  Under this thrust, education and other support programmes will be put in place to help businesses exploit e-commerce to enhance their productivity and competitiveness. Simple and easy to use trading platforms are being provided, and a usage promotion drive will be launched to bring about widespread participation of SMEs. To ensure a steady supply of business and technical work force, businesses will be encouraged to invest in retraining of their work force through incentive programmes:
- To promote usage of e-commerce by the public and businesses
  This thrust is intended to enable the citizens and businesses to enjoy the benefits that e-commerce can bring, and at the same time, create an e-commerce savvy culture. Mass education efforts will be used. In addition, e-commerce will be taught in business and professional courses in the universities and polytechnics. The government itself will be setting the pace to proliferate the use of e-commerce in Singapore through its electronic Public Services initiatives. Key public services will be delivered electronically by the year 2001; and
- To harmonize cross-border e-commerce laws and policies
  This thrust is key to enable businesses to trade confidently with overseas partners. Besides putting in place legislation that is internationally consistent, Singapore will work with its major trading partners to align each other's e-commerce laws. Efforts have already been initiated with Canada, Australia and Germany. Singapore will also continue to participate actively at major international fora to bring about international agreements on harmonization of e-commerce frameworks.

The subsequent implementation of the Masterplan can be analyzed in terms of several components: direct subsidies to promote e-business adoption and the development of e-business services industry; changes in regulations and policy framework to facilitate the diffusion of e-

commerce activities; promoting the adoption of e-commerce within the public sector itself, and promoting the development of supporting telecommunications infrastructure.

E-Business Industry Development Promotion Programs

Arising from the E-Commerce Master plan, a number of incentive schemes were introduced by IDA. After some experimentation, the incentive programs were streamlined into two schemes with a combined total of US$30 million program allocation. The two schemes are:

The eBusiness Industry Development Scheme (eBIDS)

This program aims to promote and accelerate the increase in online adoption by companies, EC transactions and total EC value for Singapore. eBIDS is targeted at companies that already have the existing EC capabilities and wish to expand further on their e-Business Value Creation. These companies will include EC exchanges and hubs. Designed as a performance-based incentive programme, eBIDS is administered and managed by the Infocomm Development Authority (IDA). IDA funds companies proportionately based on the total EC value created, up to a maximum of S$500,000. The funding is tied to the actual online transaction value brought about by the proposed project, and is limited to one e-Business project per year per company.

The Jumpstart Program

This program is introduced to focus on the local enterprises' e-Business infrastructure needs. To qualify, a company must satisfy the following criteria:

- It must have at least 30% local shareholding (Singaporean or Singapore PR);
- Its fixed assets (at net book value) must not exceed US$15 million; and
- If it is in the service industry, the employment size must not exceed 200 workers.

Managed by PSB, the Jumpstart Programme is designed to extend existing computerization incentives for local SMEs to the adoption of e-business activities, including the use of applications through the Applications Service Provider (ASP) model. These applications include customer relationship management, electronic resource planning and supply chain management. Under this plan, solution providers will be required to comply with an ASP industry code of practice or ASP industry best practices. The code of practice helps to ensure delivery of good service level to end-users. Jumpstart Programme will support up to 50% of the qualified EC related consultancy, subscription fees for up to 12 months, and hardware and software purchases. Unlike the existing local enterprise computerization program, which only funds one project per company, Jumpstart Programme allows local enterprises to apply for more than one EC project, provided that each is for developing a different EC capability. However, the incentive will be capped at S$20,000 per company.

Besides these subsidy schemes, the government also extended existing tax incentives for attracting direct foreign investment to new investments in the area of e-commerce technologies, services provision, and internet media/publishing. In particular, the government introduced a new cyber-trader act, similar to existing regional headquarter incentives and international procurement/trade office incentives, that provides reduced tax incentives for companies that generate a significant proportion of their revenues from e-commerce transactions involving

parties overseas. This scheme was used to attract the likes of Dell and HP to use Singapore as their e-commerce transaction administration hubs (even though, for example, Dell uses Penang, Malaysia for the warehousing and logistic fulfillment of the actual physical goods). The government also intensified the wooing of new media publishing and distribution company.

Changes in E-Commerce Regulations and Policy Frameworks

As part of the implementation strategy of the E-Commerce Masterplan, several basic legal and technical infrastructures to support secure and reliable e-commerce have also been in place since 1998. These include:

- Electronic Transactions Act
- Intellectual Property Rights
- Amendments to the Evidence Act
- Content Regulation; and
- Tax Issues

Electronic Transactions Act

In July 1998, the Electronic Transactions Act (ETA) was enacted to provide a legal foundation for electronic signatures, and gives predictability and certainty to contracts formed electronically. Singapore is one of the first countries in the world to enforce a law that addresses the issues that arise in the context of electronic contracts and digital signatures. The ETA follows closely the UNCITRAL Model Law on Electronic Commerce, which is setting the framework for electronic laws in many countries. The ETA addresses the following issues:

- Commercial code for e-commerce transactions - The commerce code for electronic transactions was enacted in order to create a predictable legal environment for EC and clearly define the rights and obligations of the transacting parties. It also deals with legal aspects of electronic contracts, use of digital signatures, concerns for authentication and non-repudiation;
- Use of electronic applications and licenses for public sector - In order to promote a culture of use of electronic transactions in the public sector, the ETA contains an omnibus provision through which Government departments and statutory boards can accept electronic filings without mending their respective acts. It also allows public bodies to issue permits and licenses electronically;
- Liability of service providers - While recognizing the importance of service providers in providing information infrastructure and content, the act also addresses the impracticality in having service providers check all content for which they merely provide access by specifying that service providers will not be subject to criminal or civil liability for such third- party material. The clause, however, will not affect the obligations of a network service provider under any licensing or other regulatory regime established under the law; and
- Provision for a Public Key Infrastructure (PKI) -Singapore has been developing a Public Key Infrastructure as a foundation for a trusted and secure environment in electronic commerce. In line with the PKI development, the ETA provides the appointment of a Controller of Certification Authorities (CAs) to enable regulations to be made for the licensing of CAs including cross-certification of foreign CAs.

Intellectual Property Rights

On September 1998, Singapore acceded to the Berne Convention for the Protection of Literary and Artistic Works. Consequently, works first published in Singapore, as well as works created by citizens and residents of Singapore, will be entitled to copyright protection in more than 100 countries that are parties to the Berne Convention.

There have also been recent changes to the existing Copyright Act to incorporate the concerns of Internet publishers. In particular, the Copyright (Amendment) Bill 1999 reinforces Singapore's commitment to ensure that its intellectual property laws concur with underlying principles in the World Intellectual Property Organization Copyright Treaty 1996 and the World Intellectual Property Organization Performances and Phonograms Treaty 1996. The amendments to the Copyright Act extended copyright protection and enforcement measures for copyright owners to the digital environment, and clarified the rights and obligations of copyright owners, intermediaries such as network service providers and users such as educational institutions.

Amendments to the Evidence Act

The Evidence Act was amended in 1997 to allow the use of electronic records as evidence in the courts.

Computer Misuse Act

The Computer Misuse Act defines a class of critical computer systems and provides them with greater protection. To deal with new potential abuses of computer systems, the Computer Misuse (Amendment) Bill 1998 was introduced in Parliament on 1 Jun 1998. It was passed on 29 Jun 1998 and came into force on 1 Aug 98. The amended act takes a more sophisticated approach to provide for enhanced penalties proportionate to the different levels of potential and actual harm caused. It also addresses new potential computer abuses such as denial or interruption of computer services and unauthorized disclosure of access codes.

Content Regulation

Singapore has a 3-prong approach to Internet content regulation. First, a class license scheme was instituted to provide minimum standards to safeguard values and promote healthy growth. The class license scheme is an automatic licensing scheme that requires IASPs and content providers to comply with an Internet Code of Practice. IASPs are not required to monitor or censor Internet content. They are however, required to limit public access to 100 mass impact pornography sites, as a statement of Singapore’s values as a society. Personal communications, such as email or Internet relay chat; personal websites and corporate Internet use by employees or for business transactions are not regulated. The licensing scheme was also extended to cover websites that are deemed to engage in political statements; these websites need to register with SBA. To complement this public regulatory approach, the government also seeks to encourage industry self-regulation and actively conducts public education programme to promote parental supervision.

The Internet content regulation policy of the Singapore government has been criticised by overseas commentators as a restriction against freedom of speech. It is difficult to know, however, if the regulation has any significant impact on e-commerce development in Singapore.

Tax Policy

E-commerce activities in Singapore are currently subjected to income tax and Goods and Services Tax (GST). The standard operations text applies to determine income tax liability: any Internet based operation based in Singapore which is deemed to be a revenue generating center is liable to be subjected to income tax. For businesses selling goods over the Internet, the same laws, which exist for charging GST in the offline world, would apply. In particular, a registered GST trader will need to charge GST for goods delivered to a local location. Goods that are shipped overseas are exempt from GST, but the necessary documents need to be maintained. Goods received from overseas exceeding S$400 in value would attract GST unless exempted; importantly, digitized goods imported from overseas are exempted from GST.

Promotion of E-commerce adoption within the Public Sector

The public sector itself has adopted a lead-user role in using Internet to improve both services for the public as well as to streamline internal operations. For example, several EC applications have been launched by various government agencies, including the following:

- Government services – for example, Central Provident Fund (CPF) Online services, Inland Revenue Authority of Singapore (IRAS) e-filing of income tax, building plan submissions, applications and car parking fine payment services etc. (Urban Redevelopment Authority)
- Business-to-business transactions -- for example, the Ministry of Defense Internet Procurement system (MIPS), TradeNet Plus for Trade and Customs declarations and transactions, and Public Procurement and Tender Bidding via the net by various government agencies
- E-Learning applications – for example, the National University of Singapore has implemented comprehensive web-based systems that facilitate extensive usage of the web for administration, teaching and research.

More generally, under the e-Government initiative, all government agencies are exhorted to invest aggressively in e-business applications to streamline internal operations and improve internal communications and knowledge management.

Telecommunications Infrastructure Development

The government initiated a gradual process of deregulating the telecommunications market in the early 1990s, giving the privatized public telecommunications operator Singapore Telecoms an extended period of monopoly over fixed line domestic and international telephony services (Wong, 1997). However, the rapid growth of the Internet and advancement of telecommunications technologies, especially wireless technologies, had evidently surprised the government, forcing it to subsequently accelerate the deregulation and liberalization of the telecommunications sector. The period of monopoly by Singapore Telecoms was prematurely ended through a compensation payment by the government, and competition in carrier services has been increasingly encouraged through more liberal granting of licenses. However, the

government continues to limit the number of ISPs, as well as maintaining the ban on satellite receiver dishes for household use.

To promote the adoption of broadband multimedia applications, the government initially promoted the development of a broadband backbone network called the Singapore ONE providing fiber to the "block" as a "contracted service" to be provided by Singapore Telecoms as part of the privatization agreement. To facilitate competition, the government also encouraged the deployment of a cable TV network linking all homes in Singapore by a Singapore Cable Vision (SCV), and allowing it to enter into telecommunications services, including the provision of high speed Internet using cable modems. The intention was to promote a controlled, "dualistic" competition between cable and telephone wire to eventually bring broadband services the home, while excluding satellite broadcast (Wong, 1996). However, rapid technological change in wireless technologies had again forced a re-think on government policy, whereby further competition was being allowed through wireless local loop access.

Following the examples of UK, France and Germany, the Singapore government similarly sought to promote the development of 3G wireless infrastructures by announcing the offering of three licenses for auction. However, the adverse market reactions to the 3G license auctions in the UK and Germany resulted in more than one postponement of the auction exercise and repeated lowering of the reserve price. Eventually, only two licenses were awarded to the two largest incumbent telecom operators at the reserve price. The government also sought to encourage the development of new wireless Internet applications by offering "test-bed" grants to participating parties. However, the main obstacle to more wireless innovation by new start-ups appears to be not the lack of public subsidies, but the vertical integration approach of the established telecoms operators.

Institutional Development

The launching of new policies and programs to promote E-Business is paralleled by the introduction of significant changes in the institutional structure of governmental agencies involved in the regulation, development and promotion of ICT industry and diffusion. The most significant change was the decision in 1999 to merge the previously separate National Computer Board (NCB) under the Ministry of Trade and Industry (MTI) and the Telecommunications Authority of Singapore (TAS) under the Ministry of Transport and Communications into a new, single agency called the Infocomm Development Authority (IDA) under a new and enlarged ministry called the Ministry of Information and Communications Technology (MICT). This is done clearly in recognition of the growing convergence of telecommunications and computer technology. However, I believe the government has been too slow to make this institutional reform, and as a result, valuable time was lost in putting in place a more systematic and integrated policy framework for promoting the Internet business sector. Moreover, the government has stopped short of a fully integrated response to the converging world of the Internet, by opting to keep the existing Singapore Broadcasting Authority (SBA) under the Ministry of Information and the Arts separate from IDA. With the regulation of Internet content still falling under the SBA, IDA does not have the full jurisdiction over all aspects of the Internet. In addition, ambiguity also emerged between IDA and the Economic Development Board (EDB) in terms of responsibilities in promoting the Internet and e-commerce industry, as the latter has the broad mandate of promoting investment in manufacturing and services industry.

Last, but not least, recognizing the growing importance of the Silicon Valley model which has been phenomenally successful in spawning fast-growth, high tech start-ups, including in particular the dot.com booms, the government launched an ambitious programme to promote high tech entrepreneurship in Singapore (Wong, 2001c). Called the Technopreneurship 21 Initiative (T21 for short), the programme launched among others, a US$1 billion fund to promote the development of Singapore as a venture capital hub for Asia; incentive programmes to encourage the setting up of incubators, facilitate business angel investment, remove bureaucratic red tape against start-ups; and relaxing listing requirements on the Singapore stock exchange to improve public market exit by high tech start-ups lacking profitability records. While the National Science and Technology Board (NSTB) was initially given the responsibility to spearhead the T21 initiative, various government agencies were also involved in varying degrees through the setting up of a Ministerial coordination committee comprising of representatives from the Ministry of Trade and Industry, Ministry of Information and Communications Technology, the Ministry of Education, and the Ministry of Manpower, among others. Although the dot.com boom in the Nasdaq provided the impetus for the speedy introduction of the various T21 programmes in 1999, they are likely to be sustained after the recent Nasdaq meltdown, as increasing emphasis is placed on promoting Singapore as a high tech innovation and commercialization hub. A decision was made to move the T21 implementation functions to the EDB in early 2001, while NSTB became more focused on promoting R&D in general and within the public R&D institutes and universities in particular.

Summary Assessment of Public Policy Initiatives

As the above accounts indicate, the government has continued to pursue an active approach to promote e-commerce diffusion and innovation, similar in spirit to earlier efforts at promoting IT diffusion and industry development under the IT Master Plan of 1985 and the Intelligent Island Vision of 1992. While it is too early to assess the impact of these new initiatives, overall, the broad visions appear to be well-articulated, and the actual policies and programmes introduced so far appear to be in the right directions and conducive for e-commerce development. However, as our analysis above suggests, most of the new policies introduced were imitations of policies introduced elsewhere, and there was nothing really radical being attempted. Moreover, the government appears to have been relatively cautious in introducing a number of the more major changes like the merger of TAS and NCB and the acceleration of telecommunications deregulation. Overall, because of the very rapid changes in communications technologies and e-commerce business models, the government appears to have been mostly reactive rather than pro-active.

Overview of E-Commerce Activities in Singapore

Due to the early stage of development of e-commerce, there is very little empirical data available as yet on the pattern and dynamics of e-commerce diffusion across countries. Table 8 summarizes the available aggregate indicators of e-commerce adoption in Singapore vs. selected countries in Asia. As can be seen, in terms of the number of secure servers per 10,000 populations, Singapore ranks third after Australia and New Zealand in 1999. Singapore similarly ranks quite high in terms of estimated B-to-B and B-to-C e-commerce expenditure to GDP ratio, being third highest in Asia behind only Australia and Taiwan. However, in terms of the percentage of people who have purchased online, the 5% penetration rate in Singapore appears to be not that high, behind Australia, Hong Kong, Japan and Korea.

The relatively high ranking of Singapore in Asia as shown in Table 8 is corroborated by the World Competitiveness Report 2000, which ranked Singapore as number 4 in the world in terms of electronic commerce infrastructure and number 1 in Asia, based on respondents' subjective ranking on a 1-10 Likert Scale (Singapore's score of 7.71 ranks below USA's 8.06, Iceland's 7.75 and Finland's 7.73).

TABLE 8
Indicators of Internet Infrastructure, Singapore vs. Other Asian Countries

Internet Infrastructure	Internet hosts per 1,000 population 1999[a]	Internet users per 1,000 population 1999[a]	Access cost, 40 hours, off-peak, US$ 2000[b]
Australia	57.58	316.84	$33.85
China	.06	7.03	n.a.
Hong Kong	17.09	361.57	n.a.
India	.02	2.81	n.a.
Indonesia	.10	4.30	n.a.
Japan	20.84	213.90	$85.65
Korea	9.84	231.76	$27.13
Malaysia	2.70	68.71	n.a.
New Zealand	71.12	183.69	$34.80
Philippines	.17	6.72	n.a.
Singapore	38.08	243.99	n.a.
Taiwan	27.02	205.50	n.a.
Thailand	.66	13.15	n.a.
United States	195.00	271.74	$35.40
Asia Pacific[c]	1.94	23.75	n.a.
OECD[d]	62.63	180.05	n.a.

[a]*Source:* International Telecommunication Union, World Telecommunication Indicators. Geneva: International Telecommunication Union, March 2001. ITU definitions: *Internet hosts* refers to the number of computers that are directly connected to the worldwide internet network (note, however, that the statistic is based on country code in host address and may not correspond with actual physical location); *internet users* is an estimate of the number of internet users.

[b]*Source of data:* OECD, Working Party on Telecommunication and Information Services Policies, Local Access Pricing and E-Commerce, July, 2000, Table A6. The 40-hours, off-peak refers to 40 one-hour calls with the measurement taken at 20:00.

Although the picture is still patchy, the above aggregate indicators do suggest that Singapore has so far not lagged much behind in e-commerce diffusion relative to other leading countries. At least at this stage of evolution of global e-commerce, Singapore is not visibly slow in embracing e-commerce relative to its level of GDP/capita and ICT infrastructure development. Moreover, as expected from our earlier analysis, B-to-B e-commerce development appears to have been significantly more advanced than B-to-C.

To get a more detailed assessment of the likely impact of individual national environmental factors require more in-depth data on e-commerce adoption by specific sectors and applications.

There have not been much detailed empirical studies on the development of e-commerce in Singapore at the level of specific industrial sectors or application segments. The earliest comprehensive survey of e-commerce activities in Singapore commissioned by IDA was in 1999 (IDA, 1999; Wirtz and Wong, 2001). Subsequently, the Department of Statistics released its first

annual survey of E-Commerce activities in Singapore (Wong and Lam, 1999). In what follows, we highlight the relevant findings from these two surveys.

The survey of B-to-B E-commerce in Singapore in 1999 covered five major economic sectors that were thought to have the greatest potential for e-commerce adoption: electronics manufacturing, chemicals manufacturing, aerospace repair and maintenance services, logistics services (freight forwarding, courier delivery, warehousing), and publishing (Wirtz and Wong, 2001). Overall, the survey found that only 8.5% of the firms in these sectors were already using B-to-B EC in some form, with another 28% expressing interest to do so in the near future (see Figure 1). The penetration rate was highest among electronics manufacturers (14.9%), followed by freight forwarding (9.2%) and publishing (7.8%). Chemical manufacturing (2.6%) and aircraft manufacturing, maintenance and repair (1.6%) had the lowest penetration rates. This is as expected from our earlier analysis, given the high degree of global supply chain involvement in the first two sectors. Also as expected, large firms had much higher adoption rate (16.9%) than small firms (7.8%), and foreign firms more than local firms (11.4% vs. 7.6%).

Among firms that were already using B-to-B EC or were expressing interest to do so, more were engaged in using the Internet for procurement than for selling (36% vs. 28%). Among firms already procuring through the net, the overwhelming majority (93%) was procuring less than S$100,000 (less than US$60,000) per month. Similarly, over 92% were selling less than S$100,000 worth of goods or services per month through the net. Among firms that procured through the net in 1999, the dollar value of procurement through the net accounted for only 7.8% of all procurement value, compared to 6.6% twelve months ago, and projected to increase to 12.4% twelve months later. In contrast, firms that are already selling through the net reported that as much as 18.8% of their sales were mediated through the net, vs. 8.7% twelve months ago and projected to increase to 24.4% twelve months later.

Among companies that had not adopted e-commerce, and indicated no interest to do so, by far the biggest reason cited was that they did not see it as necessary (65%) while another 8.1% preferred to “wait and see.” This is consistent with our earlier analysis that most companies are still not convinced that there is a compelling need to adopt e-commerce, due at least in part to the lack of proven models.

TABLE 9
Indicators of E-Commerce Development, Singapore vs. Other Asian Countries

E-Commerce	Secure servers per 1,000,000 population 1998[a]	Secure servers with strong encryption per 1,000,000 population 1998[a]	B-to-B trade in US$M 2000[b]	B-to-C trade in US$M 2000[b]	% Internet users who purchased online in past month 2000[c]
Australia	33.70	16.87	$5,160.55	$394.09	10%
China	.01	.00	$954.37	$72.88	n.a.
Hong Kong	10.32	1.81	$1,773.28	$135.42	7%
India	.01	.00	$675.72	$51.60	5%
Indonesia	.05	.02	$110.48	$8.44	3%
Japan	3.39	1.13	$29,618.20	$2,261.84	20%
Korea	.82	.19	$5,164.42	$394.39	16%
Malaysia	1.08	.55	$311.85	$23.82	5%
New Zealand	23.73	7.65	$632.33	$48.29	n.a.
Philippines	.04	.01	$111.70	$8.53	2%
Singapore	21.18	8.02	$1,097.84	$83.84	5%
Taiwan	1.85	.32	$3,842.73	$293.46	4%
Thailand	.10	.05	$432.15	$33.00	1%
United States	54.29	38.39	$449,900.00	$38,755.00	27%
Asia Pacific	.51	.20	$49,885.63	$3,809.59	n.a.
OECD	17.77	11.47	$588,900.80	$52,184.17	n.a.

[a]*Source:* Netcraft. http://www.netcraft.com. Strong encryption is defined as having a key length greater than 40 bits (systems limited to a 40-bit key are classified as 'weak' since it has been shown that messages encoded using a 40-bit key with RC4 can be broken in about a week by a good computer science student using facilities available in a good computer science lab).

[b]*Source:* Forrester Research Inc., Global eCommerce Model, 2000.

[c]*Source:* Taylor Nelson Sofres, Global eCommerce Report, 2000. Data are from a survey conducted in 27 countries. Internet users are defined as someone who has personally used the Internet in the past month; an online shopper is an Internet user who has bought or ordered goods or services on the Internet during the past month.

The lack of readiness of their business partners (customers, suppliers) as well as lack of readiness by the firm itself also appears to be important impediments to the adoption of e-commerce. Cost is another barrier for companies using or considering e-commerce (Table 10). These barriers seem to overweigh apprehensions about skills and competence to implement e-commerce. This observation clearly suggests that there is a significant network effect in e-commerce adoption.

TABLE 10
Top 5 Barriers for Adoption of B-to-B E-Commerce

	Non-interested firms	Interested firms	Current users
1st choice	Security issues	Set-up/ Maintenance costs	Set-up/ Maintenance costs
2nd choice	Customers not EC ready	Lack of in-house competence	Suppliers not EC ready
3rd choice	Company not EC ready	Suppliers not EC ready	Security issues
4th choice	Suppliers not EC ready	Company not EC ready	Customers not EC ready
5th choice	Lack of in-house competence	Customers not EC ready	Lack of in-house competence

Source: Wirtz and Wong (2001)

The survey by the Department of Statistics did not go into the factors influencing e-commerce activities, as it focused primarily on capturing the amount of e-commerce spending by firms.

Although there are incompatibilities in definition of what constitute e-commerce, the survey confirms the relatively higher development of B-to-B e-commerce compared to B-to-C e-commerce (Wong and Lam, 1999). It also confirms the higher diffusion rate of e-commerce in the electronics manufacturing industry and the logistics-related industries.

In summary, the preliminary empirical evidence available to-date appears to be broadly consistent with our earlier analysis about the likely trends and patterns of e-commerce development in Singapore.

Likely Socio-Economic Impacts of E-Commerce

Given that e-commerce is still at its emerging stage in Singapore, it is too early to assess its socio-economic impacts so far. Nevertheless, based on the analysis presented earlier, a number of likely long-term impacts can be identified:

- Economic impact at the firm, industry and national level: Given the open nature of the Singaporean economy and the small domestic market size, a majority of Singaporean firms are producing tradable goods and services for the regional and global markets, and as such, there is very little shielding of these firms from global competitive pressure in general and e-commerce induced competitive pressure in particular. Unless these firms can quickly adapt to e-commerce practices being adopted by globally competitive firms elsewhere in the world, they will be eliminated or get acquired by global firms over time. An interesting example is the recent trend of global consolidation of the contract manufacturing industry, whereby a number of leading Singaporean contract manufacturing firms were acquired by the global leaders and became integrated into the global supply chain management systems of these global giants (Natsteel Electronics by Solectron, JIT by Flextronics, and Omni Industries by Celestica). It is also possible that the loss of competitiveness induced by e-commerce may occur at the industry level, resulting in a shift away from Singapore of a significant proportion of whole industries. There is significant concern that this may happen to, for example, the financial services industry, if the on-going global consolidation of certain financial services (fund management, forex, investment banking, wholesale insurance, etc) into a small number of mega-financial hubs accelerates. For this reason, the government has been exerting pressure on the existing local banks to merge and internationalize. While it is likely that this industry concentration trend may be offset by the rise of new industries made possible by e-commerce (e.g. data centers, e-learning services), in the short term the former is likely to be more significant than the latter;
- Impact on social inequalities: Despite the best intention of the government to promote IT literacy among the population and encourage re-training especially among the older workers, it appears inevitable that there will be increasing social inequalities arising from the pressure of global competition in general and of growing "Digital Divide" between the younger, more IT-savvy workers and to older, less IT-literate workers. Already, income inequality has started to increase in recent years, after a period of decline in the 1980s. Structural unemployment has become an increasing phenomenon affecting the relatively unskilled, older workers. Even among IT professionals, structural unemployment is emerging, whereby middle-aged IT professionals experienced in legacy IT systems are finding it difficult to compete with younger IT professionals who are savvy with the latest Internet and e-commerce technologies (Java, XML, etc.). Even if they are prepared to re-train, firms may

still prefer to employ the younger professionals rather than offer the middle-aged the same jobs at salaries lower than commensurate with their years of experience; and

- Impact on government-citizen relationship: Unlike many other countries, the public sector in Singapore has been very aggressive in investing in ICT and e-commerce technologies to improve public services. Despite some notable failures (e.g. the attempt in the early 1990s by Singapore Telecoms to push Teleview, a proprietary teletext technology that was later quickly over-taken by the open-standard Internet), it is likely that this fast mover (and in some cases, pioneering) adoption strategy by various Singapore government agencies will result in some significant innovations and breakthroughs in "e-government" services. At the same time, concerns with protection of privacy is likely to rise as an increasing proportion of transactions with the government is conducted digitally via the net. Finally, as the population becomes more educated and has increasing access to the net as a communication tool, new forms of social community organizing and political expression may emerge, exerting pressure for change to the existing state-citizen relationship.

Conclusions

In this paper, we have attempted to highlight the likely global/regional and national environmental factors affecting e-commerce adoption in Singapore. Our summary assessment is that, in aggregate, Singapore appears to have relatively high readiness for e-commerce development. Indeed, preliminary evidence available suggests that e-commerce development in Singapore has been relatively high by international standards, and that the broad pattern of diffusion is consistent with our prediction based on the assessment of facilitating and impeding factors. Overall, as e-commerce as an innovation is still at an early stage of evolution, the biggest factor impeding greater adoption in Singapore in the near term is likely to be the newness and unproven nature of the technological applications, even on a global scale, rather than any internal national factors. Unless and until e-commerce investment has demonstrated a greater economic impact through a sufficient number of successful role models, and competitive pressures from rival adoption are beginning to emerge, the pace of diffusion is likely to be constrained, notwithstanding various active government policy initiatives to promote their development.

Although still preliminary, the development of e-commerce in Singapore seems to suggest that the earlier investment by Singapore in ICT infrastructure has strongly facilitated the subsequent development of e-commerce. In this regard, e-commerce development in Singapore so far appears to primarily build upon, rather than significantly disrupt, the prior infrastructural investments. The e-commerce development pattern by sectors in Singapore also seems to suggest that Singapore's high dependence on global MNCs has been a positive facilitating factor, rather than a negative one. The sectors that have been most advanced in adopting e-commerce -- notably the electronics manufacturing and logistics industries -- have been the most highly dependent on global MNCs and have been the most closely linked to the global production networks. In this regard, Singapore's strength in physical transportation infrastructures appears to have been an advantage, rather than a liability, as a result of e-commerce developments.

Last, but not least, Singapore's very high rate of ICT adoption in the 1980s and early 1990s has been due in large part to active government promotion policies and intervention programs (Wong, 1996, 1998). It is not clear at this early stage whether such an active government role continues to be advisable in promoting e-commerce development in the future, or perhaps, as

some scholars have argued, that the role of the state would become counter-productive in the e-commerce era, given the astonishing pace of change and chaotic uncertainties regarding business models that the internet revolution has spawned, making it impossible for any state agency to pick winners or even to provide guidance. It is our belief that there will be a continuing role for public policy intervention in promoting e-commerce development in Singapore, but the specific roles will be quite different from the ones adopted in the past. In particular, we believe that greater policy emphasis will need to be made in promoting technological innovation and market entrepreneurship, especially in a country like Singapore that has traditionally relied on DFI and under-estimated the importance of indigenous technology entrepreneurship. How public policy can contribute to the creation of a critical mass of e-commerce entrepreneurs in Singapore will be an important research area in the future.

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