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Measuring the Diffusion of Information and Communication Technology in Society and its Effects: Canadian Experience

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Abstract

Statistics Canada has measured the use of information and communication technologies (ICTs) for close to 15 years in industry and more recently in households and it has developed a body on knowledge on the effects of the use off these technologies. While ICTs have long been used in manufacturing processes, the use of computers and networks, and a growing number of ways of accessing networks, are changing the way business is done and lives are led. This paper provides examples of ICT use in private and public institutions, in households, and by individuals. It goes on to illustrate the consequent development of electronic commerce and of other uses of the Internet and concludes with some implications for the development of official statistics in light of policy requirements.

1 Introduction

Statistics Canada has been measuring the use of ICTs for most of the past 15 years. Over this period, the data collected have evolved in keeping with shifts in the policy focus of the federal government policy departments (particularly Industry Canada). In the 1980s, the focus was on measuring the use and diffusion of ICTs, as one of a number of advanced technologies used in the manufacturing sector with a view to measuring and improving the competitiveness of the Canadian manufacturing sector.

Since then, the environment facing Canadian businesses and society has changed giving rise to a greater demand for data. Globalization, declining costs associated with the use of ICTs, the deregulation of the telecommunications sector and the rise of the Internet as a medium to facilitate or conduct business have all contributed to the growth in the use of ICTs. Measuring the use of ICTs in the manufacturing sector was not sufficient in this changing environment. Statistics Canada responded to this challenge by expanding coverage of ICT use surveys to include the entire private sector, the public sector and households. These surveys now include detail on the use of the Internet and electronic commerce. The statistical program measuring the supply side has also been improved.

Content has evolved along with coverage. Statistical programs now seek to describe some of the social and economic impacts of the use of these technologies. Associated with the characteristics of the economic agents, those using the Internet (for instance) can be contrasted with the characteristics of those that do not.

This paper shows how Statistics Canada has modified and adopted its program of measuring the use of ICTs. It demonstrates how this evolution has coincided with the evolution of Canada's political, social and economic environment. Finally, it shows how these official statistics can have an impact on policy or change public discourse on the use of ICTs.

2 Evolution of the statistical program

The statistical program relating to the use of ICTs currently involves measurement of the demand for and use of these products and services by Canadian businesses, governments and households. It also includes the measurement of the infrastructure providing these products and services. This was not always the case.

Initially, the tools to measure the use of ICTs were ad-hoc and industry specific. Most of these surveys focused on the manufacturing sector. These included: the 1987 and 1989 Surveys of Manufacturing Technology (Statistics Canada 1998, 1991), the 1993 Survey of Innovation and Advanced Technology and the 1998 Survey of Advanced Technology in Canadian Manufacturing (Sabourin and Beckstead, 1999). These surveys measured the use of a basket of advanced manufacturing technologies (AMTs), including the use of ICTs. These data were used to classify industries by propensity of firms to use the technologies analyzed by country of control, size and geography.

The 1999 Survey of Information and Communications Technologies and Electronic Commerce focused on the use of ICTs and expanded coverage to include almost all public and private sector enterprises.[1] Released in August 2000, the data in this survey provided a baseline measure of the use of computers, e-mail, and the Internet. The survey also provided measures of the extent to which public and private sectors had developed web sites, and engaged in electronic commerce, including the value of sales over the Internet. Barriers to electronic commerce were also identified (Bakker 2000).

This survey was repeated in 2000 under the title: Survey of Electronic Commerce and Technology. In addition to the data above, estimates have been released on the use of Intranets, Extranets, wireless communication, EDI on non-proprietary networks and electronic funds transfer (EFT). The 2000 survey yielded a richer dataset on electronic commerce that included not only the value of sales over the Internet but also the percentage of these sales made to households (B-C) and businesses (B-B) as well as export sales.

Measurement of households' use of computers and the Internet have also evolved since the mid 1980s. From 1986 to May 1997, the Household Facilities and Equipment Survey measured the proportion of households with a computer. From 1994 and May 1997, the same survey measured the percentage of households with a modem and with Internet access. (Dickenson and Sciadas 1996, 1997). From December 1997, all three of these variables have been measured in the Survey of Household Spending.

Starting in 1997, the Household Internet Use Survey (HIUS) measures Internet Use, regardless of location (i.e. home, work, school, and public libraries). It also identifies the characteristics regular users of the Internet. The survey allows for estimates of Internet penetration rates by household income, family type as well as age and education of the household maintainer. The survey also identifies how households use the Internet (Dickenson and Ellison 1999, 2000). Starting with the 1999 HIUS, Internet purchases and "window-shopping" from home by regular use households was tracked (Ellison, Earl and Ogg, 2001).

HIUS, using the household as the sample unit has not yet described *individual* users of the Internet. While households can have an income, they cannot have an education or a sex. The 1999 General Social Survey asked individuals (as opposed to households) about their use of the Internet, the impact of technology on privacy, access to information and the social cohesion of families and communities. (Dryburgh, 2001).

These surveys on the use of ICTs form only half of the picture. On the supply side, the survey programs for telecommunications and cable services have been redesigned. April (2000), for instance, gives a baseline measure of Internet services provided by cable companies. The Quarterly Telecommunications Survey provides information on both wireline and wireless industries. The redesigned annual surveys on computer services and Internet service providers have also been put into the field.

3 Shifting policy environment

The evolution of the statistical program has been a response to the policy environment. The policy priorities of the mid-1980s were not the same as those of the 21st century. Statistics Canada's approach has had to be nimble in order to provide relevant and timely information to contribute to the policy debate (de la Mothe and Paguet, 1999). This section describes how federal government policy has

[1] This survey was administered as an attachment to Statistics Canada's Capital Expenditure Survey. This survey excludes from its sampling frame agricultural and construction industries as well as municipal governments.

shifted from the mid-1980s and how information from the statistical agency can be used to support policymakers.

3.1 Technology diffusion

In the 1980s and 1990s, the Canadian government was promoting the use advanced manufacturing technologies (AMTs) as a way to maintain or improve its competitive position, in an increasingly global market. The policy department could then single out industries identified as lagging behind in the use of AMTs and promotion policies could then be adopted to support adoption and use.

The surveys on the use of AMTs made research possible on the diffusion of these technologies. Baldwin and Rafiquzzaman (1998) linked the results of the 1993 survey of innovation to the Annual Survey of Manufacturers and found that geographical proximity to the technology plays a significant effect in the diffusion of AMTs. Canadian firms adopted domestically available technologies faster than technologies from foreign countries. Canadian plants adopted the use of AMTs before foreign controlled plants. Also, newer plants adopted newer technologies sooner than older plants.

3.2 Networks and the plant

Surveys of the use of advanced manufacturing technologies in the 1990s showed a growing role for ICTs. Programmable controllers were overtaken by computers used for process control. There was also more use of local area networks (LANs) in the plant as well as wide area networks (WANs) linking the plant to suppliers and clients. ICTs supported the 'just-in-time' (JIT) delivery and shipping of goods and the statistical process control (SPC) needed to maintain production quality as productivity grew. All of these changes in technologies had implications for skill levels of the labour force, for trade, training and productivity. The links to suppliers and clients, and the monitoring of the production process ensured that ICTs enabled the production plant to respond quickly to market signals, such as price changes, supply shortages, or market opportunities. However, ICTs were not sufficiently pervasive to support higher level modelling of the economic and social environment by the firm.

3.3 Surveys of innovation

The 1990s also saw the appearance of surveys on innovation as part of official statistics in Canada and in Europe. The policy interest was in the introduction of new or significantly improved products to the market, and the introduction of new processes, as part of wealth generation. That interest gave rise to the Community Innovation Survey in member countries of the European Union, and to various surveys in Canada. The most recent Canadian survey of innovation in manufacturing for 1999 (Schaan and Anderson, 2001) showed that a third of the innovative firms in manufacturing were involved in co-operative or collaborative arrangements as part of the process of innovation. Innovative firms sought ideas for innovation from trade fairs, suppliers, clients, conferences and from Internet. In all of these activities, ICTs were present as facilitating technologies permitting firms to gather, process, and use knowledge about themselves and their environment, past and present, in order to take decisions about their future.

3.4 Deregulation and technological improvements

Since the first measures of the use of ICTs, there have been important technological developments. Computers have become more powerful and their prices have declined. Recent surveys confirm the high rate of computer penetration in households and businesses. In 1999, half of Canadian households had a computer, compared with 10% of Canadian households in 1986. In 2000, 81% of private sector enterprises had a PC or workstation. Over half of all private sector employees (58%) had direct access to a computer.

In the 1990s, the telecommunications industry was deregulated with a view to promoting increased competition. Competition was expected to lower prices and to encourage increased use of ICT products. The use of wireless communications has progressed, beyond the analogue systems of the

mid-1980s to digital PCS networks. From the Household Facilities and Equipment Survey and the Survey of Household Spending, the number of households that reported having a cell phone rose from 14% in 1986 to 32% in 1999. According to the quarterly Survey of Telecommunications, the number of digital mobile subscribers (business and household) surpassed analogue subscribers by the end of 2000.

Currently, broadband is spreading, allowing for more products and services to be offered on-line to more people. Industry Canada has struck an industry-led National Broadband Task Force that will guide the government in the formation of a national broadband strategy.

3.5 The digital divide

With the increasing availability of ICTs (quality, quantity and cost), the focus has expanded to include questions about who takes-up the use of these technologies as well as who does not use them and how the two groups differ. This digital divide separates not only individuals and households, but also communities, public institutions and firms.

In 2000, 53% of individuals, aged 15 or over, used the Internet from home, work, school or some other location. People that used the Internet were more likely to have a higher income, had more education and were younger than those that did not. Additionally, francophones reported more barriers to the use of the Internet than anglophones (Dryburgh 2001).

While there are gaps, they appear to be narrowing. In 1998, households in the top income quartile were five times more likely to have an Internet connection than a household in the bottom income quartile. By 1999, the top quartile was less than four times more likely. In addition, while Internet use appears to decline with age, the penetration rate for households where the household maintainer is 65 or over had the strongest advances, between 1997 and 1999.

A digital divide also exists in businesses. In general, larger businesses tend to be more connected than smaller businesses. In 2000, for instance, 96% of enterprises with 500 or more employees had access to the Internet. In contrast 65% of enterprises with 1-19 employees were connected.

Larger businesses were also much more likely to use ICTs to facilitate inter-enterprise communication. In 2000, 44% of enterprises had an Extranet and 68% used EDI over a proprietary network. In contrast, for businesses with 1-19 employees, only 3% had an Extranet and 8% used EDI not on the Internet.

3.6 Connecting Canadians

In 1998, the Government of Canada adopted a policy, with the objective of making Canada the most connected country in the world. This strategy of *Connecting Canadians* involves the promotion of universal access of businesses, households and communities to the Internet to support the on-line sales or delivery of products or services, from both the public and private sector.

Data from the Survey of Electronic Commerce and Technology suggest that government is playing a lead role in Internet use. By 2000, almost all federal and provincial government departments had access to the Internet and 96% of these departments had a web site. The level of sophistication of government web sites tended to be greater than that found in all private sector industries. Federal and provincial government web sites were more likely than their private sector counterparts to offer interactivity (two-way communication), digital products, and on-line payment.

All Canadian schools that wish to be are connected to the Internet. In 1999, 15% of households had a member using the Internet from school. This ranked third behind use from home (29%) and work (22%). Also in 1999, 16% of households used the Internet to obtain health information; 13% used the Internet to get government information and 9.2% of households used the Internet for formal education or training.

3.7 Electronic Commerce

The Canadian government's electronic commerce strategy involved the creation of framework conditions that were conducive to performing transactions over the Internet. This includes the creation of a technology neutral taxation regime, the development of policies on cryptography and a public key infrastructure, the development of guidelines to protect consumer protection and legislation to protect personal information.

These policies have the overall objective of promoting e-businesses practices. While the sale and purchase of goods and services is often thought of as the epitome of electronic business, it is only one facet that includes the Internet as a tool to help develop products, communicate with suppliers, arrange for production and delivery and provide after sales service. The official statistics have provided some insight into the reach of electronic commerce into the Canadian economy.

Over half (53%) of Canadian households, in 1999, used the Internet in support of a decision to purchase a good or service, either for research on the commodity (window shoppers) or to actually place an order online. Over half (53%) of these Internet shoppers, in turn, placed an order over the Internet. Canadian households spent $417 million in 3.3 million orders over the Internet in 1999. More than three-quarters of these e-commerce households paid for their purchases on-line. Domestic sales accounted for slightly over half (54%) of orders and 60% of household spending on-line.

From the Survey of Electronic Commerce and Technology, in 2000, private sector sales over the Internet amounted to $7.2 billion.[2] This represented a 72% increase in sales from 1999. Overall, however, sales over the Internet accounted for 0.4% of total operating revenue by the Canadian private sector in 2000. This was an increase from 0.2% in 1999. Overall, sales over the Internet are a rare occurrence and still amounts to be a very small value.

The most often cited barrier to electronic commerce identified by businesses that did not buy or sell over the Internet in 2000 was that their goods did not lend themselves to Internet transactions. This was followed by a preference to maintain current (i.e. face-to-face) business models. Security concerns trailed as a distant third.

4 Impact of Official Statistics

The examples above all show how statistics on the use of ICTs have evolved to reflect the changing technological and policy environment. There have been instances, however, where the official statistics have challenged existing perceptions of reality and hence have changed the public discourse on the use of ICTs and electronic commerce.

Before the release of the results of the Survey of Electronic Commerce and Technology, it was widely held that Internet transactions were becoming more pervasive. Indeed, between 1999 and 2000, the value of sales over the Internet, by the private sector rose by 73%. However, the proportion of businesses selling on-line declined from 10% in 1999 to 6% in 2000. Looking at the enterprises that were in the sample for both 1999 and 2000, for every two businesses that started to sell on-line in 2000, five stopped. Also, in 1999, on-line vendors accounted for 17% of economic activity, rising to 29% in 2000. Electronic commerce, therefore, appears to be concentrated into fewer larger businesses.

The implications of this observation are important. Electronic commerce is certainly not the panacea it was once described to be. Larger, more organized businesses seemed to be taking control of the electronic commerce marketplace, displacing smaller players. Also, the growing level of sales hid apparent volatility among the e-commerce players. Statistics Canada was the first organization, public or private, to publish this observation. This decline in the percentage of businesses selling on-line has changed the public discourse on electronic commerce. Once the statistics were released, the press provided many examples to confirm the finding

[2] Statistics Canada uses the OECD's definition of an Internet transaction to describe electronic commerce. An Internet transaction is the sale or purchase of a good or service over the Internet, with or without on-line payment.

This illustrates how there can be a change in discourse when official statistics are provided, which are timely and relevant and which may challenge private sector data providers. This is a key role for the statistical office.

5 What next?

ICTs, their uses and the regulatory environment continue to evolve. In this section, two sets of indicators are proposed which are likely to grow in significance over the next five years. They relate to electronic delivery of products and, the activities of knowledge management.

Over the last five years, a preoccupation of policy makers has been the development of electronic commerce and the readiness of business to participate in this activity. Statistical offices have responded with surveys of the value and characteristics of electronic commerce in business. At the same time, new technological initiatives, such as broadband delivery and digital television have raised questions about the value of products delivered over the Internet, however sold, and the economic and social consequences of such activity.

Figure 1 illustrates the distinction between electronic commerce and electronic delivery. Electronic commerce is the total of the first row of products sold over computer networks, however delivered, whether electronically or conventionally. The coming preoccupation is with the first column, where the interest is in the characteristics and value of electronic delivery, no matter how the order is placed. The figure also illustrates the potential for change from the 'old economy' of conventional goods, conventionally sold and conventionally delivered to either electronic sales or electronic delivery, or both, in the 'new economy'.

Figure 1: Electronic (E-) and Conventional (C-) Sales and Delivery

	Electronic Delivery	Conventional Delivery	
Electronic Sales	Changes for Services	Changes for Logistics	Total E-sales
Conventional sales	Changes for Services		Total C-Sales
	Total E-Delivery	Total C-Delivery	

Once businesses start to move from conventional to electronic products, the nature of the products, the source of the products and the means of delivery are important. Associated with this will be a "digital product divide". Statistics will be required to identify economic agents (households, businesses, communities) being left behind because they lack broadband access to the Internet.

A second set of indicators relate to the practice of knowledge management. The early use of ICTs in the firm supported the monitoring of the production process and the flow of products from suppliers and to clients. The resulting information, combined with an understanding of the economic and social environment in which the firm operated, provided knowledge which could be managed by the firm (de la Mothe and Foray, 2001). Statistics on the use of the relevant ICTs were captured in surveys of technology use leading, over time, to data on the diffusion of the technologies.

Structural change, as service industries dominated economic activity in the industrialized countries, and pressures on commodity prices and labour costs, resulting from globalization, forced firms to use the increasingly pervasive ICTs to manage knowledge, not just of production and inputs and outputs, but also of the changing environment in which the firm was operating. This elevated the management of knowledge to a strategic level from a tactical one. The use of ICTs included their applications, such as web sites to support electronic commerce and Extranets for sharing knowledge outside the firm. Much of this activity can be captured by surveys of innovation. However, as interest grows, there will be a need for official statistics on the practices of knowledge management as well as on the related use of ICTs.

6 Conclusion

When Statistics Canada started to collect data on the use of ICTs, they were collected as a small part of a larger statistical program to measure the use of advanced manufacturing technologies (for businesses) or household spending. As policies and technologies changed, governments' interests have been directed towards the use of ICTs and electronic commerce. Statistical tools have been sharpened to focus on these activities and broadened to include the entire economy. The contents of these survey programs have been sculpted and will continue to be shaped by the changing priorities. These data will continue to evolve and contribute to an informed public policy debate.

References

April (2000). "Internet by Cable," *Connectedness Series*. Catalogue 56F0004MPE, No. 1, Ottawa: Statistics Canada.

Bakker, Cathy (2000). *Information and Communications Technologies and Electronic Commerce in Canadian Industry*, Catalogue 88F0006XIB No. 4, Ottawa: Statistics Canada.

de la Mothe, J. and Paguet, G. (1999). *Information, innovation and Impacts*, Boston: Kluwer Academic Publishers.

de la Mothe, J. and Foray, D. (eds.) (2001*). Knowledge Management in the Innovation Process,* Boston: Kluwer Academic Publishers.

Dickenson, P and Ellison, J. (2000). "Plugging In: The Increase of Household Internet Use Increases in 1999," *Connectedness Series*. Catalogue 56F0004MPE, No. 1, Ottawa: Statistics Canada.

Dickenson, P. and Sciadas, G. (1996). "Access to the Information Highway", *Canadian Economic Observer,* Catalogue 11-010-XPB, December, Ottawa: Statistics Canada.

Dickenson, P. and Sciadas, G. (1997). "Access to the Information Highway: the Sequel", *Services Indicators,* Catalogue 63-016-XPB, December, Ottawa: Statistics Canada.

Dickenson, P. and Sciadas, G. (1999). "Canadians Connected", *Canadian Economic Observer,* Catalogue 11-010-XPB, February, Ottawa: Statistics Canada.

Dryburgh, Heather (2001). "Changing our ways: Why and How Canadians are use the Internet." Catalogue 56F0006XIE, Ottawa: Statistics Canada.

Ellison, J., Earl L., and Ogg, S. (2001). "Internet Shopping in Canada," *Connectedness Series*. Catalogue 56F0004MPE, No. 3, Ottawa: Statistics Canada.

Sabourin, D and Beckstead, D. (1999). "Technology Adoption in Canadian Manufacturing," Catalog 88F0006XPB no. 5, Ottawa: Statistics Canada.

Schaan, S and Anderson, F. (2001). "Innovation in Canadian Manufacturing: National Estimates", Catalogue 88F0006XIB, Ottawa: Statistics Canada (forthcoming).

Statistics Canada (1988). "Survey of Manufacturing Technology 1987. Final Report," Ottawa

Statistics Canada (1991). "Survey of Manufacturing Technology 1989," *Indicators of Science and Technology*, Catalogue 88-002, vol. 1, no. 4, Ottawa.

Statistics Canada (2001). *The Daily*, April 3. Catalog 11-001E, Ottawa: Statistics Canada.