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ANALYZING E-COMMERCE GROWTH FROM THE PERSPECTIVES OF INNOVATION DIFFUSION

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Abstract

E-commerce was claimed to have come of age in 1996. Yet, five years later and after dramatic growth in E-commerce, there are still people who question the viability of its future. We examine the development of E-commerce from the perspectives of diffusion of innovations. This analysis leads us to conclude that worldwide E-commerce is still in its early growth stage. However, it has passed the "turning point" that marks the characteristic change of diffusion of innovations. E-commerce has achieved the critical mass that is essential to self-sustainable growth.

Introduction

The Internet is considered the most significant innovation since the development of the printing press (Hoffman 2000). The World Wide Web has made the Internet accessible to the general public and greatly accelerated Internet growth. Since the early 1990s, the Internet has brought remarkable changes to nearly every aspect our society. Among those changes is the emerging electronic commerce industry. E-commerce as a new business paradigm has experienced phenomenal growth in the last few years. It is transforming the national and world economy by challenging traditional business models, opening new local and global markets, providing new products and services, building industrial partnership and alliances, establishing seamlessly integrated supply chains, and creating new customer bases and customer relationships. Forrester Research projects that inter-company Internet commerce will reach $1.3 trillion by 2003 and that online retail trade will reach $184 billion by 2004 (Forrester Research, 1999). Other estimates of E-commerce growth vary in specific numbers, but the general consensus in 1999 was that Internet-based commerce was still in its infant stage and its future would be huge and bright. However, the dramatic turn since spring 2000 that saw a large number of ot-coms becoming ot-bombs has cast some doubts on the survivability and sustainability of E-commerce. Hundreds of Internet companies failed in 2000, and still more are predict to fail in year 2001 (Abreu 2001). Also, the recent economy downturn adds more uncertainty to the near future of E-commerce.

As a result, there have been discussions in both academia and industry regarding the viability of E-commerce. In this paper, we examine the development of E-commerce from the perspectives of innovation diffusion. This analysis leads us to believe that the growth of E-commerce will experience setbacks from time to time; but as an innovation, E-commerce has passed the ipping point. There is no turning back. In the following sections, we will discuss E-commerce diffusion and evidences for its continued growth in the future.

E-Commerce Diffusion

Diffusion of innovation is the process by which an innovation is communicated and adopted over time in a social system. Rogers (1995) presented four main elements in the diffusion of innovations: (1) an innovation that is a (perceived) new idea, practice,

or technology, (2) communication channels through which the innovation is spread, (3) a social system in which members react to the innovation, and (4) a time frame that defines the life cycle of the innovation. Although there are many internal and external factors that characterize the diffusion of an innovation, Rogers believes that the diffusion of innovations is essentially a social process in which subjectively perceived information about a new idea is communicated.

Figure 1 shows two typical innovation diffusion processes with different penetration in the potential adopters population. These processes normally start with a slow growth in the first stage. Then at certain (turning) point, the growth accelerates. What follows is typically referred as a take-off period he stage in which the innovation becomes widely accepted. Once the innovation reaches the inflection point, the growth rate starts to decrease. Because of different internal and/or external influences, the diffusion curves may have different growth rates, take-off time frames, and eventual adoption percentages of the population. Typically, the change of growth rate over time resembles a bell-shaped, normal curve.

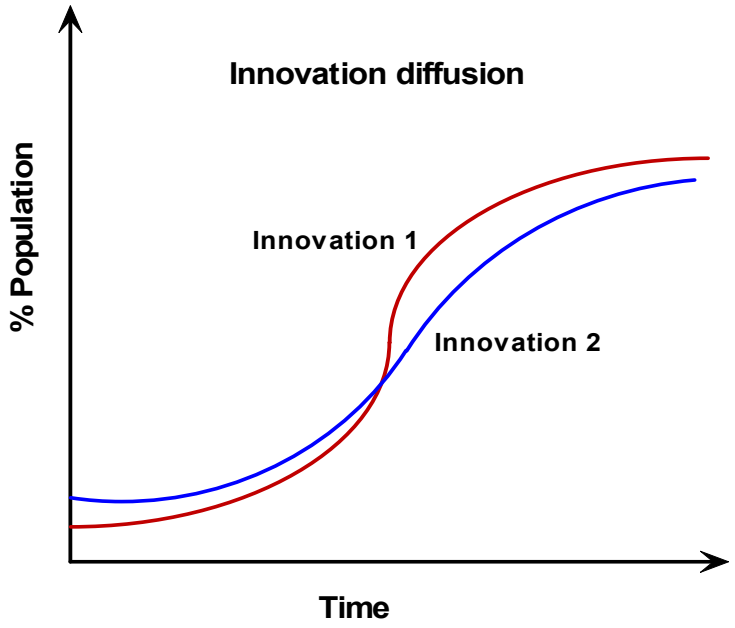

Figure 1. Typical Pattern of Innovation Diffusion

In Rogers framework E-commerce development can be analyzed in all four dimensions of innovation diffusion. First of all, E-commerce can be viewed as an innovation that represents new ideas and practices, even though some may argue that the concept of E-commerce is not really new, as businesses have used electronic data interchange (EDI) for more than thirty years (Sweet, 1999). Rogers (1995) stated, he ewness of an innovation may be expressed in terms of knowledge, persuasion, or decision to adopt. E-commerce is built on the infrastructures of the Internet and the Web that have become widely accessible in the last few years.

Secondly, the diffusion of E-commerce is facilitated by multiple communication sources that range from government policies and regulations, to mass media, to e-marketing and electronic communications between industry and consumers. Mass media channels such as radio, television, and newspapers enable innovative ideas to reach a large portion of the population quickly. Interpersonal channels such as face-to-face meetings, word-of-mouth, and so on do not reach large audiences as do the previously mentioned channels. They are, however, more effective in influencing a potential adopter of the innovation. E-commerce benefits greatly from the vast reach of the Internet and the Web, on which a potential user can easily access information and ideas from many users around the world. Thus, innovation diffusion is inherently a social process; however, in the case of E-commerce growth, technology plays an important role in the diffusion process.

The industrialized countries have embraced computer and information technology advancement in the last 50 years, and E-commerce is finding a receptive social environment. Even developing countries are now beginning to leverage the Internet and the Web to improve their foothold in the global economy (Sharma and Gupta, 2001). Thus, a global social system in which individuals, groups, organizations, and nations engage in cooperative activities has been established. In E-commerce diffusion, the *opinion leaders* are the early adopters of Internet technologies, who have constantly pushed the envelop of information and

communication technologies in pursing the dream of a global, friction-free commerce. The *change agents* that play a critical role in facilitating innovation diffusion are the bold and visionary business leaders. For example, Andy Grove, former CEO of Intel, was widely quoted saying in 1999 that all companies will become Internet companies in the near future. He followed up later in an interview by saying ell, the future is here (Fortune 2000).

The time when E-commerce started is generally considered to be the mid 1990s, although conducting business transactions over electronic networks can be traced back to half a century ago when American Airlines began to use information technology to improve the management of its operations. That effort led to the birth of SABRE, the first computer network based airline reservation system (McKenney, 1995). The time element of the diffusion of innovation considers both individual decision-making process and the aggregated rate of adoption in the population. The individual adoption decision involves five phases: knowledge, persuasion, decision, implementation, and confirmation (Rogers 1995, p. 20).

Knowledge: In this phase, the potential adaptor learns the existence of the innovation and gains an understanding of its functionalities. In E-commerce, the innovation adoption decision becomes easier with the widespread, sometimes hyped, information about E-commerce. The increasing number of Internet users has created a large potential adopter population for E-commerce. Furthermore, the Internet and its users facilitate the spread of the knowledge of E-commerce.

Persuasion and Decision: Opinions and judgments, either favorable or unfavorable, of the innovation are formed during the persuasion phase. The potential adopter enters this phase when he or she starts the process that leads to a choice to either adopt or reject the innovation. The persuasion and adoption decision are guided by the perceived benefits of the innovation. As E-commerce technology matures and the established base increases, the advantages of E-commerce over traditional brick-and-mortar model become more attractive for many individuals and firms. Generally recognized E-commerce benefits to consumers are competitive price, wide (sometimes, global) selection of products and services, quick response to needs, convenience that overcomes the time and space restrictions, customized products and services, no sales pressure, access to information, and education (Sharma and Gupta 2001). Convenience and competitive price are often cited as the key driving forces for online shopping (Iconocast 2000). For E-commerce firms, the advantages are expanded markets, new business opportunities, improved competitiveness, lower operations cost, integrated supply-chain management, industrial alliances, faster response to market change, mass customization, and improved customer relationship management (Schneider 2001, Sharma and Gupta 2001).

Implementation: Once a decision of adoption is made, the innovation is implemented. Depending on the complexity of the innovation, the implementation may be phased or piloted first on a limited scale. The implementation process of E-commerce for individual consumers is relatively easy, assuming that the potential adopters are already Internet savvy. Although online shopping needs only point and click with one favorite Web browsers, starting an E-commerce venture may represent a challenge for most businesses. The challenge is not the infrastructure implementation, which can be purchased or outsourced, but sound business models and strategies that lead to sustained profitability.

Confirmation: In the confirmation phase, adopters look for reinforcement of their adoption decisions. Depending on whether the perceived the value is achieved, the adopters may reverse previous decisions. Recent surveys have shown that online buyers prefer Internet shopping, giving it a higher level of overall satisfaction than brick and mortar stores (Fornell 2000). Thus, for most E-commerce consumers, the adoption of this new way of shopping has been successful. For E-commerce firms, the confirmation stage is a more complex process, as the firms need to devise measures that evaluate the outcomes of the innovation based on their long-term strategic goals.

After a firm has gone through the five phases of adoption decision and the perceived value of the innovation is confirmed, an "infusion" (Kishore and McLean 1998) process will follow. The infusion is the depth dimension of innovation diffusion during which the innovation is put to full and complete use.

The rate of innovation diffusion is determined by the perceived advantages by the potential adopters. The large body of literature on technology acceptance research has well established theories that suggest perceived usefulness and perceived ease of use are the key factors determining the technology acceptance rate (Davis 1989; Gefen and Straub 2000). Rogers (1995, p. 36) puts the key attributes of innovations in five categories: (1) relative advantage, (2) compatibility, (3) complexity, (4) trialability, and (5) observability.

Relative advantages: E-commerce offers relative advantages compared with traditional business models as we have discussed previously. Factors such as competitive price, convenience, wide selections, and comparative shopping may not be attractive for everyone, but each offers added value for certain consumers. For companies engaged in E-commerce, B2B models lead to reduced

cost and increased revenue through tighter integration of business activities with suppliers, customers, and business partners. B2C E-commerce opens opportunities for global reach, improved operations efficiency, and a higher level of customer satisfaction (Fornell 2000).

Compatibility: E-commerce is compatible with traditional businesses in the sense that they are not mutually exclusive. Individuals continue to use both modes for their shopping, guided by their preferences at the time. Companies can operate both E-commerce and traditional business channels. In fact, many companies are now adopting so called "click and mortar" and "brick and click" model, in which they combine the strengths of the reach and convenience of E-commerce and the logistics efficiency and local presence of traditional retail stores. Traditional retailers such as Wal-Mart, Best Buy, and Radio Shack are now offering multiple-channel E-commerce—allowing customers to browse and shop online and pick up or return items at a nearby offline store.

Complexity: The complexity of E-commerce for consumers is low. Since studies have shown that convenience is considered the single most important factor (Iconocast 2000), we would conclude that online shopping is relatively hassle free for most Internet users. The availability of search engines, Web directories, shopping bot (software), and bargain-hunter software agents makes online shopping even more quick and efficient.

Trialability: The easier an innovation can be experimented and observed the more likely and faster it will be adopted. Driven by Moore's law, the computer industry has been growing at exponential speed, resulting in dramatically increased computing power and reduced cost. A robust E-commerce industry has been established over the last decade, providing E-commerce support from network infrastructure to Web hosting and packaged services. Storey et al. (2000) suggested that the E-commerce industry can be divided into ten segments: (1) network access service providers, (2) E-commerce related hardware manufacturers, (3) E-commerce management providers, (4) E-commerce payment/billing services providers, (5) E-commerce payment/billing software providers, (6) E-commerce security providers, (7) E-commerce designers/installers, (8) server-side software providers, (9) client-side software providers, and (10) Web integrating software providers. Even though building a top notch E-commerce Web site may cost millions of dollars, companies can pilot testing E-commerce with demos and trials offered by software vendors and service providers. For consumers, online shopping requires no special skills once they have learned Internet surfing.

Observability: Observation of E-commerce is relatively easy for both consumers and industry adopters. Because of the reach and convenience of Internet communication, Internet marketing, and/or online word-of-mouth communication, have been used effectively to promote E-commerce. Since it is very easy for consumer to use email, online discussion boards, chat rooms, and instant messaging to relay information, person-to-person marketing is becoming increasingly popular on the Web. This form of communication is more persuasive than mass media and adds a new dimension to E-commerce observablity. Bannan (2000) reported a case where a Web site used an online ell-a-friend promotion to increase its membership from 30,000 to more than 500,000. In this particular case, the cost of gaining a new member via online promotion is one hundredth of the cost per member using TV ads.

Classic diffusion theory deals with distinct innovations whose salient features do not change during the diffusion process; for example, the diffusion of facsimile. In this theory, the success of the innovation is measure by the breath dimension; i.e., the percentage of people who adopt the innovation in the population of potential adopters. In classic diffusion literature, which is well documented by Rogers (1995), one of the key concepts of successful diffusion is the *critical mass*—the continued diffusion of an innovation becomes self-sustaining once enough members in the population have adopted it.

Since E-commerce is much more board than a single technology innovation, we should not expect to see the simple diffusing patterns shown in Figure 1. As the underlying technology and social-economic environment change, we anticipate that the diffusion rate for E-commence would vary, and the diffusion pattern would be a composite curve that aggregates multiple innovations (Figure 2). This view is supported by historical data. EDI (electronic data interchange, an early form of E-commerce) had a rather slow and limited diffusion (among the large firms). It experienced significant growth with the arrival of the "new" E-commerce, prompted by the Internet boom (Wojtkowshi and Walker 2001). The next "phase transition" of E-commerce could be facilitated by broadband network technology and ubiquitous mobile computing.

Examining E-commerce from Rogers' framework of innovation diffusion, we find that existing research literature and industrial reports have provided ample examples that E-commerce has indeed all the characteristic of a successful innovation. However, having the necessary characteristics does not guarantee eventual success. We still face questions such as "where does E-commerce stand now in the diffusion curve? Has E-commerce reached the critical mass that supports its continued growth? What are the forces that will shape the future of E-commerce?" We will address these questions after we present some recent data that indicate continued growth in E-commerce.

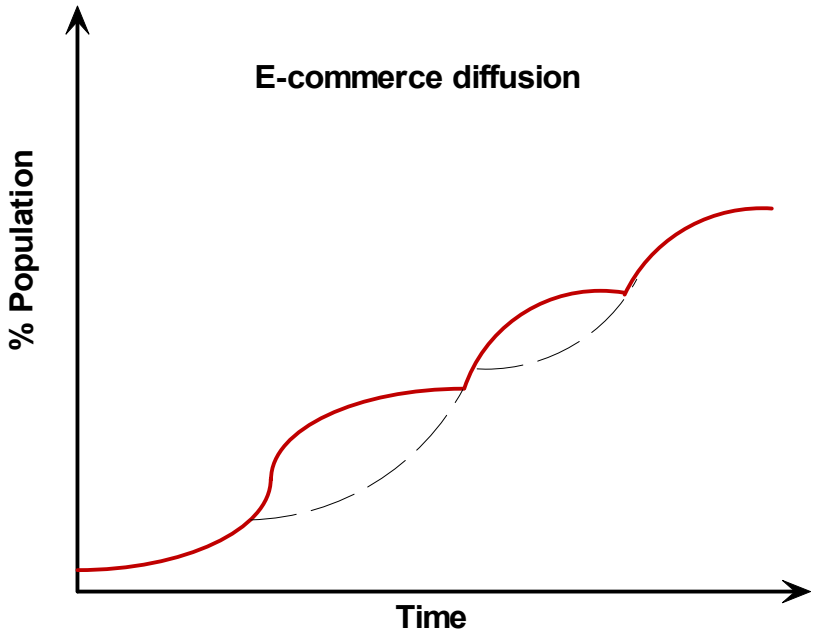

Figure 2. E-Commerce Diffusion is Expected to have Varied Rate

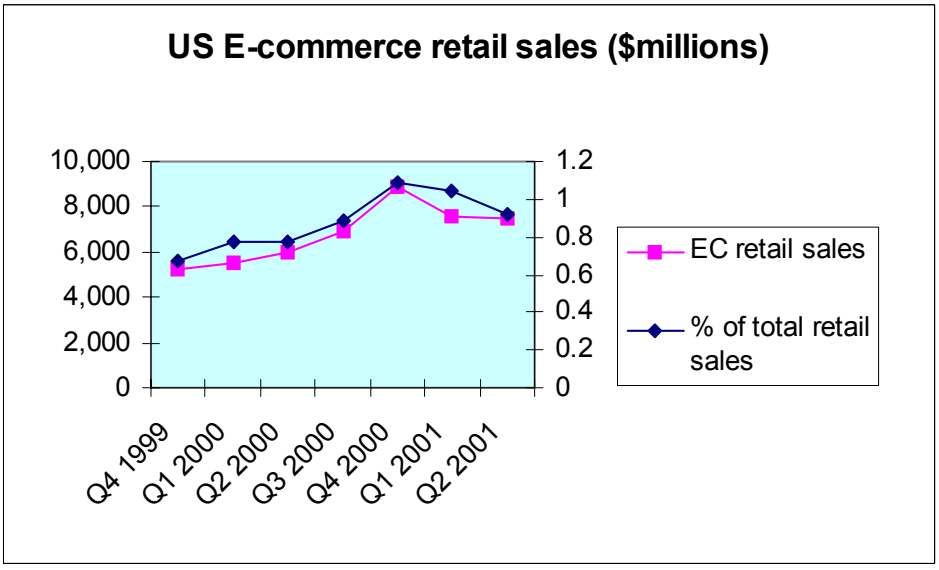

Figure 3. US Retail E-Commerce Growth (Source: US Dept. of Commerce Census)

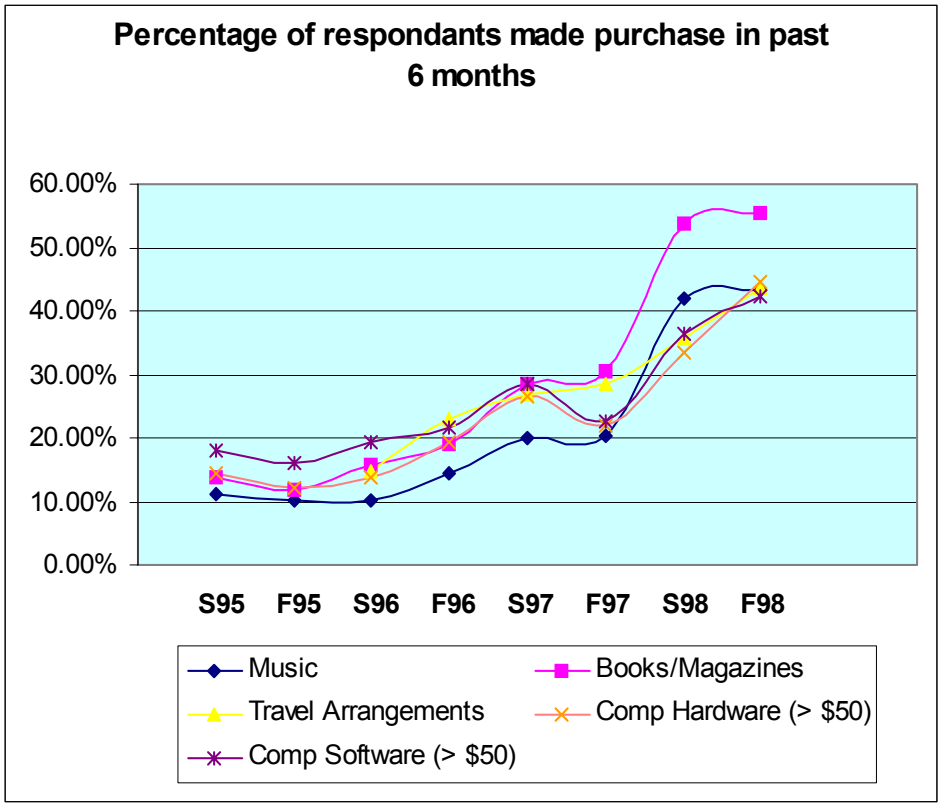

Figure 4. Online Purchase Trend (Source: Ward 2001)

Recent E-Commerce Growth Evidences

Even though the recent crash of technology stock markets and the slump in world economy prompted some people to claim the death of E-commerce, recent E-commerce data portrait a very different picture. The recently released data from the US Department of Commerce shows that B2C E-commerce is still robust in the United States. Although there is decline in E-commerce retail sales in the last two quarters, the data show significant growth over the same quarters last year (Figure 3). Although E-commerce retail sales is still tiny compared with total retail sales, the year to year percentage is also growing.

Online purchasing has shown a growing trend in the past few years (See Figure 4.). Ward (2001) compiled the Georgia Tech University's GUV Web User Survey from spring 1995 to fall 1998. The results indicate a growing proportion of Internet users are becoming E-commerce consumers. Across different product/service categories, in the Fall 1998 survey more than 40 percent of Web users have purchased online during the last 6 months.

Internet users have been growing and the trend is expected to continue in the near future. Figure 5 shows the estimates of Internet users, online shoppers, and online buyers through 2005. What is encouraging for E-commerce is that not only the absolute numbers of online shoppers and online buyers are increasing, but also the percentages of the total Internet users have grown significantly in the last few years (Figure 6). In 2001, the proportion of Internet users who had purchased online reached 70 percent.

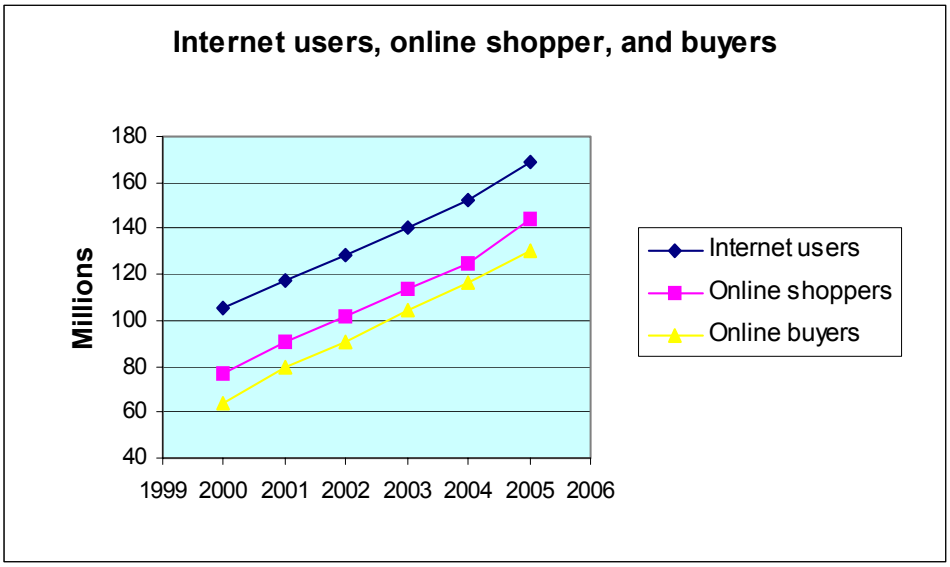

Figure 5. Online Usage Growth (Source: eMarketer 2001)

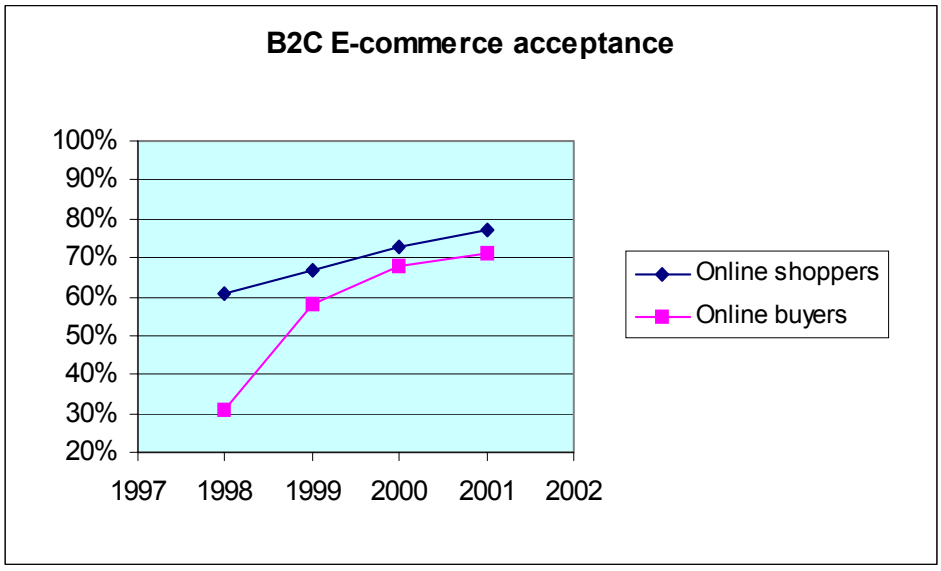

Figure 6. Online Buyer as Percentage of Internet Users (Source: eMarketer 2001)

Discussions

All the aforementioned data—E-commerce sales, Internet users and online shoppers, Internet usage, percentage of Internet users buying online, and E-commerce customer satisfaction—point to continued growth in E-commerce. However, given the recent dot-com bust, there may still be doubt concerning the future of E-commerce. Since we are examining E-commerce development as an innovation diffusion process, we need to answer the following questions.

(1). Has E-commerce reached the critical mass that ensures continued growth?

Harrington and Reed (1996) declare that E-commerce has come to age in 1996. The reasons they gave are (1) E-commerce was no longer the privileged of large corporations—the computer and the Internet revolution had made E-commerce

accessible for anyone with a computer and a phone line, (2) public network and open standards (TCP/IP) put small businesses on an equal footing with large ones, (3) departments and units within companies were able to build direct links with customers and suppliers, and (4) Internet access made it possible to develop new B2C applications.

A quick review of some statistics reveals that dramatic change has occurred since 1996: the number of websites has increased from 50,000 in 1996 (Harrington and Reed 1996) to 33 million in 2001 (Netcraft, http://www.netcraft.com/Survey/), Internet hosts increased from 15 million in 1996 to 160 million in 2001 (Matrix.Net, http://www.matrix.net /index.html), and worldwide online users increased from 45 million in 1996 to 513 million in August 2001 (http://www.nua.ie/surveys/how_many_ online/). If E-commerce had come to age five years ago with less than one tenth of the present network infrastructure and potential adopters (Internet users), there should be little doubt that E-commerce has indeed reached the critical mass for sustainable growth.

Although the total U.S. E-commerce retail sales is still very small compared with total retail sales (about 0.9 %, cf. Figure 3), the number of people online in has reached 166 million, nearly 60 percent of U.S. population (Nielsen NetRatings, August 2001). Using a conservative estimate of 50 percent of those Internet users would shop online results in 83 million E-commerce consumers, which is far above the typical critical mass of 5 to 20 percent of the adopter population. Studies have shown that people tend to use traditional channels for big items such as automobiles; but they also use E-commerce websites to search for information and do comparative shopping for those items.

Given the recent economic slow down, International Data Corp. (IDC) still estimates that worldwide B2B purchasing will increase 83 percent in 2001. In dollar amount, worldwide B2B E-commerce will catapult from $282 billion in 2000 to $4.3 trillion by 2005, resulting a compound annual growth rate of 73 percent. Other estimates vary, but similar significant growth is predicted.

(2). Where does E-commerce stand now in the diffusion curve?

Even though we believe that E-commerce diffusion will not be following a simple smooth S-curve, as discussed in Section 2, it is reasonable to assume that the mega trend would still show the stages of initial *germination*, *early growth*, *accelerated growth*, *inflation point*, *decelerated growth*, and *saturation*. There are not enough data to build a predictive model for E-commerce growth. However, given the strong correlation of Internet users and online buyers (cf. Figure 5), we may use Internet growth data to help us to see the future trend of E-commerce.

Using Internet host data from Internet Domain Survey (http://www.isc.org/ds/), we built a network diffusion model based on classic random network models. Assuming the current Internet global diffusion pattern continues, the network diffusion model forecasts 7 to 10 years of continued significant growth before saturation. The growth rate will peak between year 2002 and 2004, depending on the assumption of potential adopter population size.

Thus, the Internet is still in the accelerated growth stage. Considering the time lag between E-commerce development and Internet diffusion, the logical conclusion would be that E-commerce is still in between *early growth* and *accelerated growth* stage. This is, of course, a very simple qualitative characterization of current E-commerce growth status. The E-commerce growth rate and current status varies greatly in different parts of the world.

Conclusion

We have examined the development of E-commerce from the perspectives of innovation diffusion. Using Rogers' frameworks, we discussed the characteristics of successful diffusion, the phases of a diffusion process, and how those concepts apply to the growth of E-commerce. Further, we summarized recent E-commerce data from various sources and discussed the driving forces for future E-commerce growth. Based on the diffusion frameworks and empirical evidence, we conclude that E-commerce has gained the critical mass needed for sustainable growth, and it is still in the *early growth* stage of the approximate S shaped diffusion curve. This analysis helps us to gain a better understanding of E-commerce development and its future direction.

The varied views of E-commerce future may be a result of biased experiences or information. The industry reports vary greatly in their estimates. For example, the projected B2C E-commerce in 2001 ranges from a low of $37 billions by Direct Marketing Association to a high of $117 billions by Keenan Vision. (Source: eMarketer 2001). We believe that if we look beyond the statistics and put E-commerce development in the framework of innovation diffusion, we will see that E-commerce has a very bright future.

References

Bannan, K. J. preading the Word *Adweek*, June 5, 2000, pp. 24-26.

Chatterjee, D. and Sambammurthy, V. Business Implications of Web Technology: An Insight into Usage of the World Wide Web by U.S. Companies. In *EM - Electronic Commerce in the Americas and Local versus Global Electronic Commerce,* B. F. Schmid, D. Selz, S. Klein, and C. Steinfield (eds), 1999.

Davis Jr., F.D. erceived usefulness, perceived ease of use, and user acceptance of information technology, *MIS Quarterly*, 13 (3), 1989, pp. 319-340.

Fornell, C. Commentary on ACSI 2000 Q3 E-commerce survey. http://www.bus.umich.edu/research/nqrc/Q3-00ce.html. Retrieved October 22, 2001.

Fortune, Have We Hit Bottom In Tech? Monday, November 27, 2000, p. 94.

Gartner Group. Convenience is key for online shoppers, November 2, 2001, http://www3.gartner.com/5_about/press_releases/2001/pr20011031a.html. Retrieved Nov. 5, 2001.

Gefen, D. and Straub, D. The Relative Importance of Perceived Ease of Use in IS Adoption: A Study of E-Commerce Adoption, *Journal of the Association for Information Systems*, 1(8), 2001.

Harrington, L. and Reed, G. Electronic commerce (finally) comes of age, *The McKinsey Quarterly*, No. 2, 1996, pp. 68-77.

Hoffman, D. L. The Revolution Will Not Be Televised: Introduction to the Special Issue on Marketing Science and the Internet. *Marketing Science*, 19(1), 2000, pp. 1-3.

Iconocast. Macroview: Post-Modern E-commerce, Septemer 28, 2000. http://www.iconocast.com/issue/20000928.html. Retrieved Feb 14, 2001.

Kishore, R. and McLean, E. R. "Diffusion and Infusion: Two Dimensions of 'Success of Adoption' of IS Innovations." *Proceedings of the Fourth Americas Conference on Information Systems*, Baltimore, MD. August 14-16, 1998, pp. 731-733.

Krishnamurthy, S. "Person-to-Person Marketing: Marketing and the New Consumer Web", *Quarterly Journal of Electronic Commerce*, 2(2), 2001, pp. 123-138.

Rogers, E. *Diffusion of Innovations*. The Free Press, New York, NY, 1995.

Maes, P., Guttman, R.H. and Moukas, A.G. "Agents that Buy and Sell," *Communications of the ACM*, 42(3), 1999, pp. 81-91.

McKenney, J. L. *Waves of Change, business evolution through information technolog*y. Boston, MA: Harvard Business School Press, 1995.

Nakahara, T. "Technology strategy in a borderless economy," *International Journal of Technology Management*, Vol. 17, No. 6, 1999, pp. 711-724.

Scharl, A, Bauer, C. and Kaukal, M. ommercial scenarios of digital agents deployment: a functional classification, *Journal of E-commerce Research*, Vol. 1, No. 3, 2000.

Schneider, G. P. and Perry, J. T. *Electronic Commerce*, Course Technology, Thompson Publishing., 2001.

Sharma, S. K. and Gupta, J. N. D. E-commerce opportunities and challenges, in *E-Commerce Diffusion: Opportunities and Challenges*. Mohini Singh and Thompson Teo, Editors. Heidelberg Press, Sydney, Australia, 2001.

Storey, V.C., Straub, D. W., Stewart, K. A. and Welke, R. J. "A Conceptual Investigation of the E-commerce Industry," *Communications of the ACM*, Vol. 43, No. 7, 2000, pp. 117-123.

Sweet, D. Giving Them the Business, *Infoworld*, July 26, 1999, pp. E2-E4.

Ward, M. R. On Forecasting The Demand for E-commerce, in *Forecasting the Internet: Understanding the Explosive Growth of Data Communication*s, David G. Loomis & Lester D. Taylor editors. Kluwer Academic Publishers. 2001.

Weber, K. M.and Paul, S. Political forces shaping the innovation and diffusion of technologies: An overview. SEIN Project Paper No. 4, 1999.

Wojtkowshi, W. and Walker, D. EDI Revisited, in *E-Commerce Diffusion: Opportunities and Challenges*. Mohini Singh and Thompson Teo, Editors. Heidelberg Press, Sydney, Australia, 2001.