BANKING ON THE INTERNET AND ITS APPLICATIONS

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Abstract

As the Internet becomes one of the most important communication networks in the world, many Financial Institutions (FIs) had developed their home pages to introduce their products and services to the public on the World Wide Web. However, many large banks do not provide online Internet services where sensitive and confidential information is involved, mainly for security reasons. Although security issues seem to be a concern for the large banks, the picture is different for the smaller ones. Many small financial institutions offer online services which include opening new accounts and processing loan applications. These institutions also plan to add new services to their Internet offerings such as downloading information, including electronic cash onto a smart card. In general, small FIs are ahead of the big ones in using the network power of the Internet as a tool for business expansion.

1. Background

1.1 What is the Internet?

The Internet is a communication/information network consisting of thousands of networks connected together around the world. It has its roots in a network developed in 1969 by the U.S. Department of Defense to meet the requirement for a reliable communication network that could survive nuclear war ([1];[2]). Networks on the Internet are connected to common routers using TCP/IP (Transmission Control Protocol/Internet Protocol). This connection allows the networks to share each other's traffic and in turn provide an efficient and reliable communication system.

In mid-1993, the Internet sprouted multimedia wings. A combination of special software and a way of connecting documents enabled users to travel a huge network loaded with pictures, sound and video. This multimedia side of the Internet was conceived in 1990 and was named the World Wide Web (WWW). The WWW is essentially the Internet made easy to operate through a point and click Graphical User Interface (GUI) such as Mosaic, and more recently Netscape.

1.2 Demographics

The emergence of the WWW and many inherently easy to use web browsers have enabled people around the globe to get "connected" to and "surf" the web. The widespread appeal of the WWW is rapidly developing its own digital culture and economy. Companies world wide are desperately attempting to understand the demographics of the Internet. Recently, CommerceNet (http://www.commerce.net/) and Nielsen Media Research (http://www.nielsenmedia.com) conducted an Internet Survey ([3]; [4]) which details many aspects of Internet use and its users.

The above survey was accomplished using two different sampling methods: collect information from Internet users through online survey questions; and acquire data through telemarketing. The survey identified three types of users in Canada and the USA: (1) Internet users, (2) Online users and (3) Non-users [4]. It is important to note however, that the sample population numbers were extrapolated to provide a picture of the Internet demographics encompassing Canada and the US as a whole. The survey reported the following key findings:

1. 37 million people, aged 16 and above have access to the Internet.
2. Average Internet use per week was 5 hours and 28 minutes (a surprisingly high figure).
3. 66% of Internet Users are males and account for 77% of the traffic.
4. More than 55% of the WWW users have an income of over $50,000.
5. About 50% of the WWW users are in professional or managerial positions.
6. About 64% of the WWW users have at least one college degree.
7. About 52% of the WWW users are younger than 34 years of age.

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1.3 Internet Access

To determine how feasible it is to use the Internet for electronic commerce, it is important to understand how many people have access to the Internet and how many actually use it. The Nielsen survey [3] summarizes the magnitude of Internet Access and Use as shown in Figure 1. The difference between the number of people who have access and those who actually use it suggests that an additional 13 million people could potentially be reached [3] in addition to present users.

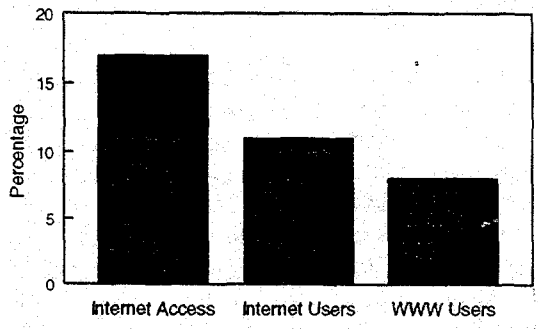

Figure 1. Percentage populations on Internet access and use.

1.3.1 Access Location and Usage. The Nielsen survey also established the location(s) from where Internet access is available and where it is actually used. Results suggest that the Internet access location is predominantly facilitated through the home: 62%; 54% at work and 30% at school [3]. Note that the percentages do not add up to 100% because some people have Internet access from more than one location.

1.4 Opportunities for Business

Since its development, the Internet has been used for research and educational purposes and, in fact, users actively discouraged anyone from using it for commercial applications. However, as companies started to use the Internet, and specially the WWW, it has become a new environment for doing business. The connectivity and resources offered by the Internet represent an unprecedented opportunity for business as even the smallest company can use the network to interact with customers or suppliers anywhere in the world. The massive network allows businesses to reach market niches that are not available in any other way. With today's technology, people can access the Internet if they have a personal computer equipped with a modem. The information on the Internet is available 24 hours a day, 7 days a week anywhere in the world at the user's convenience.

Statistics have shown that the number of commercial entities with an Internet presence has doubled by early 1995 and Internet usage is growing at over fifteen percent a month [5]. As a component of the Internet, the WWW has experienced, and will continue to experience, a phenomenal growth rate. Forrester Research [6] predicts that retail sales on the WWW will grow at a rate of 1,327% between now and the year 2000. Banks are among those commercial entities that established themselves on the Internet. Figure 2 [6] shows the relative business usage of the WWW and selling products/services contributes the smallest portion to the overall Web usage at present. This suggests that there is tremendous growth potential in this area, but this low percentage also suggests that there are some issues hindering the growth. Until these issues are resolved, selling products/services will not be a major business activity on the WWW.

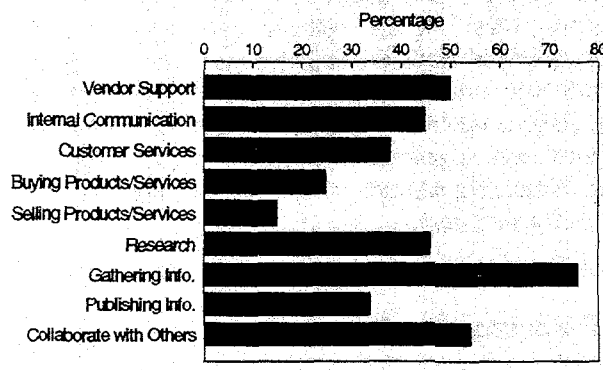

Figure 2. Business related usage of the World Wide Web.

2. Current Trends in Banking

2.1 Existing Self Serve Banking Products

Competition in the banking industry has lead to new products and services. As customers' demand grows for more innovative services and products, banks are using state-of-art technology to improve their delivery channels. Convenient banking is extremely important to today's customers [7] as people are looking for ways to meet their banking needs without actually visiting a branch. Although the automatic teller machines (ATM) have undergone substantial improvements over the years, they cannot handle complex transactions such as financial planning activities. Telephone banking and PC banking on the other hand allow customers to do their banking at home or from wherever they are located at the time.

Figure 3 shows the preference for various banking services to be delivered via PC banking ([8]; [9]).

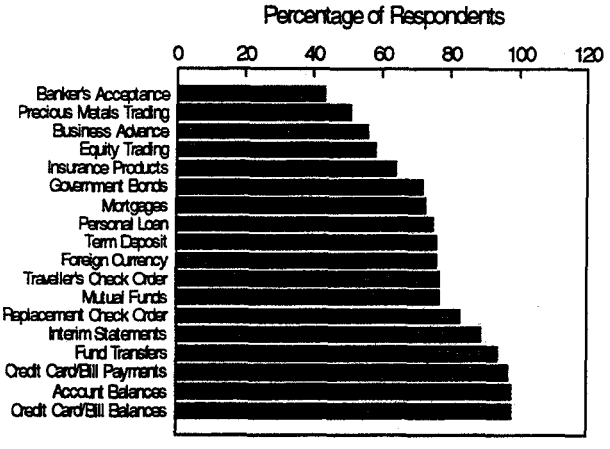

Figure 3. Products/services to be delivered by PC banking based on a survey [8].

2.2 Internet Based Banking

Banking on the Internet is the step beyond or perhaps in parallel with PC banking. A customer who has established an Internet account with an Internet Service Provider (ISP) will already have all the necessary software to perform Internet banking since only a Web browser is required. The actual banking software resides on the bank's servers in the form of home pages. A simple "click" on the appropriate hotlink invokes the browser to connect and request the web page that facilitates the customer's financial service needs. Unlike the PC banking model where several connections and downloading processes must be performed, a bank server on the Internet can offer these functions seamlessly and provide an integrated "snapshot" of the customer's financial affairs. Thus the once arduous method of providing customers with software upgrades, changes in service components or the provision of new information via PC banking can easily be facilitated through Internet banking by simply using the bank's web site as the place for information dissemination. Furthermore, since the actual banking software resides on the bank's server and is utilized only when accessed by the customer, the concern for availability of storage space on the customer's PC is eliminated.

To assist customers in maintaining their personal financial records, software such as Intuit's Quicken, Microsoft's Money, Meca's Managing Your Money and others are available. These software packages are Internet compatible when importing and exporting financial data. Once customers obtain their data from the bank's web site, they can do their own financial planning using these software packages.

3. Objectives

The Internet is emerging as an efficient alternative delivery channel for financial services. With the Internet, banks can be assured of maintaining their own identity and continue to differentiate themselves by offering customized services and financial information through their own home page designs. Therefore, the objectives of this study are to investigate the parameters of bank participation and the potential and real problems they face when introducing banking services on the Internet. We also focus on the strategic use of the World Wide Web and in this context, on the differences between large and small competitors and those in different geographical locations around the world.

4. Methodologies

The first part of the study is to determine the parameters of bank participation. This is done by exploring bank sites available on the Internet. Since there are many Web sites which list the URLs of banks around the world, we have chosen one which lists that information according to the banks' geographical locations. The types of information and services found are classified based on the underlying risks associated with the transaction. The second part of the study compares the strategic use of the World Wide Web between large and small competitors in different parts of the world based on the types of information and services available on their Web pages. One hundred and thirty-four bank sites were studied as of this paper was submitted. These sites were not selected based on specific criteria because we planned to cover as many banks as possible. Therefore the 134 sites studied consist of small banks, large banks and banks with very different business directions.

4.1 Risk Factors

A risk factor ranging from 1 to 10 was assigned to each bank service offered. These risk factors were obtained from the results of a survey we conducted on "Banking Services on the Internet". Paper copies of the survey were given to various age groups and an electronic copy was sent to various discussion groups through email. The demographics of the respondents included university students, administrative personnel; business people, and technical staffs of different industries. Our intention is to

gather opinions from those who have some computer training and have some knowledge about the Interent, since they are more likely to use any Internet service than those who don't know the Internet at all. The age of the respondents ranged from 20 to 55. They frequently use personal banking services, investment banking services and credit card services. A small portion of the respondents uses business and commercial banking services.

The survey gathered information on how bank customers feel about specific Internet services in terms of the magnitude of the associated risk. The total number of respondents was 50. Survey respondents rated each bank service on the survey based on the mount of risk that these services involved in their opinion. A rating of 1 is the least risky and 10 is the most risky. The mean value of the risk factor for each bank service on the survey is used in our analysis. Based on our online investigation, the bank services most offered on the WWW are listed in Table 1 together with the risk factor obtained from the survey.

Table 1. Average Risk Factors Established From a Customer Survey.

Internet Banking Services	Risk Factors
Bill Payment	7
Account Balance	5
Fund Transfer	8
Electronic Mail	3
Cheque Issuance	8
Online Mortgage Application	5
Online Loan Application	5
Online Credit Card Application	6
Downloadable Tools or Forms	3
Electronic Commerce Software/Ability	4

5. Strategic Use of the Internet

In this study, we consider 4 types of activities the banks use the Internet for: promotion, information on products and services, sales literature and banking transactions. These activities are similar to the levels of service mentioned by Alder [10]. Services listed in Table 1 are the only transactions considered in this study. Alder suggested that the lowest service level of online banking is dispensing information about the bank's services, press releases and mortgage rates. The next level includes clients reviewing account activity, obtaining balances on chequing and credit card accounts. The final stage is allowing customers to actually move money between accounts and pay bills online.

5.1 Promotion

Promotion is one of the fundamental uses of the Internet for companies. Because of its massive coverage, the Internet is able to transmit information to users around the world at minimal cost. Like other businesses, financial institutions use the Internet for promotional purposes. These banks and trust companies typically hire professionals to create their home pages on the WWW. These pages are very carefully designed and tailored for the particular company's needs because they are intended to give an overall favourable image of the company to potential clients. There is a great variety here as some of these home pages contain colourful graphics such as cartoons and photographs, others are created with a central theme such as a cyber bank branch (Security First Network Bank). Regardless of what the designer uses in creating the home page, the most important objective is to get people's attention and fulfil the firm's marketing goal. Creating a home page on the WWW is like putting a commercial on television. The prime purpose is to promote the company. One difference between the two media is that images on the WWW can be seen anywhere in the world at any time but television commercials can only be seen locally and at particular times. Many home pages have enjoyed excellent coverage, for example, the Toronto Dominion Bank's home page receives 7 - 900,000 "hits" per week!

At present, there are several "rating" firms which choose the best home page for different industries every month. This creates additional competition for companies. In our experience, which is largely anecdotal, financial institutions with an especially attractive home page are much easier to remember. This is especially true in the case of small U.S. banks. Some of these banks are so small that they may have only one or a few branches in a limited number of states in the U.S.. It would be very difficult for them to make themselves known to the rest of world using local media.

5.2 Products, and Services Information

Out of the 134 sites we have investigated, about 65% contain products and services information. Features of each bank product such as account type, interest rate, service charge and minimum opening balance, are listed on the Web page. Information on different types of services such as mortgages, personal loans and business loans, are provided as well. Many banks also offer the opportunity to request information online; the customers can fill in the appropriate request form displayed on the Web page and submit it online. None of the bank Web sites we visited offers return to the requested information

online at the moment.

Banks that do not have product information on their sites provide other types of information such as research data and analysis with a focus on investment and corporate banking. They have research departments that provide information on money markets, stock markets, the local economy and the world economy in general. Some of the research data are specific to a particular geographical location, such as Spain, depending on the business direction of the particular bank, and in many cases these can be requested online.

Product information and research analyses are provided only on North American and the European banks' Web pages. None of the Japanese banks that we investigated provide such information aside from corporate profiles. In fact, with a few exceptions, most Japanese banks' Web page is in Japanese only. Although we are not sure whether the Japanese version contains additional information, we believe that the English version, where available, does provide us with a general picture of their view on the use of the WWW. We came to this conclusion by looking at the sites in Japanese. These sites contain many pictures and graphics which are easy to understand. In addition, the language consists many Chinese characters that we are able to reconize.

According to our study, about 20% of the banks list statistics on stock prices, mutual fund performance and currency exchange rates on their Web site. Among these institutions, large banks were represented to about 70%. Many of these companies are involved in investment banking and hence products such as stocks, mutual funds and money market transactions are important parts of their business, hence, providing statistics on the performance of these products should attract more customers. For smaller banks, their business focus is on retail banking and business banking on which such statistics are not available.

Another function of the banks' web page is to quickly locate the nearest branch for the customer. We found that 42 out of 134 banks have either listed their branches on their web page or offer, interactively, directions to the nearest bank branch and automatic banking machine once the customer input their address. This is particularly true in the case of small U.S. banks as out of the 42 banks, 23 are small banks with only a few branches.

5.3 Sales Literature

The third function the banks use the WWW is to distribute sales literature. As we browse through the banks' Web pages, one of the most common information on these sites are what we classified as "brochure type" information or "sales literature". These include company profiles, financial reports, and staff profiles which give an overview on the business, its structure and its people. Among the 134 bank sites, 73% does contain this kind of information and by looking at the design of the page, it is easy to see that corporate profile and history is given high priority since in most cases this topic is the first listed among the choices. In fact for Japanese banks, this is the only information on their Web sites which implies that the Japanese, at this time at least, consider the WWW only as an image making media.

Some sites make their corporate profile and financial data downloadable in a special format so that customers might make use of this information if they consider purchasing the banks' stocks. In many cases, personal messages from the banks' executives introduce the bank's business directions as well as its corporate environment. Prior to the development of the WWW, financial data and corporate information were only available in the bank's printed annual and quarterly reports. With the help of the WWW this is readily available to the public as soon as the reports are released. Other materials such as news clippings, special promotions, significant events, branch openings, press releases form the latest news available on every aspects of the bank's operation.

In addition to providing sales literature, responding to customers' request for more information is the other main function of the Web page. We found that 118 out of the 134 banks (89%) studied have electronic mail addresses listed on their Web sites for comments and questions. When we break down these figures into different areas in the world, we found that over 95% of the banks in both the United States and Canada offer electronic mail access, while in Europe, this figure drops to 85% and for Japanese banks, it drops to less than 30%. These figures suggest that financial institutions in North America and Europe adopted the electronic mail system as the most convenient communication method. However, it is a different story for the Asian companies especially for Japan and China. Since the Internet is English oriented, using a keyboard to create a Japanese message, for example, would require the use of software which enables the client to enter the message in Japanese through a standard keyboard. Communicating through e-mail with any language that requires other than English or other character based languages proves to be extremely difficult.

5.4 Transactions, Loan Pre-authorization and Other Services

As listed in Table 1, we looked at the services actually available on the banks' Web site. We divided these

services into several groups: cash transactions, loan pre-authorization, downloadable tools and electronic commerce.

5.4.1 Cash Transactions. Cash transactions include: bill payment, account balance inquiry, funds transfer and cheque issuance. Since these services deal with the movement of cash, they raise the security and confidentiality issues of the Internet. We took two different approaches to establishing the perceived risk (we could not measure the real risk, but "perception is reality") in conducting these types of transactions.

First we assessed the amount of risk involved in these cash transactions from an customer's point of view using a survey we conducted. The survey was sent to various people through e-mail. We think this method is appropriate because Internet banking is not targeted to everyone at the moment. It is focused on individuals who have access to the Internet through direct network connection or from a network access provider.

Among the banking services listed in Table 1, bill payment, funds transfer and cheque issuance have the highest risk factors: 7, 8 and 8 on a 10 point scale respectively. Specifically, bill payment received a score of 8 or greater from 60% of the respondents while funds transfer was so rated by 67% of the respondents, making it the riskiest banking service offered on the Internet. We found a wide range of opinions on obtaining account balances via the Internet, the perceived risk factor scores varied over the full 1 to 10 scale. In fact, more than 62% of the respondents assigned a risk factor of "5" or less to this service. Those who consider this service not as risky do so because there is no actual money transfer involved. On the other hand, those who consider this service risky are more concerned about privacy issues. But, it is interesting that many worry less about an unauthorized look at their balances - probably because very few keep their wealth in a bank account today.

Because of the difference in sample sizes (the number of banks investigated for each geographic location is different), we calculated the percentage of the banks that offer different types of services on the WWW from different geographical areas and present the results in Figure 4. It shows that more U.S. banks provide Internet bill payment, fund transfer and account balance on the Internet than banks in the other categories. In fact none of the Canadian or Japanese banks provide such services at the moment. Interestingly, banks that provide one of these services, typically provide all of them. This implies that banks accept that the same risk levels are associated with all of these transactions.

U.S. banks, large and small, are ahead of other banks in the world in terms of providing cash transaction services. As shown in Figure 4, more than 20% of the large U.S. banks and 18% of the small U.S. banks in our sample provide the riskiest services: bill payments and funds transfer. For European banks, this figure is less than 10%. For account balance inquiry, Figure 4 shows that 30% of large U.S. banks, 20% of small U.S. banks, 10% of the Canadian banks and less than 10% of the European banks provide the service. These findings suggest that the U.S. banks are willing to accept more risk associated with offering services on the Internet.

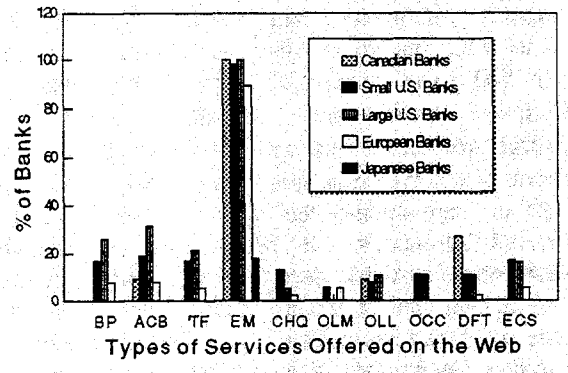

Figure 4. Percentage of banks offering various types of services on their WWW sites. (BP= bill payment; ACB=account balance; TF=fund transfer; EM=electronic mail; CHQ=cheque issuance; OLM=online mortgage; OLL=online loan; OCC=online credit card; DFT=downloadable financial tools and ECS=electronic commerce software.)

In general, banks behave consistently in offering all three services within the cash transaction category, if they offer any, except for Canada where only 10% of the banks provide account balance inquiry but not the other two services. When examined closely we found that even this 10% is represented by small banks as none of the big five Canadian banks offer these kinds of services. Because there are only 11 banks in Canada, it is difficult to draw a clear conclusion from this behaviour. However, the Canadian banking industry is controlled by the big 5 banks (all rank within the top 110 in the world), we can conclude that Canadian banks are conservative in terms of offering cash related transactions on the Internet.

Cheque ordering is another service within the cash transaction group. Some banks offer online cheque request services where customers fill out an order form and the cheques are mailed to them. Figure 4 shows that about 15% of the small U.S. banks offer this service while only 5% of the large U.S. banks and about 2% of European banks join in. This suggests that small U.S. banks are willing to accept more risk than the others.

There is one notable case we found where the bank provides an electronic payment service (BankNet of England) where customers can write cheques (payment orders) electronically, sign these cheques digitally and then send them via the Internet to the payees. This forms a very risky service and would be interesting to study over time to see if there are real security problems with it.

5.4.2 Loan Pre-authorization. The second group of services offered by banks on the Internet is loan pre-authorization. This group includes mortgages, consumer and other loans and credit card applications. Based on our survey, the risk factor associated with these services are similar to each other. Both mortgage and loan applications rate a risk factor of 5 while credit card application has been judged to be a 6. These results are as expected since these are pre-authorization types of services where the applicants will have to sign the actual paper forms at a bank branch even if the loan applications are approved online. As well, pre-authorizing any kind of loan does not subject the banks to significant risks since there is no actual money transfer. On the other hand, the concern from the customers' point of view is that their confidential data may be seen by others during transmission. In any case, a lower risk factor was given to each of these services.

Figure 4 shows the percentage of banks which offer loan pre-authorization on the Internet, and as can be seen, at this time, only a few banks offer such services. Among these banks, small U.S. banks are prominent, this again indicates that small U.S. banks are more aggressive in providing advanced services. Actually, only one large U.S. bank (Bank of America) offers online mortgage application. It appears that banks are holding back on offering this service. The percentage of banks offering online loan and online credit card applications are significantly higher than online mortgage applications for large U.S. banks. As shown in Figure 4, more small U.S. banks offered online credit card application than the other two services.

Figure 4 again suggests that Canadian, Japanese and European banks are more conservative in offering these pre-authorized credit services on the Internet. In the case of Canadian banks, again, only one small Canadian bank offers online personal loans, while the others offer "RRSP loans". These loans are specifically set up for those who wish to contribute to their tax free "Registered Retirement Savings Plans" at the end of the taxation year. These loans are short term (a few months) in nature and have a maximum limit of CAN $14,500. Japanese banks are even more conservative in this aspect as no bank offers any services of this type, while only about 5% of the European banks provide online mortgage applications.

5.4.3 Downloadable Tools. We also found that some of the banks offer downloadable financial tools which they have developed in-house. These tools include mortgage calculators, money management tools, investment profile analyzers and application forms for various services. As shown in Figure 4, Canadian banks out perform other banks in this aspect. Over a third of the Canadian banks sampled offer some type of downloadable tools to their customers. This is probably due to the low risk nature of this service: respondents in our survey assigned a risk factor of 1 to this service. Figure 4 also shows that the percentage of large and small U.S. banks offering this service is similar (about 10%), while most of the Japanese and European banks do not participate.

5.4.4 Electronic Commerce. The last type of service we investigated is electronic commerce. In this study, electronic commerce includes the functionality to download data to commercially available software, such as Quicken, Money etc., and the ability to purchase any kind of products or services through the banks' Web page. Our survey shows that customers perceive this to have a risk factor of 4. Of course, some of these purchases are not fully online as customers enter an online order without payment, and then download the order form to their printer. Once the form is printed, it is then faxed or sent via the mail to the company with payment (cheque or credit card) much like using mail order. In this case no cash transaction is made or credit information is given through the Internet, therefore customers are subjected to minimal risk.

Figure 4 again shows that twice as many small U.S. banks provide electronic commerce than banks in other parts of the world, both large and small U.S. banks are similar in this effort at about 10%. European banks are conservative towards electronic commerce as only about 5% offer this service, while Canadian and Japanese banks are again the most conservative as no bank provides such a service on its Web site.

5.5 Risks Taken by the Banks

5.5.1 Banks in Different Geographical Areas. Now we assess the perception of risk from the offering banks' point of view. Figure 5 shows the risk acceptance behaviour of all banks in different geographical regions. We derived this data by examining the extent of the services being offered with similar risk values and the data was averaged. The value for risk we reported in the previous sections were from the customer's point of view. Services offered by the majority of the banks are either less risky or involve minimal resources from a bank's point of view

and therefore a low risk factor is assigned to them. Based on the patterns that we observed from Figure 4, a new set of risk factors in Table 2 (from banks' view) is calculated based on the ratio between the participation levels in different services with the highest risk, online mortgage application, arbitrarily assigned to be 10. Figure 6a shows the level of bank participation in each service. We found that bank participation in risk level 1 services is significantly higher than at the other levels for all banks, obviously, banks are not taking many risks. We then looked at participation levels with respect to the bank's risk factors in Figure 6b. Participation levels are averaged over services that have the same risk factors. Figure 6b shows that bank participation drops exponentially as risk level increases. This suggests that banks are not ready to offer services at higher risk levels.

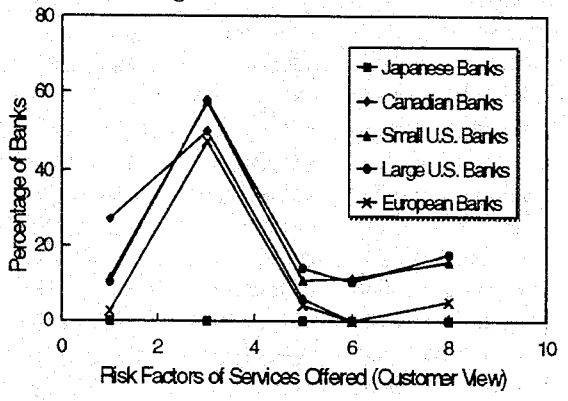

Figure 5. Bank participation at different risk levels (customer view).

As can be seen, risk acceptance patterns for the different bank groups are very similar except for the Japanese banks. Figure 5 further indicates that small U.S. banks behave in a similar manner to large U.S. banks in these terms as the percentage of banks at the various risk levels are almost identical. Both Canadian and European banks are not comfortable in taking high risks and Japanese banks are the most conservative ones.

5.5.2 Comparing Large Banks to Small Banks. Figure 7 shows the total risks undertaken by banks with different asset size ([11]; [12]; [13]). Total risk (customer view) is the sum of all the risk factors for each service based on our survey. Banks with an asset size less than $20 billions offer more services on the Internet (as measured by risks). Banks with an asset size between $20 and $100 billions are not as aggressive in terms of Internet banking. Those with an asset size more than $100 billions are very conservative in offering services. Banks can be classified into two groups: the aggressive group and the conservative group across the whole range of asset sizes.

Table 2. Risk Factors Computed Based on Bank Participation in Offering Different Internet Services

Internet Banking Services	Risk Factors (Banks) on a 1 to 10 Scale
Bill Payment	3
Account Balance	2
Fund Transfer	3
Electronic Mail	1
Cheque Issuance	6
Online Mortgage Application	10
Online Loan Application	7
Online Credit Card Application	6
Downloadable Tools or Forms	4
Electronic Commerce Software/Ability	4

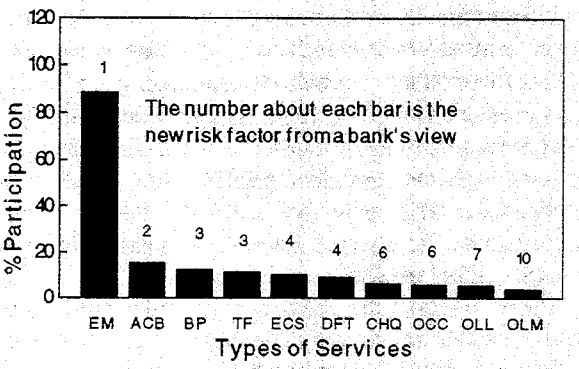

Figure 6A

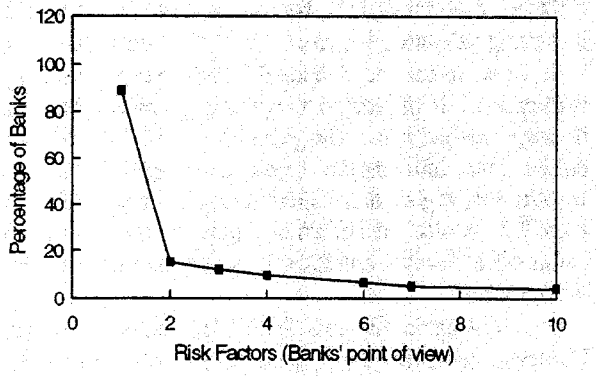

Figure 6B

Figures 6A and 6B . Bank participation at different risk levels (bank view).

The data shows that either they are very conservative, thus have a total risk level of 3 or less, or quite aggressive with a total score of 20 or more. Interestingly, there are few in-between. Any bank that lies above the exponential curve in Figure 7 can be considered aggressive. In general, significantly more banks are in the conservative group (i.e. those banks that lie on the horizontal line and

total risk level of 3), suggesting that banking on the Internet is progressing slowly. Both large and small banks are holding back on offering risky services on the Internet due to security concerns [14].

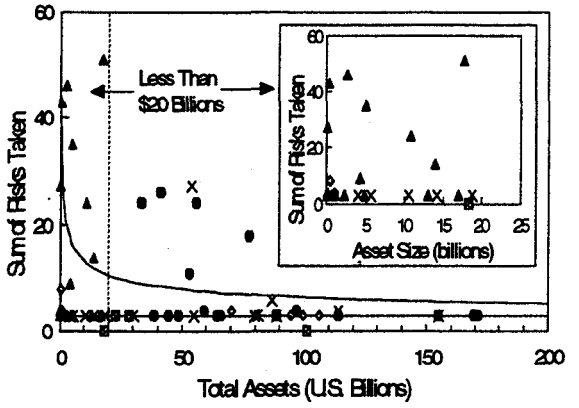

Figure 7. Total risks undertaken by banks with different asset size. (✱ = Japanese, ◆ = Canadian, ▲= Small U.S. Banks, ● = Large U.S. Banks, × = European Banks)

6. Security Issues

Secure transaction processes over the Internet are imminent, Netscape announced in May 1996 that it has a secure browser ready and will make this widely available shortly. Forrester Research Inc. predicts that customers will be able to perform online purchases, without security risks, by the Fall of 1996 [6]. To execute a secure and reliable transaction over the WWW, four conditions must be met. Security in the context of a web transaction means that there is no threat to the information being sent, meaning that it will not be altered, deleted, replaced or read enroute to its destination, nor can counterfeit transactions be created. Reliability in the same context can be defined as verification, confirmation and guarantee of the validity of the transactions to the trading partners. Security and reliability requires that the system has the following capabilities.

1. Encryption
2. Authentication
3. Certification
4. Non-Repudiation

6.1 Encryption

Encryption is the transformation of data into an unreadable form. The purpose of encryption is to provide secrecy by keeping the information hidden [15]. Information can be encrypted through the use of an encryption key and decrypted for viewing via a decryption key. Public key cryptography (PKC) and Secret key cryptography (SKC) are currently the two leading cryptosystems. Refer to [16] and [17] for details in SKC and PKC respectively.

6.2 Authentication

This is a process that provides confidence to the message receiver as to the identity of the sender and the integrity of the message itself. In a digital environment authentication is achieved through the use of a digital signature, which is analogous to a handwritten signature. This piece of data asserts that a named person wrote or otherwise agreed to the document to which the signature is attached.

6.3 Certification

A digital document issued by a certifying authority attesting to the relationship between the individual/organization and the assigned public key. Certificates issued by certifying authorities are issued to deter and detect an entity from impersonating another using a fake key. The information contained in a certificate includes a public key, the name of the entity to whom the key is issued, the expiry date of the key, name of the issuing certification authority and the serial number of the certificate [18].

6.4 Non-Repudiation

Non-repudiation is the final step in assuring a secure financial transaction through the Internet. The non-repudiation goal is reached when confirmation of the message (being sent or received) is returned. There are two sides to non-repudiation. One side is relevant to the sender, known as non-repudiation of origin, to assure that the sender cannot deny having sent the message. The other side is at the receiver's side, known as non-repudiation of receipt, to assure that the receiver cannot deny having received the message.

7. Conclusions

We found that banks are slow in offering all but the least risky transactions on the Internet. U.S. banks are the leaders in the industry, however, the percentage of banks offering such services is still low. Small banks are more

aggressive in offering Internet banking as they offer more services than their larger competitors and they are willing to accept more risk by providing Internet based cash related transactions. At present, more than 70% of the banks we sampled use the WWW as a marketing tool because of its low cost. For conservative banks such as those in Japan, this is the sole purpose for Web page development. Canadian banks and European banks behave similarly in Internet banking. They are willing to offer low risk services such as electronic mail, downloadable information and tools but not cash transactions.

One of the banks specifically mentioned on its web page that security issues are the main obstacle for progressing in Internet banking. It bears repetition that these concerns come from both the banks' customers and the banks themselves. The same concerns apply in non-banking electronic commerce, people are not yet comfortable in issuing any payment related instruction through the Internet until a standard security protocol is fully in place. Even if a standard was already available, it will take some time for bank customers to accept and trust it.

In summary, banks have taken the first step in "cyberbanking" by offering some basic services and information on the World Wide Web. In order to go one step forward in meeting the customers' needs for the 21st Century, banks have to work with both hardware and software companies to develop the standards for secure and reliable transactions on the Internet.

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