

The Progress of ISDN: In Germany and Beyond

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Five-hundred ISDN subscribers in Germany were surveyed to assess their experiences with the installation and usage of this technology. The results were compared with a prior study conducted in the United States. ISDN in Germany has been more popular among small businesses to support telephony and data transmission activities. Both US and German respondents have not fully utilized the capacity of ISDN services to support their communication activities. The major reasons were found to be inadequate support from service providers and incompatibility of ISDN hardware and software with existing systems.

Huge leaps in voice and data communication technologies and capabilities have resulted in a potential global information exchange infrastructure. This world-wide architecture is expected to evolve into seamless interconnection of all major networking protocols on a shared, well-managed backbone. Integrated services digital network (ISDN) technology is a major contributor to this environment. ISDN provides a network architecture, in digital format, to support the integration of voice, data, and image services over existing twisted pair telephone wires (Hertzoff, 1989). There are currently two ISDN services available: basic rate interface (BRI) and primary rate interface (PRI). The BRI, also known as 2B+D, provides two bearer channels of ISDN service at 64 Kbps and one control channel at 16 Kbps. It is appropriate for residential and small business users. The PRI provides either twenty-three (as employed in the United States) or thirty 64 Kbps bearer channels and one 64 Kbps channel for control. This service is better suited for organizations with a heavier demand for communication of voice, data, and/or visual images.

Although ISDN has been slow to come to fruition in the United States (Lai, Guynes, and Bordoloi, 1993), its use is widespread in many European and Asian countries. Among the European countries, Germany is the heaviest user of ISDN.

By the end of 1993, 70% of all German territory and almost 100% of the western parts of the country already had access to ISDN services (Data Communications, 1993). In addition, over one million ISDN bearer channels were sold in Germany, as compared to Britain's 300,000 channels and France's 500,000 channels (Gronert, 1993).

This high market penetration gives the impression that ISDN technology has been very successfully diffused throughout Germany. But how is this possible when other countries, such as the United States, face considerable problems which prevent the rapid diffusion of ISDN (Lai, et al., 1993)?

The objective of this study was to perform a critical evaluation of ISDN implementation in Germany. More specifically, we investigated the experiences of ISDN installation, usage, and economic implications in Germany. German experiences were then compared with those within the United States. The results provide insight to other countries who wish to design effective strategies for ISDN introduction.

Literature Summary

The adoption and diffusion of ISDN is a relatively neglected area in the large and rapidly growing literature related to innovation research. Prior studies of ISDN adoption and diffusion have been conducted by researchers from both Computer Science and MIS disciplines, focusing on ISDN design, technology, implementation, or standards. The major MIS focus has been on the economic benefits (Philip, 1993), implementation strategies (Johnson and Cooper, 1990; Kennedy and Yen, 1989; Ramarapu, 1995), and adoption and diffusion (Lai et al., 1993; Lai and Guynes, 1994) of ISDN. The research approaches are primarily conceptual in nature, with empirical studies limited to ISDN usage and implementation within the United States (Lai et al., 1993; Lai and

Guynes 1994; Thachenkary, 1993). While successful implementation of ISDN within Germany appears impressive, there has been little research to validate these claims. Few articles covering the diffusion and implementation of ISDN within Germany have been published in the past decade. And, of these articles, the majority focus on marketing strategies (Kahl 1990; Peters 1990), applications (Peters 1990), or tariff structures (Kahl 1989; Kahl 1990), as proposed by Deutsche Telekom.

Cognit GmbH in Köln conducted a survey on the use of ISDN within Germany (TELETECH NRW, July 1992). This study was among the few studies that addressed the economic and organizational implications of the use of ISDN in Germany. Thirty percent of the ISDN subscribers in the German state of Nordrhein-Westfalen were surveyed. A response rate of twelve percent was achieved, based on a sample of 360 organizations and individuals. Their results showed that ISDN subscribers were primarily from the service sector (especially software houses), and were small organizations. However, since data were collected from only one German state, and a relatively low response (less than fifteen percent), their findings cannot be generalized for the entire country. A more detailed analysis, with a larger sample of firms, covering a broader area of Germany, would definitely provide more meaningful insight into the implementation of ISDN.

German Background

The German telecommunication infrastructure is based upon the Deutsche Bundespost (DBP) which, until recently, enjoyed a monopoly position. In the late 1980's, the telecommunication functions were organizationally detached from the DBP and unified within a new publicly-owned organization, called Telekom. Telekom greatly pushed the diffusion of ISDN. It justified the introduction of ISDN to the general public by stressing its cost advantages and competitiveness of the German economy as a whole (Schön, 1986). While these advantages supported the decision of Telekom to introduce ISDN, they did not necessarily provide the incentive for German telecommunication users to adopt this new service.

Realizing the need for additional customer-based incentives, Telekom provided initial proactive support for ISDN until the diffusion process could carry itself (PC Woche, 1990). This support was primarily in the form of customer education and initial funding.

As with many new technologies, market understanding and acceptance are not guaranteed. Telekom tackled this problem by supporting the development of ISDN applications and publishing the promising results (Zeller, 1989). The primary objective was to adjust Telekom's implementation efforts to the actual needs of potential ISDN users. This was achieved by supporting the exchange of implementation related experiences. At that time, pilot projects were initiated to improve the adoption and implementation of ISDN (TELETECH NRW, 1990).

Telekom provided financial incentives to early adopters

of ISDN by subsidizing services and products to assist them with the high initial investment in the infrastructure, thereby providing a rate structure that was competitive with alternative services. These financial incentives were justified on the basis that it was expected that early adopters would provide greater benefits to the community as a whole, yet receive fewer benefits than later adopters.

In addition to a tariff structure that was comparable to alternative networks, Telekom provided direct financial support to attract new ISDN customers in an effort to achieve a critical mass of users (Claus and Schön, 1990). The financial support program was initiated in mid-1989 and, during that first year, Telekom provided between 30,000 DM (approximately \$17,650) and 500,000 DM per organization (PC Woche, 1990). If an organization needed additional ISDN peripherals, Telekom furnished additional subsidies. These included 2,000 DM (\$1,176) for small ISDN-based PBXes and 888 DM (\$522) for ISDN PC-adaptor cards.

Telekom's efforts to educate the adopter and to provide financial incentives resulted in considerable growth in the number of basic and primary ISDN connections sold. The number of ISDN subscribers had significantly increased from 2,687 BRI and 415 PRI in January 1990 to over 220,000 BRI lines and 16,000 PRI lines in 1993.

To foster a higher ISDN subscription rate, Telekom fully integrated ISDN with the existing telephone, telex, teletex, and packet switching networks (Kahl, 1990). At the end of 1992, ISDN was available in 1,919 German cities (Data Communications, 1993). Telekom's goal was to have ISDN available in all German cities (including what was formally East Germany) by the end of 1995. In order to speed up the progress of national and European ISDN standards, Germany formed a quadripartite cooperation with France, Italy, and the United Kingdom (Penn and Robin, 1990). More recently, Deutsche Telekom formed an alliance called Global One with France Telecom and Sprint to provide worldwide services for corporate clients (Financial Times, 1996). Telekom's enthusiasm of ISDN is not confined to the standardization of the main ISDN equipment such as interface, functional performance, and hardware development. They have also developed several specific ISDN applications to accelerate deployment. It was because of these efforts that Germany has accomplished positive results in its ISDN implementation, which includes the establishment of a widespread national network.

Research Framework

Researchers and practitioners alike claim that Germany is at the forefront of ISDN implementation. This research was interested in seeking the extent of ISDN diffusion within German organizations after Telekom's years of active planning for the introduction of this network technology. The model in Figure 1 explores the well-established relationships between innovation diffusion, extent of installation, usage magnitude, and economic benefit to provide a basis for understanding the progress of ISDN in Germany.

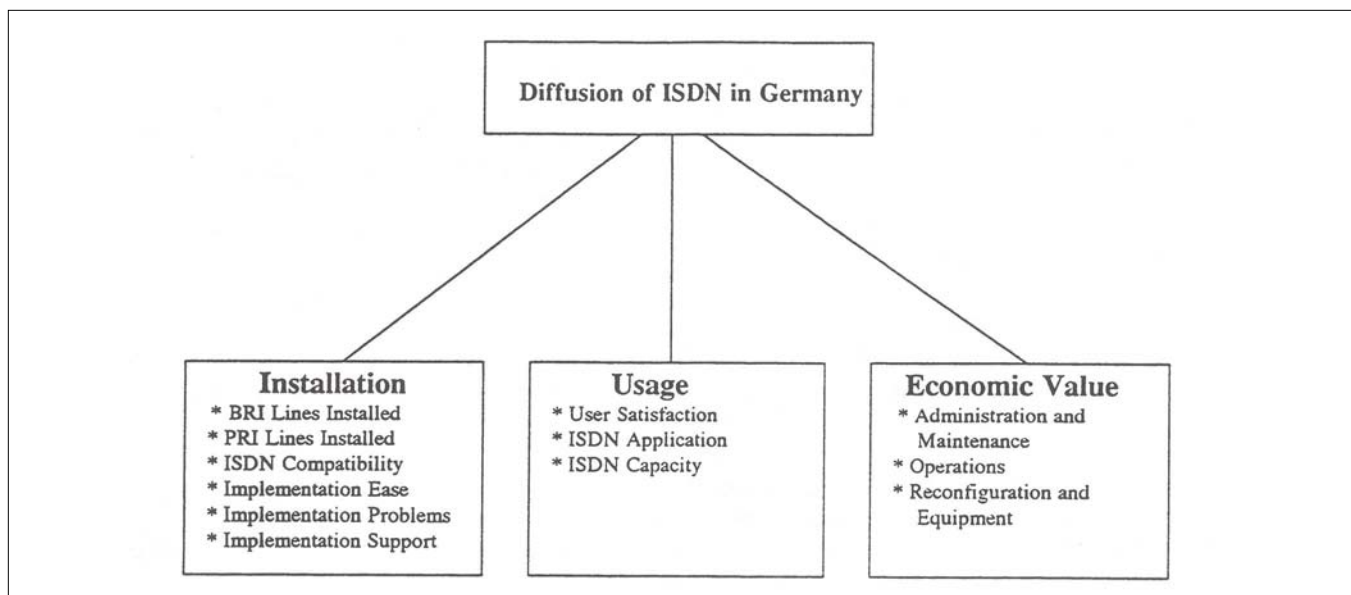


Figure 1: Research Model

ISDN provides various telecommunication services through one common interface to the subscriber line. ISDN also increases the availability of some applications, improves the quality of others, and facilitates some completely new ones. Sophistication of ISDN applications within organizations signifies a greater extent of ISDN diffusion within Germany. Hence, we investigated how ISDN was applied in German organizations to support network services and uses such as telephony, video conferencing, and data communications. Several questions were included to seek feedback on the perceptions, comments, and facts regarding issues such as number of BRI and PRI lines installed, difficulties and support experienced during the implementation of ISDN, and compatibility of ISDN to existing network and system platforms.

In regard to magnitude of usage, questions were raised to determine how ISDN was used and what type of applications were more prevalent among organizational users. Additionally, we evaluated the extent of user satisfaction with regard to the use of ISDN, as compared to other network technologies.

The economic value of ISDN also affects diffusion rate. It was therefore important to examine the benefits and savings of implementing and using ISDN in data communication activities, bearing in mind the financial and personal support provided by Deutsche Telekom. Several questions were adopted to solicit responses to cost of operating, administering, and maintaining ISDN, as compared with other technologies. In addition, several questions were posed to determine whether the evolution process to ISDN was deemed affordable to potential ISDN adopters, or if there were any potential savings in transmission, equipment, or reconfiguration when ISDN was fully implemented and operational.

In summary, the following research questions were posited:

1. What is the extent of ISDN implementation in Germany?
2. What compatibility, interface, or hardware problems were

encountered during the implementation process?

3. Are German network users satisfied with their ISDN technology? If not, what are their complaints?
4. What ISDN capabilities are used in the communication services? What are their major applications?
5. What is the capacity of BRI and PRI services used in data communications?
6. Are the perceived economic benefits of implementing and using ISDN services being realized?

Research Methodology

In an effort to assess user experiences with ISDN within Germany, a detailed questionnaire was developed. Most of the questions in the questionnaire were adapted from previous studies in innovation, diffusion, implementation, and information management. Additionally, specific questionnaire items were developed to collect data relevant to the objectives of the study, as well as descriptive information. The questionnaire was pilot tested with three senior IS executives from two different companies with varying degrees of diffusion of ISDN in their operations. The feedback from pilot testing provided estimates of time required for completion of the questionnaire and refinement of measurement items. After revising the survey instrument, one of the authors, a native German, translated it into German.

Data for the study were collected from a field survey of 500 firms in Germany, randomly chosen from *ISDN: Alles,ber ein Netz (Amtliches Verzeichnis der ISDN-Teilnehmer der Deutschen Bundespost)* (Telekom, 1992), the German directory of ISDN subscribers. Ninety-six responses were received, out of which ninety-two were usable, representing a response rate of 18.4%. This was a good result, as compared to the local survey (12% response rate) conducted by Cognit GmbH in 1992.

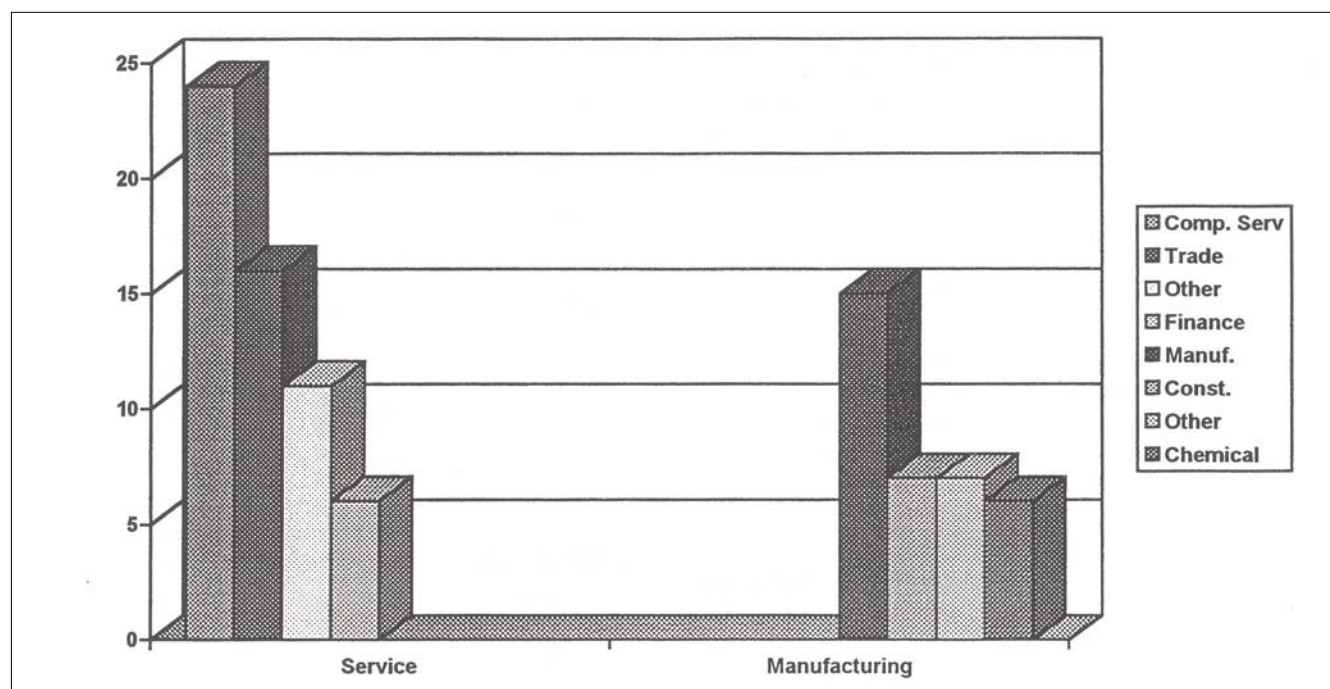


Figure 2: Respondents' Demographics

Since nonrespondents could not be identified, it was difficult to test for nonresponse bias. However, the analysis on sample profile (discussed below) indicated that many of the demographic characteristics of this study were similar to other recent German ISDN studies (such as Cognit GmbH). This gives us sufficient confidence to consider the sample to be a fair representation of the population of ISDN adopters in Germany.

Discussion of Results

Profile of Responding Organizations

Our survey respondents were primarily from small to mid-size organizations. Approximately 83% of the respondents were from organizations with less than 500 employees. This result is probably fairly reflective of Telekom's marketing strategy of marketing ISDN as a low cost, flexible alternative to small and mid-sized organizations that cannot justify the expense of more powerful dedicated networks for their diverse telecommunication needs (TELETECH NRW, May 1992).

As shown in Figure 2, sixty-two percent of the respondents were from the service sector, indicating a strong tendency that the service sector is the leading utilizer of ISDN services within Germany. Among these service-oriented companies, most were in the computer/DP services and trade industries. As for non-service oriented ISDN adopters, most were engaged in manufacturing. These findings were very similar to the results reported in the Cognit GmbH study, which indicated small, service-oriented businesses were the leading users of ISDN services.

Installation

Although ISDN has been diffused to many organizations in Germany, the level of ISDN implementation is minor. The majority of respondents (79%) had implemented less than 100 ISDN lines, and none of the respondents had employed more than 1,000 ISDN lines. Seventy-two responding companies reported that they subscribed only to BRI lines, twelve subscribed only to PRI lines, and eight subscribed to both BRI and PRI lines. This implementation level can be partially explained by the relatively small size of the adopting organizations. Overall, the survey respondents had a positive experience with the introduction of ISDN within their organizations. As indicated in Table 1, most respondents reported no difficulty introducing ISDN services (an average of 5.53 out of 7) to their organization. However, several expressed concern about the compatibility of ISDN services with their existing systems. Only thirteen percent of the respondents strongly believed ISDN to be very compatible (Likert scale of 6 and 7) with their existing equipment and software. Respondents mentioned problems with interfaces, adjustment of their hardware and software, and installation of ISDN PC-cards.

ISDN performance and installation were the most

| Issue | Mean | Std Dev |
|------------------------------------|------|---------|
| No ISDN introduction problems | 5.53 | 1.57 |
| No software compatibility problems | 4.85 | 2.34 |
| No hardware compatibility problems | 4.56 | 1.61 |
| No ISDN performance problems | 4.46 | 1.96 |
| No ISDN installation problems | 4.38 | 1.82 |

(1=strongly disagree and 7=strongly agree)

Table 1: Evaluation of ISDN Implementation

significant problems encountered by the respondents. Almost thirty percent of the respondents encountered problems with Telekom, related to lack of service and/or incompetency of Telekom representatives. Unsatisfactory performance by the service provider, thereby affecting smooth performance and installation of ISDN was also mentioned. Although Telekom assisted over 50% of the respondents in either acquiring or implementing ISDN, it was not viewed as very involved in supporting ISDN implementation through to completion. Closer assessment of involvement revealed that Telekom spent, on average, less than twenty hours with each subscriber. This finding suggests the need for Telekom to provide its customers with more assistance and education to achieve greater ISDN implementation success and customer satisfaction.

ISDN Usage

Overall, the survey respondents appeared satisfied with ISDN. Seventy-eight percent of the respondents felt they made the right decision to introduce ISDN technology, and over fifty percent of the respondents claimed that ISDN was accepted positively by its users. However, when asked to compare ISDN with other telecommunication alternatives, only thirty percent preferred ISDN, while twenty percent favored alternative technologies. The remaining fifty percent were undecided. This difference in opinion is reflected by the fact that most respondents still appear confused about the capabilities of ISDN. They failed to recognize the improvements that can result from ISDN, and did not know how to

| | Cognit's Survey | Current Survey |
|----------------------|-----------------|----------------|
| Telephony | 86% | 92% |
| Data Transmission | 53% | 56% |
| * bulk data transfer | 49% | 48% |
| * on-line retrieval | 37% | 20% |
| * graphics | 9% | 12% |
| Btx (videotext) | 30% | 24% |

Table 2: Types of ISDN Services Used

exploit the benefits of the technology. These confusions are made evident by the manner in which ISDN is used to support communications.

The responses to our survey are quite similar to the Cognit GmbH's study, with telephony, data transfer, and videotext being the major ISDN applications. As shown in Table 2, Telephony is the most commonly used service among Telekom's ISDN users (92%). This was to be expected. In contrast to advanced forms of technology usage, even the smallest organization requires a telephone. And, ISDN technology offers additional features for voice communication not normally available with the German telephone system. However, the low utilization rate of ISDN for data transmission (56%) was unexpected. This phenomenon may be attributed to the uniqueness of the customer base, which is primarily small organizations with no need for frequent data transmission. Other possible explanations could be the lack of customer awareness, lack of compatible protocols of the ISDN-PC cards to support data communications, or the lack of other ISDN subscribers with which to transmit data.

Seventy-eight percent of the survey respondents subscribed only to BRI lines, while 22% were using PRI by itself

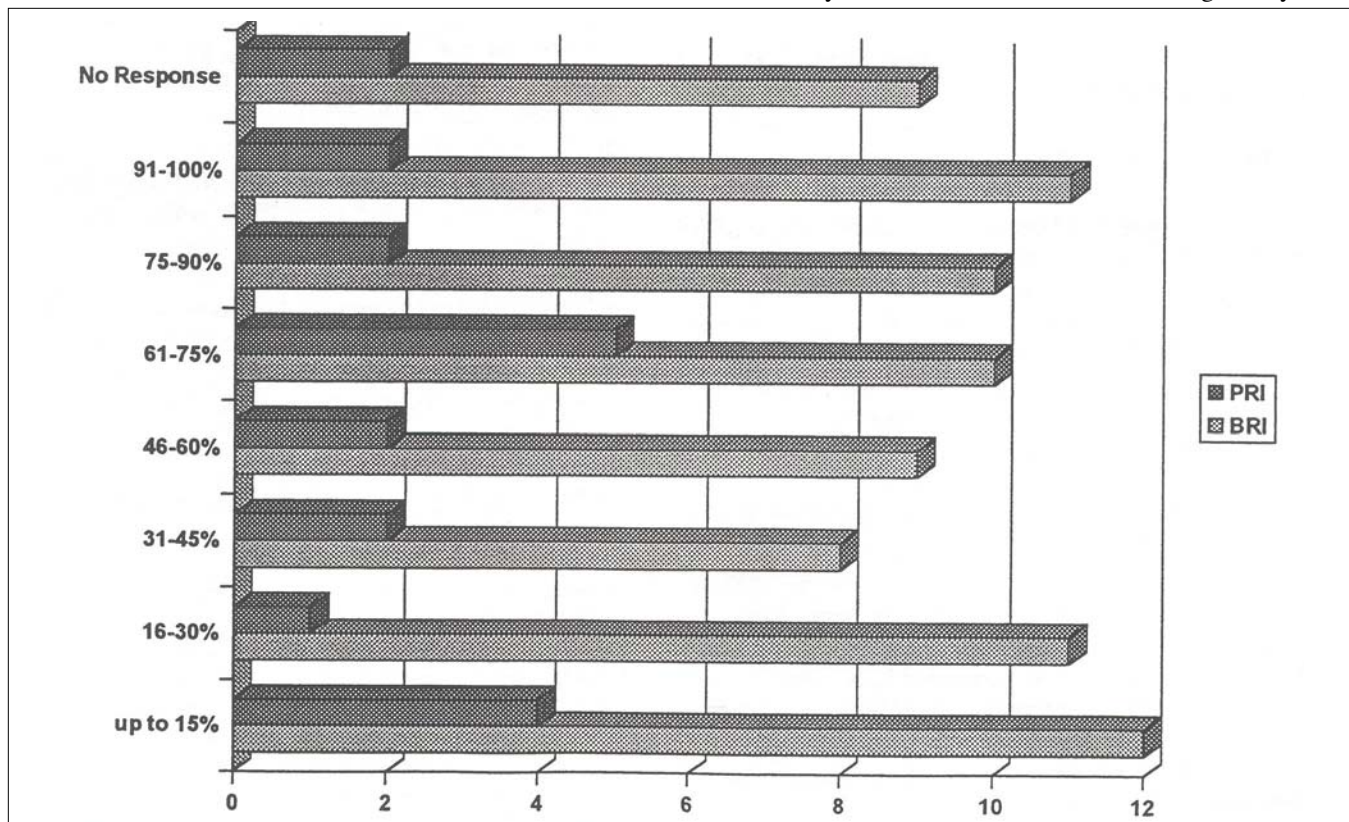


Figure 3: Estimations of BRI and PRI Line Utilization Capacities

| Issue | Mean | Std Dev |
|---|------|---------|
| <i>Network Administration and Maintenance</i> | | |
| Lower network administration costs | 5.64 | 1.16 |
| Lower network maintenance costs | 5.87 | 1.32 |
| <i>Network Operations</i> | | |
| Lower network transmission costs | 5.43 | 1.46 |
| Lower network operation costs | 5.38 | 1.61 |
| <i>Network Reconfiguration and Equipment</i> | | |
| Lower network reconfiguration costs | 4.93 | 1.56 |
| Lower data communication equipment costs | 3.25 | 1.57 |
| (1=strongly disagree and 7=strongly agree) | | |

Table 3: Evaluation of ISDN's Economic Side

or in combination with PRI. This was to be expected, considering the majority of ISDN subscribers were smaller organizations. However, it was interesting to note the limited capacity of usage of even the BRI lines (Figure 3). Approximately twenty-nine percent of the respondents utilized the basic rate at less than thirty percent capacity. Only 15% of the BRI users were at or near capacity. The PRI lines were even more grossly underutilized. This helps to explain why there was a limited number of PRI subscribers.

Economic Implications

The German Bundespost perceived ISDN as a network for the mass market. As such, its intended use was primarily for replacing existing services or for providing slightly more advanced telecommunication services. To strategically market this technology to the small and mid-sized customers, Telekom fixed ISDN tariffs in accordance with two principles: (1) ISDN tariffs were to correspond with current telephone tariffs in regard to amount and structure; and (2) were to be service-independent (Kahl, 1990). Thus, ISDN was promoted as a low-cost transport service in parallel to other networks such as Datex-P, Datex-L, and permanent data lines (Teletech NRW, May 1992). To evaluate the economic aspect of ISDN, the respondents were asked to estimate the total reduction in communication costs after this technology was installed. As shown in Table 3 ISDN cost savings are grouped into three primary categories: network administration and maintenance, network operations, and network reconfiguration and equipment. The majority of respondents strongly believed that implementation of ISDN resulted in network administration and maintenance savings. The respondents also saw some economic benefits of operating ISDN. They agreed that there were savings in data transmission and network operations with ISDN services (mean evaluations of 5.43 and 5.38 respectively). However, most respondents failed to see any savings in the reconfiguration and acquisition of ISDN devices, when compared to similar communications systems. This indicates that the initial investment in ISDN hardware and software was too high, even with financial subsidies from Telekom.

American Versus German ISDN Implementation and Usage

When these results were compared with those of an

| Issue | German Mean | US Mean |
|--|-------------|---------|
| No ISDN introduction problems | 5.5 | 2.8 |
| No software compatibility problems | 4.9 | 4.8 |
| No hardware compatibility problems | 4.6 | 4.7 |
| No ISDN performance problems | 4.5 | 4.5 |
| No ISDN installation problems | 4.4 | 4.7 |
| (1=strongly disagree and 7=strongly agree) | | |

Table 4: Comparison of German vs. US Implementation of ISDN

earlier study performed in the United States (Lai and Guynes, 1994), we found both similarities and discrepancies. Following is a comparison of the major factors.

Profile of Responding Organizations

The US study intentionally targeted large organizations (surveyed Business Week 1,000 companies, sixteen questionnaires were undeliverable and 181 companies responded, representing a response rate of 18.4 percent). There were several reasons for this. The major reason is that other studies (Mock and Morse, 1977; Dewar and Dutton, 1986) have argued that large firms are more innovative than small firms, primarily due to their ability to absorb a greater risk. Additionally, the very nature of ISDN within the US leads it to be more desirable and available to large firms. The US has no government policy to promote ISDN services, nor is any financial support provided to adopters. Additionally, since ISDN in the US does not enjoy the pervasiveness seen in Germany, it was felt that large firms would have more clout with the telecommunications firms and therefore be able to receive and pay for the services they required.

Installation

As expected, the level of ISDN implementation in the US was minor. Of the forty-one US companies which had adopted ISDN, 36 subscribed only to BRI services, while only five had subscribed to both BRI and PRI services. Although the US study included much larger firms, this lack of implementation can be attributed, in part, to the lack of policies and standards regarding ISDN. As shown in Table 4, the US survey respondents had very similar ISDN implementation experiences, except in regard to ISDN introduction (German mean 5.5 vs US mean 2.8). The US respondents experienced major problems with introduction. Problems cited include: ISDN is not a unique technology, it is not cost justifiable, nor is it well established. Many companies which evaluated, yet rejected ISDN, pointed out that it simply was not revolutionary. These problems, plus the immaturity and lack of wide-spread availability of ISDN, have greatly contributed toward the difficulties introducing this technology to organizational network users.

ISDN Usage

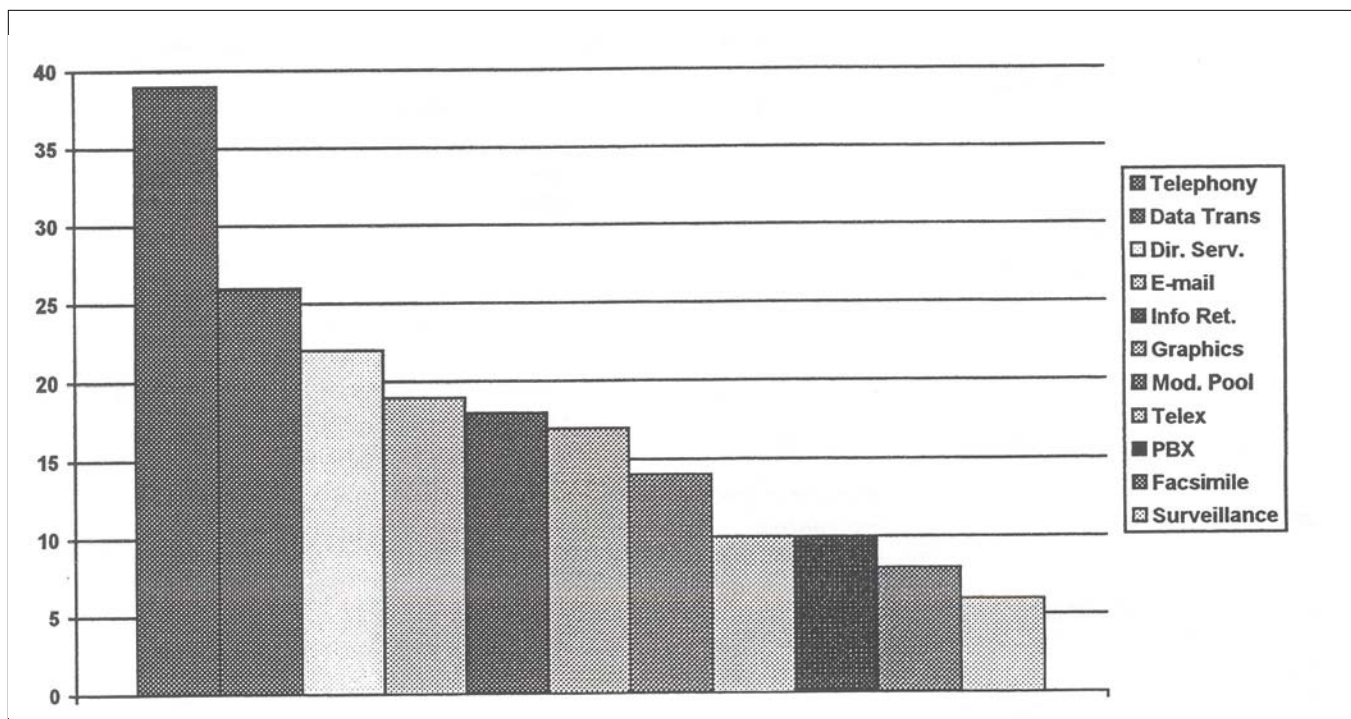


Figure 4: Major US Applications of ISDN

Overall, the US respondents were satisfied (mean=5.3) with using ISDN. However, management support (mean=3.6) seemed to be a major problem. This implies that management is still not convinced of the viability or desirability of ISDN technology. However, management's vision is extremely important in determining the implementation, usage levels, and pervasiveness of ISDN within an organization. Management can profit from ISDN training in two ways: 1) they can better understand how ISDN technology and its implications for connectivity can improve the acceptability and support from general network users, and 2) they can better understand the strategic implications of ISDN in regard to how their company can enhance or sustain competitive advantage. In the US, eighty-eight percent of ISDN respondents subscribed to BRI lines, while only 12% were using both BRI and PRI. None of these companies utilized more than 60% capacity in the BRI lines. Utilization of PRI was even more disappointing, with no company exceeding 30% capacity. Although the German implementation scale was better than that of the US, the utilization rate of both countries was disappointing. Both countries have unique problems to be resolved, yet both face the need to generate enough interest to cause a demand pull for ISDN. The supply push marketing strategy alone, as demonstrated in Germany, has proven inadequate in creating general acceptance of ISDN. Although there is little difference between ISDN implementation levels in both German and US corporations, the US is far more diverse in its applications. As shown in Figure 4, the five most commonly used ISDN services were telephony, data transfer, directory services, e-mail, and information retrieval. Although these options were included on the German survey, none of the German respondents even mentioned directory services, or e-mail.

Economic Implications

ISDN possesses unique features and applicabilities that could possibly conserve a company's investment in communications costs. Bushaus and Travis (1990) indicated that a company could save as much as 20% of total communication costs by investing in ISDN. The savings associated with ISDN are not restricted to the direct costs paid for the lines. Subscribers should also consider the savings derived from flexibility, bandwidth, services, speed, and convenience of the networks. However, the high overall cost of ISDN is one of the most frequently cited reasons for failing to adopt technology (Lai, et al., 1993). Could it be that these savings projections are over-optimistic, or do the rejecting companies not spend enough time investigating costs associated with ISDN?

The full economic impact of ISDN technology within the US is still unknown. ISDN tariffs in the US are still in the infancy stage and vary widely from state to state. As a result, consumers are still not clear as to what ISDN will cost. Currently, most carriers are charging twice as much for ISDN service as for regular phone lines, but that is only expected to be a temporary measure. Network professionals are forecasting price reductions as user demand increases. Until the costs associated with ISDN are stabilized, network users will continue to rely on existing, less expensive modem technology.

Implications and Conclusions

Although Deutsche Telekom's subscription base is the largest in Europe, we found that ISDN has only been applied to very restrictive applications such as telephony. The results

of both the Cognit GmbH survey and our survey indicate that Telekom may still be far away from achieving market penetration in the sense of being accepted by its potential users. Market penetration of ISDN within the US is also disappointing. However, the primary reason appears to be lack of standards associated with ISDN technology. Based on the discussion of results, several observations could be made, which have affected the diffusion of ISDN in Germany and the United States:

- ISDN is primarily used by smaller organizations within Germany. This could be attributed to Telekom's marketing strategy. We have insufficient data to determine the network requirements of these organizations, but it seems unlikely that telephone service is the only service with which ISDN may be of use. This could be related to a variety of reasons, such as poor marketing strategy, known or perceived lack of reliability among ISDN systems, or lack of understanding on the part of the customer.
- Both German and US subscribers of ISDN mentioned problems with the implementation of this technology. The most frequently mentioned problems by German respondents were compatibility with existing software and hardware, whereas the US respondents experienced major problems simply trying to introduce the technology. Respondents from both countries reported difficulties in solving these problems in-house, primarily because they did not have the required expertise. Telekom tried to address this problem in Germany by providing technical support with the operational introduction of this technology. However, based on the opinions of the responding ISDN subscribers, it has not been very successful. This indicates the importance of providing effective technical support for ISDN adopters.
- The US lags far behind Germany in regard to ISDN pervasiveness. This is due, in part, to the divestiture of AT&T and the lack of government intervention and deregulation policies in the US. The existence of ISDN islands is evidence of a lack of government efforts to coordinate and streamline the overall implementation of ISDN. Therefore, the US may need to reconsider collaboration either by the government, communication carriers, or both, in the formulation of national telecommunication policies to guide the development of ISDN issues such as implementation, standards, and tariffs.
- Both German and US respondents complained about the high initial cost of ISDN. However, the genuine attraction of ISDN is related to performance enhancement, not savings. These enhancements include faster response time, more diversified data service, higher throughput, and improved reliability.

We feel that most of the problems associated with ISDN within Germany can be attributed to improper training of users and insufficient service and support by the service provider. A major promotional effort by Telekom to stimulate the user's awareness and understanding of this technology is badly

needed to boost the diffusion rate of ISDN in Germany. It appears that Telekom must also assist the subscribers in developing applications, as well as provide a source for customer concerns and issues. According to the respondents, ISDN seminars and formation of ISDN user groups would be beneficial.

Lack of standards appear to be the major problem within the US. This lack of nationwide policies leads to incompatible ISDN implementation and the formation of islands of ISDN, which could not communicate with each other without relying upon complex protocol converters. This limits the internetworking of ISDN through different Central Offices, causes unattractive tariffs, frustrates potential customers, and provokes their indifference toward ISDN. As a means of alleviating this problem, Bellcore, the Corporation for Open Systems (COS), and the North American ISDN Users Forum (NIUF) joined forces to develop standard interfaces and messaging for future ISDN development and implementation. It is hoped that National ISDN-1 and its subsequent ISDN-2 standards will unify different industry constituencies to push for a coast-to-coast ISDN network. Although these standards have been slow in coming, and late in implementation, Srinivasan (1995) recently confirmed that ISDN implementation in the US is increasing, spurred by the introduction of National ISDN standards.

Clearly, the results indicate that ISDN has not been used to perform the sophisticated applications (such as telemetry, high-speed data, and video) promoted by its providers. This restricted scope of ISDN applications has severely hampered the potential diffusion of ISDN services. If ISDN services are not applied to applications for which they are uniquely designed, users will not be attracted to nor will they accept and use the technology (Lai, et al., 1993). ISDN is a very viable technology, which, when utilized properly, can meet or exceed the telecommunications needs of most organizations. However, as with most technologies, it must be properly marketed, and the potential users must be fully cognizant of what the technology was intended to achieve. In summary, we provide the following suggestions for the successful implementation of ISDN:

- ISDN standards must be implemented
- ISDN must be better marketed so that potential adopters are more aware of its capabilities and availability
- Management must be educated in terms of ISDN capabilities and availability
- ISDN providers must be able to arrange for both technical and managerial training in regard to ISDN
- Proactive technical support must be available
- Tariffs and associated ISDN costs must be clarified and finalized

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