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Adoption of new information technologies in rural small businesses

G. Premkumar *, Margaret Roberts

College of Business, Iowa State University, 368H Carver Hall, Ames, IA 50011, USA

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Abstract

The media discussion on 'information superhighway', 'Internet' and 'national information infrastructure (NII)' has highlighted the potential of information technology in modern society. The changes in information and communication technologies provide both opportunities and threats to small businesses located in rural communities. The objective of this study is to identify the state of use of various communications technologies and the factors that influence the adoption of these technologies in small businesses located in rural communities in the US. A research model is postulated that contains 10 independent variables under three broad categories — innovation, organizational and environmental characteristics. The dependent variable, adoption of information and communication technologies, is measured as the degree of adoption of four modern communication technologies by the organization. Data from 78 organizations were collected using a structured interview process. The results of data analysis using discriminant analysis indicate that relative advantage, top management support, organizational size, external pressure and competitive pressure are important determinants of adoption.

Keywords: Small business; IT adoption; Communication technologies; IS implementation; Innovation adoption; Information technology

1. Introduction

Leading thinkers in the communications field have claimed the advent of the digital 'revolution' has created a society that is increasingly dependent on information and the technology to process it [4]. However, it is yet to be seen how well the society will accept and assimilate these technologies. Researchers predict that future society will employ more people in information related industries than in previous decades, and that access to information and skills in using the technology will become predominant determinants of success for individuals and organizations. Hence, it is not surprising that the news media are reflecting society's transformation and highlighting the potential opportunities from these technologies.

While there is little doubt about information and communications technologies' impact, researchers in business and sociology have questioned whether the impact of technology will be even and whether certain categories of business (e.g. small business) or certain regions (e.g. urban or rural) will be adversely affected by the technologies [19, 33]. As the structure of the US economy shifts from a focus on manufacturing to service industries access to information and its efficient processing will become vital to the local economy [23]. The changes in information and communication

* Corresponding author. Tel.: +1-515-294-1833; fax: +1-515-294-2534; e-mail: prem@iastate.edu

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technologies provide both opportunities and threats to small businesses located in rural communities [28].

New communications technologies have made geographic locations and distances irrelevant, especially in the service industry. They open up new markets that were not previously accessible. Hence, rural businesses can compete with their urban counterparts in the same market and may have a competitive edge in terms of lower labor costs and overheads [2]. This may motivate urban businesses to take advantage of the cheaper labor resources relative to urban areas and potential markets in rural communities by relocating some of their operations to these communities. Investing in these technologies can lead to economic benefits through more price competition, lower inventory costs, reduced business travel and new distribution channels without middlemen [20].

These communication technologies also bring in potential threats to small businesses. History has shown that availability of basic infrastructure, such as rivers, railroads and interstate road systems drives local economic development. The lack of access to an interstate road system in the US significantly affected the economic survival and growth of some rural communities. In an information economy the drivers of economic growth would be the telecommunications and IT infrastructure. Unfortunately, the telecommunications infrastructure seems to follow a similar pattern as the interstate road system. Market forces that dominate the creation of the telecommunications infrastructure may inhibit development of 'universal access' to all areas in the country, since demand in urban areas is greater than rural areas [22]. Hence, rural businesses are caught in a vicious cycle — lack of communications infrastructure reduces the demand for communications services, which further constrains future investment in the infrastructure [19]. This may result in rural businesses being further alienated from mainstream economic activity [23]. Another source of threat is that these new technologies provide the opportunities for businesses to bypass the rural areas and relocate in developing countries where the labor and overhead costs are much lower.

Prior studies on information technology in small businesses have primarily focused on use of traditional IS application systems, user satisfaction and success with these systems. In this study we are examining the adoption of communications technologies, which we believe has not been studied in depth so far. The primary objective of this study is to identify the state of use of various communications technologies and the factors that influence the adoption of these technologies by small businesses located in rural communities. While most prior studies on IT adoption have focused on large corporations in urban settings, this study focuses on small businesses in rural communities in the US. The management issues, problems and opportunities for small businesses are very different from larger organizations; therefore, this study of IT adoption should provide useful findings that could provide guidelines for small businesses. Since the adoption decision is an organizational level decision, the unit of study will be the individual organization [9].

2. Background

The traditional innovation adoption/diffusion literature examines a wide variety of innovations in different contexts and provides a rich foundation for studies on adoption of information technologies [27, 29, 31]. This study proposes to use this literature along with IS implementation literature to study the adoption of new communications technologies.

An innovation is any idea, practice or object that is perceived as new by the adopter. The innovation adoption/diffusion literature examines the various factors that influence the adoption of innovation, the characteristics of the adopters, the process of adoption decision making and the diffusion of innovation in the population. Rogers [27] provided a number of generalizations regarding classical adoption/diffusion:

- Innovations have certain characteristics that adopters perceive as determining the rate of adoption. Some of the characteristics are relative advantage, compatibility, complexity, trialability and observability.
- There are personal characteristics (e.g. level of education) of potential adopters that make them more innovative than others.
- The decision to adopt and use unfolds in stages: *awareness* stage of acquiring information about the innovation, *persuasion* stage of being persuaded to adopt the innovation, *decision* stage of deciding to adopt, *implementation* stage of implementing the innovation and using it and finally *confirmation* stage of evaluating the actual outcomes with expectations. Different factors influence the adopters in the various stages.
- The behavior of some individuals (champions or change agents) can accelerate adoption of the innovation.
- The diffusion process usually starts out slowly, but 'takes off' rapidly after an initial period and eventually levels off.

The primary motivation for businesses to adopt new technologies is the anticipated benefits these technologies would bring to the company. However, before organizations can anticipate the benefits they must first be aware of the need for the innovation (demand pull) and how that innovation can be used to overcome the existing performance gaps/deficiencies or exploit new opportunities [35]. Rogers [27] describes innovation decisions as being: *optional* — choices to adopt or reject an innovation are made by the individual; *collective* — choices to adopt or reject the innovation are made by consensus among members; or *authoritative* — choices to accept or reject an innovation are made by a few persons with some sort of authority (power, status, technical expertise). The decision to adopt or reject information technologies within an organization would generally fall into one of the latter two categories, since the decision must be made by a consensus among members of the organization or handed over from top management.

Attewell [1] observed that most adoption/diffusion research in the IS area conforms to one of two distinctive styles: 'adopter studies' and 'macro diffusion studies'. The former primarily addresses understanding differences in adopter innovativeness, while the latter deals with characterizing the rate and pattern of adoption of a technology across a group of potential adopters [3]. This study would fit in the earlier category. Studies on adoption typically evaluate various environmental, organizational and technology characteristics that facilitate or inhibit adoption. Kwon and Zmud [15] in their review of innovation adoption literature in the management area identified five major categories of factors influencing adoption. They are product or innovation, organizational (or structural), environmental, task and individual characteristics. A brief review of factors in each category is provided below.

In a meta-analysis of 75 studies, Tornatzky and Klein [31] examined the relationship between *innovation* characteristics and adoption. The 10 characteristics they found most frequently used were relative advantage, complexity, communicability, divisibility, cost, profitability, compatibility, social approval, trialability and observability. Of these, relative advantage, compatibility and complexity were found to be consistently related to adoption. Recent studies in IT adoption have found these variables to be also important in the context of adoption of various information technologies [6, 24].

Research in IT adoption identifies many *organizational* factors that influence the adoption of IT [15]. They are: top management support, size, quality of IS, user involvement, product champion and resources (time, funding, technical skills). Product champions create the awareness and mobilize the support for the innovation. Top management's commitment ensures adequate resources for implementing the innovation [7, 12]. Palvia et al. [21] found that the use of computers in small businesses was influenced by the size of the business, computing skills of the owner/manager and the number of years the business has used computers. Once adopted, however, the extent of diffusion was influenced primarily by the size and age of the business [16].

The external *environment* also plays a significant role in the adoption of new technologies. Kwon and Zmud [15] claim that studies on the influence of organizational environments are generally undertaken from two different perspectives: as a source of information or as a stock of resource. When viewed as a source of information, factors such as heterogeneity (e.g. customer diversity) and uncertainty (e.g. instability and turbulence) are major attributes. When viewed as a stock of resource, factors such as competition in the adopter industry and in the technology-vendor industry, interfirm dependence and resource concentration/dispersion play an important role. The growth in interorganizational systems (IOS) and strategic business systems has highlighted the role of external environmental factors. Premkumar and Ramamurthy [25] found that trading partner exercise pressure to adopt IOS. Gatignon and Robertson [10] found that competitive pressure in the adopter industry, marketing support of suppliers and competition in the supplier industry have an impact on adoption. Studies in sociology have found that vertical linkages are the primary conduits for flow of technology to rural communities [32]. Delone [8] found that small businesses depend on external support for their IS applications.

Research studies have also examined the role of *task* characteristics, such as task structure, autonomy, uncertainty, etc. on innovation adoption [15]. However, when an innovation is used in different contexts with varying task characteristics it becomes difficult to generalize the results. *Individual* characteristics, such as education, age, experience, psychological traits, etc. have been found to strongly influence innovation adoption [27, 30]. IT adoption literature examines adoption under two broad categories — individual and organizational adoption [9]. While individual characteristics are considered for the first category, it is normally not included for studying the second category, organizational adoption, since the adoption decision is a collective decision based on a consensus of a group of decision makers, rather than one individual [27]. Once an adoption decision is made, most often it is not optional for the employees to adopt or not adopt the innovation.

Since this study is examining adoption at the organizational level, individual characteristics were not considered in this study. Also, the technologies examined in this study spanned multiple tasks and therefore task specific characteristics were not considered appropriate. Hence, in this study we are examining the influence of innovation, organizational and environmental characteristics on adoption of communication technologies in small businesses.

3. Research model and hypotheses

The research model is illustrated in Fig. 1. It describes the impact of three sets of antecedent factors — innovation, organizational and environmental characteristics — on the adoption of information technologies in small businesses.

The innovation characteristics considered are relative advantage, cost, complexity and compatibility; the organizational characteristics are top management support, IT-expertise and size of the business and the environmental characteristics are competitive pressure, vertical linkages and external support. The dependent variable, adoption of information technology, is a dichotomous variable based on adoption of four communication technologies — e-mail, online data access, internet access and EDI. A brief justification for the variables selected followed by research hypotheses for each variable is provided in this section.

The primary focus of this study is adoption of communications technologies. Based on an initial study we found that the communications technologies most used are fax, online access to computers, electronic mail, electronic-data-interchange and internet. Since fax is ubiquitous and well diffused in the society, we did not consider it relevant for our study. The remaining four technologies can be broadly termed as computer-mediated communications technologies. Since all the four technologies require computer interaction, prior research on IT adoption can be used for developing the research model. Electronic mail (e-mail) is becoming very popular for communication among business partners. Often, while dealing with large firms, small businesses have to use e-mail to facilitate communication. Further, small businesses also find it cost-effective to have e-mail as it provides asynchronous communication. Electronic data interchange (EDI) provides an automated transfer of business transaction communication between computers of trading partners. The benefits of lower labor costs, accuracy of data, reduced turnaround time and pressure from large trading partners have made EDI very popular among businesses [24]. While e-mail and EDI provide, respectively, unstructured and structured transfer of messages between trading partners, online data access provides remote access capability to trading partners' computers. This allows firms to directly interact with partner's computer, and enter or retrieve information from

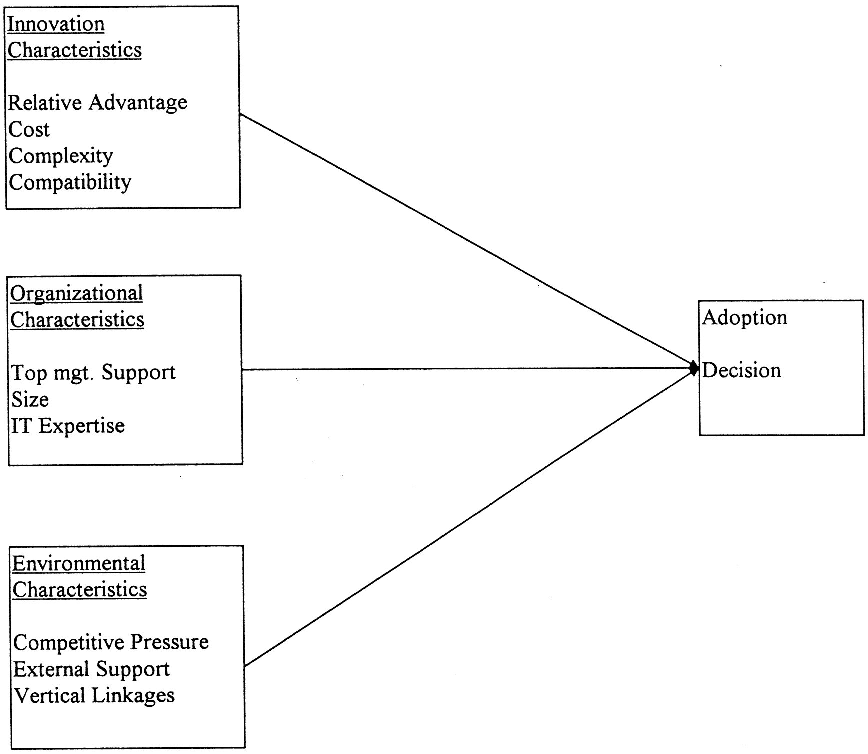

Fig. 1. Research model.

it. Very often, this communication option is used in tightly integrated firms such as subsidiaries/franchises of the parent organizations. The parent organization makes available its computers and its IS applications to their subsidiaries or franchisees. For example, they may use the parent's point of sale (POS) system or their inventory system. Internet as a communication technology for electronic commerce has attracted considerable media hype and created interest among businesses to exploit this technology. However, the implementation of these technologies for true business-to-business communication in the small-scale sector is yet to be determined.

The four innovation characteristics considered in this study were found to be consistently significant in studies of innovation adoption [31] and IT adoption/diffusion [24]. Among the organizational factors top management support and size have been found to be important in many studies on IT adoption and IS implementation [7, 17, 21]. Since IS expertise and experience has been found to be directly related to a variety of organizational IS characteristics and MIS success [8, 21, 26], the internal expertise variable was included in the model. External environment plays a significant role in adoption of communication technologies since these are interdependent technologies whose utility increases only if their trading partners use them [18]. Hence, there is increasing pressure exerted by external partners to adopt these technologies [11, 25]. If a firm is tightly integrated with another firm (as a franchisee or subsidiary), vertical linkages to the parent organization becomes an important factor [32]. Also, the external support from vendors is critical for small firms without adequate IT expertise to try out these new technologies [8].

3.1. Relative advantage

Rogers [27] defined relative advantage of an innovation as the degree to which the innovation is perceived as better than the idea it supersedes. Studies have found it to be a significant variable, positively related to the adoption of innovation [15, 24, 27, 31]. A rational adoption decision in an organization would involve evaluating the advantages of the new technology. These communication technologies provide many benefits to the adopters in terms of reduced turnaround time, better customer service, reduced costs and timely information availability for decision making. In a competitive market place these benefits create significant motivations for adopting these technologies.

Hypothesis 1. *The greater the perceived relative advantage of new communication technologies the more likely they will be adopted.*

3.2. Cost-effectiveness

Firms would like the benefits from the adoption of a new innovation to be commensurate with the costs associated with the adoption of the innovation. Tornatzky and Klein [31] states that technologies that are perceived to be low in cost are more likely to be adopted. Premkumar et al. [24] found cost-effectiveness to be an important variable in the context of EDI. Palvia et al. [21] pointed out that cost is no longer a bottleneck for small businesses to adopt new information technologies due to advent of powerful PC's, rapidly declining hardware and software prices and the availability of ready-to-use user-friendly software packages. However, for small businesses the cost of hardware/software is still a big deterrent to adoption, and therefore firms evaluate the cost relative to the benefits before adopting a new technology.

Hypothesis 2. *Firms that perceive greater cost effectiveness, i.e. benefits from adoption of new communication technologies greater than the costs, are more likely to be adopters of these technologies.*

3.3. Complexity

Complexity is the degree of difficulty associated with understanding and learning to use an innovation [27]. The complexity of the technology creates greater uncertainty for successful implementation and therefore increases the risk in the adoption decision. Hence, it is negatively associated with adoption [6, 11]. The proliferation of standards and protocols and multiplicity of hardware and software make implementation of communication technologies a very complex task.

Hypotheses 3. *The lower the perceived complexity of communication technologies the more likely they will be adopted.*

3.4. Compatibility

An innovation's compatibility is defined as the degree to which it is perceived as being consistent with the existing values, past experiences and needs of the potential adopter [27]. Tornatzky and Klein [31] in their meta-analysis found it to be an important determinant of adoption. The use of computers and modern communication technologies can bring in significant changes to the work practices of businesses and resistance to change is a normal organizational reaction. It is important, especially for small businesses, that the changes are compatible with its values and belief systems to ensure that the owner would adopt the new technologies.

Hypothesis 4. *The greater the perceived compatibility of new communication technologies with current infra-*

structure, values and beliefs the more likely they will be adopted.

3.5. Top management support

Several studies have found top management support to be critical for creating a supportive climate and providing adequate resources for adoption of new technologies [12, 15, 27]. Delone [7] found that top management commitment is critical to success of small business systems. Their support is more critical for communication technologies since the use of these technologies requires the cooperation of the trading partners [25]. Senior management of the trading partners often have to closely interact to create electronic business partnerships, examine legal and other issues and facilitate the adoption of these technologies. In small businesses the decision-maker is very likely to be in the top management team and therefore should have his/her support.

Hypothesis 5. *The greater the top management support for new communication technologies, the more likely they will be adopted.*

3.6. IT expertise

Expertise is an important factor in the adoption of new technologies and has been found to be positively related to adoption [15, 26]. Firms that do not have the IT expertise may be unaware of new technologies or may not want to risk the adoption of these technologies.

Hypothesis 6. *The greater the IT expertise available in the organization the more likely communication technologies will be adopted.*

3.7. Size

The size of the organization has been shown by several studies to impact the adoption of new technologies [8, 13, 14, 17, 21, 27]. Larger organizations are found to have greater slack in resources and are therefore able to experiment with new innovations. They are also able to more easily mobilize adequate financial resources required for implementing innovations. Even within the small business category the larger ones are able to take risks with new technologies [21].

Hypothesis 7. *The bigger the size of the business the more likely communications technologies will be adopted.*

3.8. Competitive pressure

Competition in the adopter's industry is generally perceived to positively influence the adoption of innovation [10]. This would be even more evident if the innovation directly affects the competition. Prior research on communications technology, particularly EDI, has shown that it has become a strategic necessity to have these technologies to compete in the market place [25]. For example, many firms adopted EDI due to demand from customers to improve the efficiency of their interorganizational transactions. Small businesses are more vulnerable to customer pressure since they are more likely to be economically dependent on the bigger customers for their survival. This is amply illustrated by the experience of small firms adopting EDI to satisfy the demands of large firms such as Walmart or GM. Firms also create electronic links with their suppliers to reduce their operations costs and thereby be more competitive in the market place.

Hypothesis 8. *The greater the competitive pressure the more likely communications technologies will be adopted.*

3.9. Vertical linkages

Strong vertical linkages of franchises/subsidiaries to their parent organizations facilitate the transfer of technologies and new innovations [32]. The larger parent organization can use its size advantage to experiment with technology and innovations and then transfer the innovation to the smaller units. Firms may also be required by their franchiser or parent unit to have certain information technologies to communicate with them. It could be an online data access system or EDI to order supplies or to communicate financial and sales information to them.

Hypothesis 9. *Firms with vertical linkages are more likely to adopt communications technologies.*

3.10. External support

External support refers to the availability of support for implementing and using an information system. While some studies have not found external support to be important for MIS success [7, 26], other studies have found the availability of external support to be positively related to adoption [8, 10, 15]. The popularity of outsourcing and the growth in third party support has had a significant impact on adoption of new technologies. Organizations are more willing to risk trying new technologies if they feel there is adequate vendor or third party support for the technology.

Hypothesis 10. *The greater the external support for communication technologies the more likely they will be adopted.*

4. Research methodology

4.1. Measurement

The variables identified in the research model were measured using multi-item indicators that aimed to capture the underlying theoretical domain of the construct. Most of the items were measured using a five point Likert-type scale ranging from strongly disagree to strongly agree. A single item was used to determine if the respondents adopted each one of the four communications technologies — online data access, e-mail, Internet access and EDI.

Relative advantage was measured based on items adapted from Premkumar et al. [24]. The items assessed the perceived benefits of these communications technologies to the firm. Compatibility was assessed by two items that determined if these technologies were compatible with the firm's beliefs and value systems and work practices. Cost-effectiveness was measured by three items that determined the cost-effectiveness of these technologies in terms of costs relative to benefits. Top management support assessed the level of top management commitment to the technologies using four items. The items for these three constructs were adapted from Premkumar et al. [24]. Size of the firm could be assessed by both sales revenue and number of employees [21]. Typically, small businesses are reluctant to provide their sales revenue for confidentiality reasons. Although we used both measurements for assessment of size, the lack of response on sales revenue forced us to use the number of employees as a measure of size. IT expertise was assessed by number of years of computer experience [21, 26]. Competitive pressure was assessed by four items, adapted from Premkumar and Ramaurthy [25]. External support was assessed by five items that evaluated the level of support from vendors and local community agencies. Vertical linkages was measured by a single item that determined if the firm was independent, or was a franchise or subsidiary to a parent organization with vertical linkages. The items used for measurement are provided in Appendix A.

4.2. Data collection

A survey instrument was developed to measure the variables. Apart from the research variables the instrument had other questions that assessed the general levels of use of various communications and information technologies. The instrument was pilot tested with six firms. One of the researchers was present during pilot testing to get their feedback as well as identify other key issues that may have been left out. Based on their responses, the instrument was refined.

The data for the study were collected from a field survey of five rural communities in a mid-western state in US. These communities were chosen as a part of a larger study that used various criteria for choosing a community such as size of community, availability of state sponsored fiber-optic network services, geographic location, and remoteness from urban cities. Businesses were identified by interviewing personnel in community agencies such as chambers of commerce and department of economic development, as well as referrals from other businesses in the community and telephone directories.

A common problem with a survey-based research methodology is the inability to have face-to-face interaction with the respondent. The researcher hopes that the items are self-descriptive and the respondent answers them in the context as envisioned by the researchers. Although pilot testing to some extent enables the researcher to refine the instrument, remove biases and set the right context for the respondent, it still constrains the researcher from engaging the respondent in a dialog to enable him/her to reflect on their organization and respond accurately to the questions. To overcome this drawback we chose to collect data through a face-to-face interview, using the survey instrument to provide the structure for the discussion.

A senior person in each of the businesses selected was contacted by telephone and asked to participate in this study. The purpose of the survey was explained during the initial telephone contact and an additional interview was set up to meet with the person most qualified to complete the questionnaire at a subsequent date. On an average each questionnaire took about 30–45 min to complete. For a few respondents who wanted to participate in the study, but who did not have the time to meet at a subsequent date, the questionnaire was mailed to them, and picked up at a mutually agreed upon time and date. A total of 78 usable responses were obtained.

4.3. Sample characteristics

The characteristics of the sample are shown below in Table 1.

Several industry sectors were included in the sample. Retail and wholesale sector were the largest category followed by financial, insurance or real estate sector. The sample included firms of varying sizes. The sample had firms with different levels of computer experience.

4.4. Assessment of the validity and reliability of the research constructs

The constructs were tested for two psychometric properties, validity and reliability, to ensure that the measurement was accurate and sound. While validity

Table 1
Sample characteristics

	Number of firms	Percentage
Industry		
Manufacturing	11	14.1
Retail sales and wholesale trade	28	35.9
Service	14	17.9
Finance, insurance or real estate	19	24.4
Other	6	7.7
Company size		
Less than five employees	36	46.2
6–10 employees	11	14.1
11–15 employees	4	5.1
16–20 employees	3	3.8
21–25 employees	2	2.6
More than 25 employees	20	25.6
Annual sales revenue		
Less than US$1 million	24	50
US$1 to US$10 million	16	32
US$10 to US$20 million	4	8
US$20 to US$50 million	2	4
More than US$50 million	3	6
Do not know	29	
Computer experience of company		
Less than 5 years	21	26.9
6–10 years	28	35.9
More than 10 years	28	35.9

assesses the degree to which the items measure the theoretical construct, reliability assesses the stability of the scale based on an assessment of the internal consistency of the items measuring the construct [5]. Validity was assessed through content, convergent and discriminant validity. Content validity assesses if the measurement covers the complete domain of the construct; convergent validity evaluates if all the items measuring the construct cluster together to form a single construct; and discriminant validity measures the degree to which a concept differs from other concepts and is indicated by a measure not correlating very highly with other measures from which it should theoretically differ [5].

Content validity was established through the extensive process of item selection and refinement in the development of the instrument. The items used for measuring the constructs were derived from operationalizations used in prior empirical studies (discussed in Section 4.1), and were adapted to suit this research context. A team of researchers involved in the larger project scrutinized the items and ensured that it measured the appropriate domain of the construct and covered the complete domain of the construct. Extensive pilot testing of the instrument ensured that the items were relevant from a practitioner's perspective.

Convergent and discriminant validity was evaluated using principal component factor analysis. Factor analysis of multi-item indicators can be used to evaluate if the theorized items for a construct converge together for convergent validity. The extent of cross-loading of an item on other factors where it does not theoretically belong can be used to examine discriminant validity. The results of factor analysis along with general statistics are shown in Tables 2 and 3.

The standard criteria of eigen-value greater than 1.0, factor loadings greater than 0.3 and a well-explained factor structure were used in the analysis [34]. The items loaded on six factors that directly mapped with the theorized constructs. The cross-loading of items on other factors was also minimal, except in two instances. In the first instance, the three items measuring *cost* loaded with the items measuring *relative advantage* in the overall factor analysis, raising doubts whether they were two separate constructs. However, an independent factor analysis of the items measuring just these two constructs revealed that they loaded on two separate factors mapping to the two constructs. Based on the results of the independent factor analysis and findings from prior research that has clearly differentiated these two variables, it was decided to consider them as two separate variables. In the second instance, the four items measuring competitive pressure loaded on two separate factors (two items each), one measuring competitive pressure to adopt the innovation and another measuring the external pressure applied by suppliers and customers. Hence, we split them into two variables — competitive pressure and external pressure.

The reliability of the constructs was assessed using Cronbach's α. The results in Table 2 indicate that all the constructs have adequate α-values (>0.6), except for complexity (0.56). The low value could be attributed to using only two items for measuring the variable. α-values are sensitive to the number of items used for

Table 2
Validity and reliability properties

Variable	No. of items	Mean	S.D.	α-value
Relative advantage	4	3.77	0.72	0.72
Cost	3	2.96	0.80	0.68
Top management support	4	3.59	0.92	0.86
External support	5	2.34	0.86	0.78
Competitive pressure	2	3.43	1.12	0.81
External pressure	2	2.51	1.08	0.75
Complexity	2	1.96	0.90	0.56
Compatibility	1	2.23	0.86	

Table 3
Factor analysis

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
Cost1	0.814					
Cost2	0.742					
Rel3	0.678					
Rel4	0.660					
Cost3	0.656					
Rel1	0.480					
Rel2	0.450					
Topmgt2		0.795				
Topmgt3		0.780				
Topmgt1		0.675				
Topmgt4		0.637				
Extsupt3			0.841			
Extsupt4			0.757			
Extsupt5			0.739			
Extsupt1			0.705			
Extsupt2			0.615			
Comppres1				0.650		
Comppres2				0.467		
Extpres1					0.872	
Extpres2					0.763	
Complex2						0.770
Complex1						0.746
Eigen Value	6.12	2.95	1.96	1.88	1.57	1.41
Var. Explain	26.6	12.9	8.5	8.2	6.6	6.2

measuring a construct. Assessment of interitem correlation is an alternate approach to evaluate reliability and in our case the correlation coefficient between the two items measuring complexity was 0.4072, which was significant at $p < 0.001$. Hence, complexity exhibits adequate reliability.

4.5. Status of communication technologies used by small businesses

One of the broader objectives of the study was to determine the level of information and communication technology use in small businesses in rural commu-

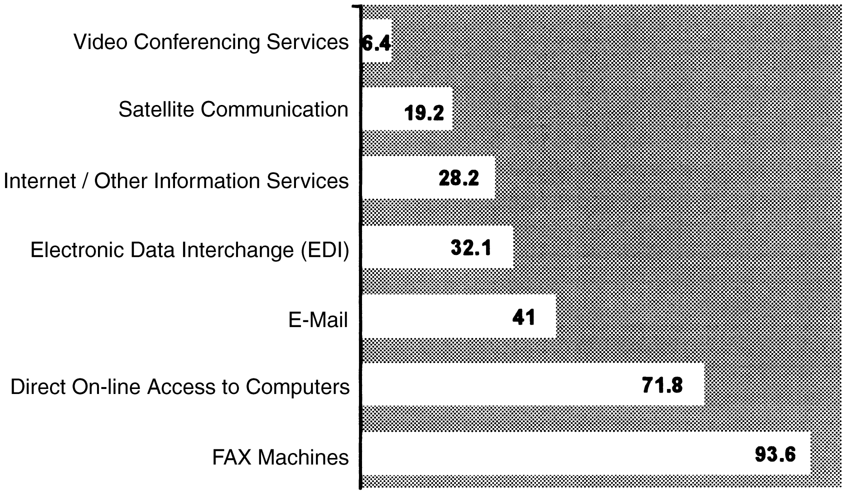

Fig. 2. Communication technologies.

nities. Fig. 2 illustrates the use of communications technologies.

Fax is the most prevalent communication technology used by over 93% of the firms. This is followed by direct online data access used by 70% of the firms. 32% of the sample reported using EDI in their operations. Since all communication technologies are interactive and require two or more participants, the utility of the technology increases as the number of users increase and is most useful when there is universal access. Initially, we need a critical mass of users to enable the technology reach a threshold level of usefulness that will motivate potential adopters to adopt the technology [18]. For example, fax has almost reached universal access among businesses to become a common medium for business communication compared to EDI or other technologies.

Fax is the most used communications technology as it is considered as an extension to the telephone, it is easy to use, relatively inexpensive and accepted as formal document for most business transactions. However, fax is inefficient, since the information undergoes multiple transformation from paper to electronic format leading to data reentry at both ends. Direct *online access* is a more efficient way to transmit the information as it avoids the conversion. However, compatibility and security issues may prevent a firm from providing direct computer access to its trading partners. Also online access is normally restricted to only a few transaction communication rather than a whole range of business communication. It is also inefficient if you need to make multiple connections with different trading partners. E-mail provides the broadest scope for communication and is closest in analogy to the paper mail system. However, e-mail is normally restricted to text-based messages, and the information has to be transformed to be used in other transaction applications. EDI overcomes this drawback as it lets transaction information be directly transferred from sender's application to receiver's application without manual intervention. However, it is a more complex technology that requires extensive cooperation and trust between the two trading partners. Internet access is the latest communications technology that lets you access as well as disseminate information world-wide and has the potential to subsume all the earlier technologies. Satellite communications is more complex and requires more investment and expertise. Video conferencing is a newer technology compared to the others in the study and requires significant investment. While used to some extent in large corporate organizations, it is still a rarity in small businesses, particularly in rural communities where the bandwidth may not be available to support this application.

Table 4 shows the communication media currently being used by the organizations for common business transaction communications with customers and suppliers.

Except for sales invoice that is currently sent through the US mail/fedex service, the telephone/facsimile is the most popular media. EDI and e-mail are being used to a limited extent in purchase orders and shipment information.

The software applications used by the respondents are shown in Fig. 3.

The number of firms using the three basic computer packages (word processing, spreadsheet and database) is very high. Among the business applications accounting systems are the most popular (96.2%) followed by customer billing (84.6%) and payroll systems (79.5%).

5. Results

Multivariate discriminant analysis was used to test the research hypotheses. It provides a statistical procedure to identify the research variables that best discriminate between adopters and nonadopters. This is a more powerful and accurate statistical procedure that provides a multivariate estimation compared to a bivariate *t*-test approach of comparing means of variables between the two groups independently. Discriminant analysis involves deriving a linear combination of one or more research variables that will best discriminate between the a priori defined groups [13]. The objective of the analysis is to maximize between-group variances relative to within-

Table 4
Communications media for business transactions

Transaction	Face-to-face (%)	US Mail/Fedex (%)	Telephone/fax (%)	E-mail (%)	EDI (%)	Online data access (%)
Purchase orders	1	2	49	–	18	30
Shipment information	–	14	51	1	17	17
Sales orders	7	11	64	–	11	7
Sales invoice	6	48	38	1	3	4

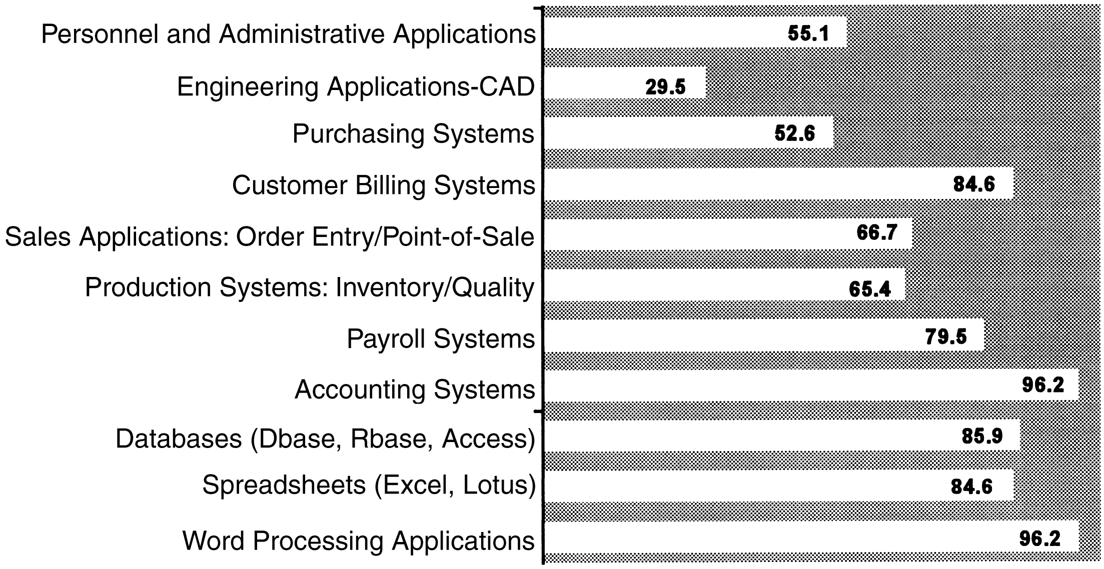

Fig. 3. Software applications.

Table 5
Discriminant analysis — online data access.
Wilk's Lambda = 0.6045, χ^2 = 34.21, df = 8, sig. = 0.0001

Variable	Discrim. coefficient	Discrim. loading	Univariate analysis group mean (S.D.) adopter	nonadopter	sig.
Relative advantage		0.389	3.92 (0.61)	3.43 (0.77)	0.005
Cost	0.405	−0.132	2.93 (0.81)	3.12 (0.69)	0.385
Compatibility	0.389	−0.394	1.80 (0.83)	2.42 (0.96)	0.008
Complexity		−0.381	2.06 (0.83)	2.63 (0.72)	0.009
Top management support	0.531	0.385	3.77 (0.93)	3.15 (0.65)	0.01
IT expertise	0.262	0.260	11.68 (5.25)	9.15 (5.44)	0.07
Size	0.556	0.455	0.34 (0.47)	0.00 (0.00)	0.002
Competitive pressure		0.453	3.69 (0.95)	2.78 (1.21)	0.001
External pressure	0.517	0.439	2.75 (1.00)	1.94 (1.01)	0.003
Vertical linkages	0.233	0.30	0.58 (0.49)	0.31 (0.47)	0.04
External support	−0.435	−0.177	2.26 (0.90)	2.54 (0.74)	0.22

Classification accuracy

	total	adopters	nonadopters
Adopter	55	42 (76.4)	1 (23.6)
Nonadopter	19	2 (10.5%)	17 (89.5%)
Overall accuracy	79.73%		
Chance accuracy	61.0%		
Sig.	0.001		

Table 6
Discriminant analysis — e-mail.
Wilks Lambda = 0.7108, χ^2 = 23.894, df 4, sig. = 0.0001

Variable	Discriminant coefficient	Discriminant loading	Univariate analysis group mean (S.D.)		
			adopter	nonadopter	sig.
Relative advantage		0.457	4.06 (0.58)	3.61 (0.69)	0.004
Cost		−0.287	2.82 (0.72)	3.09 (0.80)	0.15
Compatibility		−0.108	1.80 (0.87)	2.06 (0.91)	0.215
Complexity	0.264	−0.155	2.11 (0.82)	2.27 (0.84)	0.40
Top management support	0.823	0.565	3.97 (0.75)	3.35 (0.92)	0.003
IT expertise	0.498	0.446	12.75 (5.58)	9.79 (4.94)	0.018
Size	0.675	0.522	0.41 (0.50)	0.13 (0.35)	0.006
Competitive pressure		0.451	3.85 (0.95)	3.17 (1.11)	0.007
Vertical linkages		−0.007	0.51 (0.50)	0.51 (0.50)	0.97
External pressure		0.263	2.90 (1.01)	2.29 (1.03)	0.013
External support		0.073	2.42 (0.81)	2.26 (0.81)	0.44

Classification accuracy

	total	adopter	nonadopter
Adopter	31	23 (74.2%)	8 (25.8%)
Nonadopter	43	8 (18.6%)	35 (81.4%)
Overall accuracy	78.38%		
Chance accuracy	50.64%		
Sign.	0.001		

Table 7
Discriminant analysis — EDI.
Wilks Lambda = 0.7649, χ^2 = 18.224, df = 6, sig. = 0.005

Variable	Discriminant coefficient	Discriminant loading	Univariate analysis group mean (S.D.)		
			adopter	nonadopter	sig.
Relative advantage	0.942	0.469	4.04 (0.46)	3.67 (0.75)	0.03
Cost	0.643	−0.036	2.96 (0.72)	2.99 (0.82)	0.86
Compatibility		−0.079	1.80 (0.81)	2.06 (0.93)	0.23
Complexity		−0.046	2.14 (0.85)	2.27 (0.82)	0.52
Top management support		0.096	3.62 (0.84)	3.59 (0.95)	0.88
IT expertise		0.046	11.06 (4.09)	11.14 (5.97)	0.94
Size	0.625	0.617	0.44 (0.50)	0.14 (0.35)	0.00
Competitive pressure	−0.616	0.096	3.54 (0.99)	3.41 (1.15)	0.66
Vertical linkages		0.157	0.64 (0.49)	0.43 (0.50)	0.10
External pressure	0.511	0.424	2.90 (1.04)	2.39 (1.02)	0.65
External support	−0.396	−0.094	2.29 (0.91)	2.38 (0.91)	0.05

Classification accuracy

	total	adopter	nonadopter
Adopter	25	15 (60%)	10 (40%)
Nonadopter	48	16 (33.3%)	32 (66.7%)
Overall accuracy	64.38%		
Chance accuracy	56.0%		
Sig.	0.01		

Table 8
Discriminant analysis — Internet;
Wilks Lambda = 0. 8367, $\chi^2 = 12.47$, df = 4, sig. = 0.01

Variable	Discriminant coefficient	Discriminant loading	Univariate analysis group mean (S.D.)		
			adopter	nonadopter	sig.
Relative advantage	1.00	0.552	4.05 (0.56)	3.70 (0.70)	0.042
Cost		−0.377	2.85 (0.63)	3.03 (0.83)	0.388
Compatibility	0.548	0.217	2.09 (0.83)	1.90 (0.92)	0.416
Complexity		0.046	2.26 (0.71)	2.18 (0.88)	0.736
Top management support		0.342	3.72 (0.90)	3.56 (0.91)	0.505
IT expertise		0.017	12.00 (4.06)	10.65 (5.81)	0.334
Size		0.094	0.33 (0.48)	0.22 (0.42)	0.349
Competitive pressure		0.347	3.71 (0.99)	3.35 (1.12)	0.495
Vertical linkages	−0.601	−0.383	0.38 (0.49)	0.56 (0.50)	0.155
External pressure		0.234	2.66 (0.99)	2.50 (1.09)	0.209
External support	−0.531	−0.182	2.22 (0.81)	2.37 (0.88)	0.545

Classification accuracy

	total	adopter	nonadopter
Adopter	22	14 (63.6%)	8 (36.4%)
Nonadopter	54	18 (33.3%)	36 (66.7%)
Overall accuracy	65.79%		
Chance accuracy	60.01%		
Sign.	0.1		

group variance. Step-wise variables selection, with the selection criteria of minimizing Wilks Lambda and a tolerance level of 0.001, was used to generate the discriminant function.

Separate discriminant models were generated for the four communication technologies — online access, e-mail, Internet and EDI. The value of Wilks Lambda, the χ^2 value and the level of significance are shown in Tables 5–8. All the four models were significant at $p < 0.01$.

The standardized discriminant coefficients and discriminant loadings for the variables are given in the table. Univariate statistics in terms of group-wise means and *F*-value significance on equality of means are also provided for comparative analysis. Discriminant loadings (also known as structure correlation), measuring the simple linear correlation between each predictor variable and the extracted discriminant function, is used to determine the significance of the variables. While there are no rigid rules about the goodness of these values, the general guidelines are that values above 0.3 are satisfactory and acceptable [13]. While discriminant loading evaluates the significance of the variables, classificatory test determines the ability of the model to classify accurately. The classification test compares the classificatory ability of the discriminant model to the chance model [13]. Chance accuracy is determined by the formula $p^2-(1-p)^2$ where 'p' is the proportion of the sample in the first group. For a sample with equal number in both the groups the value of 'p' will be 0.5. The chance accuracy for each of the four models was calculated and compared with the value for the discriminant model. A *t*-test was used to determine if the discriminant model was statistically better than the chance model. In all the cases the discriminant model was significantly better than the chance model.

The first model for 'online data access' (Table 5) was significant at $p < 0.001$. The significant variables were: relative advantage, complexity, external support, competitive pressure, external pressure, compatibility, size and top management support. The univariate *F* statistics also indicate that these variables were significant independently as well. The classificatory ability of the model was 79.73% and the *t*-test indicates that it is better than the chance model.

Table 9
Summary table of significant variables

Variable	Hypothesis	Online data access	E-mail	EDI	Internet
Relative advantage	1	X	X	X	X
Cost	2				X
Compatibility	3	X			
Complexity	4	X			
Top management support	5	X	X		X
IT expertise	6		X		
Size	7	X	X	X	
Competitive pressure	8	X	X		X
External pressure	8	X		X	
Vertical linkages	9	X			X
External support	10				

The second model for 'e-mail' (Table 6) was significant at $p < 0.0001$. The independent variables that were most significant were: relative advantage, size, top management support, competitive pressure and IT expertise. The classificatory ability of the model was 78.38% and the t-test indicates that it is better than the chance model.

The third model for 'EDI' (Table 7) was significant at $p < 0.001$. The independent variables that were most significant were size, relative advantage and external pressure. The classificatory ability of the model was 64.38% and the t-test indicates that it is better than the chance model.

The fourth model for 'Internet' (Table 8) was significant at $p < 0.01$. The independent variables that were most significant were relative advantage, vertical linkage, top management support, cost and competitive pressure. The classificatory ability of the model was 65.79% and the t-test indicates that it is better than the chance model.

Table 9 presents the results of the four models along with the hypotheses numbers in a summarized form. It helps to identify patterns and variations among the four communication technologies.

6. Discussion of results

The summary table indicates that *relative advantage* is the only significant variable to discriminate adopters from nonadopters in all the four communication technologies, thereby providing strong support for hypothesis 1. This is consistent with the results of prior studies that have found it to be a significant variable for initiating many innovations [11, 24, 31]. Firms adopt technology only if they perceive a need for the technology to overcome a perceived performance gap or exploit a business opportunity. During the interviews some of the benefits mentioned by the adopters were reduced turnaround time, increased transaction speed, access to current information and reduction in data entry errors. Among the nonadopters, while some of them were not aware of the benefits of the technology, a few were aware of the technology but did not find any need for these technologies in their businesses. It was particularly apparent in the context of Internet. While media hype extolled the role of Internet in business communication many small businesses were using a 'wait and see' strategy since they could not see a direct benefit for this technology from their business perspective.

Top management support, size and competitive pressure were found to be important determinants for three of the four communications technologies, partially supporting hypotheses 5, 7 and 8. Top management's vision and commitment to the innovation is essential, especially in small businesses, to get adequate resources and support to implement the innovation. This is consistent with findings from prior studies in small business [7]. Their support becomes more important for communications technologies since it involves interaction with trading partners and creating business agreements for using the technology. The use of these technologies could significantly change the way business is done within the organization as well as externally with its trading partners. Top management's commitment is required to overcome the resistance to change that is normal in such situations. In small firms it is likely that the owner/manager may be the top management and if he/she is not convinced of the technology it is very unlikely to be adopted. It is not clear why it did not turn out to be a significant variable for EDI adoption, which is inconsistent with prior studies on EDI. Perhaps, the overwhelming influence of external pressure reduced the impact of top management support.

Size was found to be a critical variable even within the small business category with more larger firms adopting these technologies compared to smaller ones. This is consistent with prior studies that have found size to a critical factor in IT adoption and use [21]. Larger companies have the resources to invest in technologies and the organizational slack to experiment with them. Other factors, perhaps, also facilitate their adoption of these technologies. They may have inhouse IS support service that could create the awareness, and initiate and facilitate the adoption of these technologies. The really smaller firms may be small enough to be managed without these technologies and therefore there may not feel the need for these technologies.

Another important variable was *competitive pressure*. The digital revolution combined with the availability of network infrastructure has made it technically feasible and a socially acceptable business practice to use electronic means for business communication. Hence, it has become a strategic necessity for firms to have these technologies [11]. A closely related factor that was significant in two of the models was *external pressure*. Since the benefits of communication technologies are only realized if there is a critical mass of adopters many firms are requesting, and sometimes requiring, their trading partners to be linked electronically with them to realize the full benefits of the technology [11]. This is particularly true in the case of EDI [25]. For example in the retail industry, large store chains have insisted on their suppliers to use EDI. Some firms, particularly parent-subsidiary firms, provide direct online access to their computers to facilitate electronic communication.

A factor that came out in many of the interviews, especially for firms that were franchisees or subsidiaries or divisions, was that the flow of technology came from their parent unit through *vertical linkages*. Very often, the corporate unit acquired the expertise and developed the necessary systems and then implemented the system in the local unit. Most often these are implemented as direct online access systems. It provides the ability to directly interact with the server in the parent organization and is the most convenient form of connection. It is interesting that there was a significant negative association between vertical linkages and Internet adoption. Firms with vertical linkages very often do not have the need to use other means to communicate, since their primary communication is with their parent unit. For firms without vertical linkages internet is a good option for communication.

Technology adoption literature, particularly in sociology, identifies two variables, vertical and horizontal linkages that are critical for adoption of new technology [32]. While vertical linkages are more useful for initiation of new technologies, horizontal linkages in terms of internal initiatives are better for ensuring sustained diffusion of the technology [22, 26]. The authors found during their interviews, that while vertical linkages facilitated innovation adoption it did not necessarily lead to awareness or diffusion of technology within the company. For example, in a telemarketing firm, none of the employees was aware that their computers had modems that could link up with computers in their parent organization, even though at the end of the day they were uploading all their data to the corporate office using the modems. Their knowledge was limited to clicking a button on the screen to send the data without realizing that they were using online data access for file transfer. In another instance, a retail firm, which is part of a national chain, used online data access in their point-of-sale terminals to access price and inventory information from a corporate database for their daily sales operations. The employees in the store were unaware that they were communicating with a remote computer in the corporate office. In these situations, the local people were never involved in the implementation and therefore never thought of newer methods of exploiting the technology and become more productive and competitive.

Rogers [27] identifies different levels of knowledge about innovation in terms of what is the innovation, how does it work and why does it work. The first question provides the 'awareness knowledge' on the innovation, the basic information requirement for making an adoption decision. The next level, 'how to knowledge', is essential to use an innovation effectively. The amount of 'how to' knowledge required increases as the complexity of the innovation increases. Finally, 'principles-knowledge' provides information on the functioning principles and basic theories on the innovation. Normally, this knowledge is not essential for using an innovation, but would be required if the adopter has to troubleshoot or improve the existing innovation. It is important for a firm to determine the level of knowledge required for its employees. Are computer technologies as simple as telephones to provide only 'how to' knowledge or do we need to provide more knowledge to enable the users to find innovative uses? This would have a bearing on the training and education provided to its employees.

One variable, external support, was not found to be significant for all the four communications technologies, thereby rejecting hypothesis 10. The evidence from prior studies on significance of external support has been inconclusive. While Delone [8] found it to be an important variable, others [7, 26] did not find it to be a critical variable for computer success. There could be many reasons for lack of significance in this study. Firstly, a few variables may have had such an overwhelming influence on the adoption decision it paled the influence of other variables. For example, vertical linkages provide the necessary support to adopt online data access that external support may not be necessary for that technology. Also in the case of EDI, the trading partner who exerts external pressure to adopt EDI may also provide the expertise to adopt and implement the technology. Secondly, the level of external support in terms of vendor and 3rd party agencies is the same for both adopters and nonadopters, since both categories of firms could tap into those resources. Hence, it is not a significant variable to discriminate between adopters and nonadopters. A second reason could be attributed to the technology itself. If we examine the pattern in Table 9 we find that complexity of the technology and IT expertise were also found to be not significant for three of the four technologies. It may suggest that firms (both adopters and nonadopters) perceive the technology to be simple, have the IT expertise and do not require external support to adopt the technology. This argument, if true, is a welcome trend that indicates that computers have finally become simple to use for even nonsophisticated users. However, the large market for third party support (particularly EDI) makes us doubt this assertion. More research is required to determine the exact reason for this result.

7. Summary

New information technologies have opened up many new opportunities for small businesses in rural communities as well as exposed them to additional risks. This study, based on prior research in innovation adoption, identified 11 variables under three broad categories (innovation, organizational and environmental) and evaluated their influence on adoption of four communication technologies (online data access, e-mail, EDI and internet). A structured survey instrument was developed to measure these variables and data were collected from 78 organizations using a structured interview process. Discriminant analysis was used to identify determinants for adoption of four communications technologies. The results indicate that relative advantage, top management support, size, external pressure and competitive pressure were important determinants to the adoption of communications technologies by small businesses in rural communities.

The study has some limitations that need to be recognized. The small sample size, due to our face-to-face interviews, reduced the power of our statistical analysis. A large-scale field survey could be used to collect data that can validate the model on a larger scale and provide greater generalizability of the results. Further, it was done in the US and needs to be replicated in other countries. Also, two of our variables used fewer than three items for measurement. Future studies should examine the construct in greater detail and identify a few more items that would provide more reliability to the measurement instrument.

8. Implications of the study

The research findings from this study have significant implications for the researchers. While prior studies focused on traditional IS applications, this study provided insights on adoption of communication technologies. Studies on small businesses have generally focused on MIS success and usage rather than adoption of information technologies. This study extended the knowledge of IT adoption in corporate setting to small businesses in rural communities.

This study provides the impetus for future research on many issues. This study was only concerned with adoption of technology. A majority of adopters indicated that external forces such as competitive pressure, customer/supplier requirement, etc. are important factors that influenced their adoption decision. Given that external directive provides fast adoption rate but slow usage diffusion, future research could examine the other phases of adoption/diffusion, and identify the factors and their influence on the diffusion of these technologies.

Another interesting topic would be to examine the specific industry wide differences in use of IT in rural communities as well as differences between rural and urban areas with respect to different industry segments. A pair-wise comparison of IT adoption and use between rural and urban firms controlling for size and industry would help to determine if rural firms are lacking in their level of IT sophistication. A question that is frequently asked is 'are rural firms stagnating from lack of technology infrastructure?' We could only generally comment that if a firm is a franchisee or a subsidiary of a parent company they are likely to have the necessary IT infrastructure that compares well with their urban counterparts. Also, firms that face competitive or external pressure to use certain technologies seem to have the necessary infrastructure. However, we did notice independent firms with minimal IT in situations where owners were unaware of new IT developments or did not find the need for it.

One consistent constraint to Internet access identified by respondents was the lack of a local access telephone number for accessing the Internet. Perhaps, the Internet providers could use this information and make available local access number to their customers for Internet access at a fair and reasonable price. Some communities have taken a proactive stance and developed alternate arrangements to get cheap access to Internet due to lack of response from local telephone companies.

Relative advantage was found to be an important factor influencing the adoption of communication technologies. Many adopters reported doing so because they were aware of the benefits of these technologies. A major implication of this finding is that increasing user awareness of the benefits of these technologies would have a positive effect on the adoption of new telecommunication technologies. Awareness could be increased through better education and training. Many respondents indicated that training seminars on these technologies would be very useful in facilitating adoption. In some communities, nonprofit agencies and community groups have taken the lead in providing these seminars.

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Appendix A

Measurement items

Items were measured using a five-point Likert type scale ranging from strongly agree to strongly disagree.

A.0.1. Relative advantage

1. The technology will allow us to better communicate with our business partners.
2. The technology will allow us to cut costs in our operations.
3. Implementing the technology will increase the profitability of our business.
4. Adoption of the technology will provide timely information for decision making.

A.0.2. Cost

1. The costs of adoption of these technologies are far greater than the benefits.
2. The cost of maintenance and support of these technologies are very high for our business.
3. The amount of money and time invested in training employees to use these technologies are very high.

A.0.3. Complexity

1. The skills required to use these technologies are too complex for our employees.
2. Integrating these technologies in our current work practices will be very difficult.

A.0.4. Compatibility

1. Implementing the changes caused by adoption of these new technologies is not compatible with our firm's values and beliefs.

A.0.5. Top Management Support

1. The owner or manager enthusiastically supports the adoption of these new technologies.
2. The owner or manger has allocated adequate resources to adoption of these new technologies.
3. Top management is aware of the benefits of these new technologies.
4. Top management actively encourages employees to use the new technologies in their daily tasks.

A.0.6. Competition

1. We believe we will lose our customers to our competitors if we do not adopt these new technologies.
2. We feel it is a strategic necessity to use these technologies to compete in the marketplace.

A.0.7. External Support

1. There are businesses in the community which provide technical support for effective use of these technologies.
2. Community agencies provide incentives for adoption of these technologies.
3. There are agencies in the community who provide training on these new technologies.
4. Technology vendors actively market these new technologies by providing incentives for adoption.
5. Technology vendors promote these new technologies by offering free training sessions.

A.0.8. External Pressure

1. Our suppliers require the use of these technologies to do business with them.
2. Our customers are demanding the use of these technologies for doing business with them.

A.0.9. Size

1. Number of employees in the company — categorised.

A.0.10. Vertical Linkages

1. Firm has a business relationship with a parent organization (subsidiary or franchisee).

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