Research Article

Using Diffusion of Innovations Framework to Explain Communal Computing Facilities Adoption Among the Urban Poor[1]

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Abstract

In general, studies of the adoption of communal computing facilities (CCFs) such as telecenters tend to be atheoretical. In this article, we use Rogers' diffusion of innovations (DoI) theory as a framework. As the number and variety of CCFs has increased, so has the number of research studies on CCFs. However, most of the studies are presented in isolation without using any theoretical framework. The use of frameworks would help to bring structure and rigor to the research in this field. This study analyses data from our existing articles on CCFs to see how well DoI would explain the adoption of CCFs operating among the urban poor in Cape Town, South Africa. The article considers all the five perceived attributes of innovation, channels of communication, social system in which the innovation is diffusing, and consequences of innovation. The article notes that DoI explains most of the adoption pattern of CCFs: All the five attributes of innovations influence adoption according to DoI. As a consequence, the article notes that the introduction of CCFs has consequences not only for the community but also for the institution hosting the CCF.

Introduction

An innovation, no matter how well designed, would be perceived as useless if it is not adopted. Therefore, one of the important duties of those responsible for an innovation is to maximize its adoption rate. One of the first steps toward maximizing an innovation's rate of adoption is to understand the factors that influence its adoption. Several theories have been used to explain adoption of technological innovations. This article applies one such theory, diffusion of innovation (DoI) (Rogers, 2003) to the adoption patterns of communal computing facilities (CCFs) among the urban poor in Cape Town, South Africa. This section introduces the challenge of understanding those patterns through a variety of theories. The next section describes DoI. After that, a summary of the study that we are analyzing in this article is presented. That summary is followed by a data analysis in which we show how DoI fits within our findings. Finally, we draw conclusions to the article.

As an example of one such theory, the technology acceptance model (TAM) states that adoption is affected by the perceived usefulness and the

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perceived ease of use of the technology (Davis, 1989). Another approach is the theory of reasoned action (TRA), which posits that the adoption decision is influenced by attitudes toward the use of the innovation and perception of what people who are important to an individual think about the adoption (Fishbein & Ajzen, 1975). These and other theories serve to direct the attention of innovators to those factors directly influencing the uptake of an innovation and guide them in understanding those factors so that the uptake can be influenced through those factors.

There are four benefits of any theoretical framework. The first benefit is the ability to make *predictions.* After all, if the theory is generally true, the predictions from the theory should be true, too. The second benefit is purely *procedural;* it allows researchers as well as those managing or offering an innovation to proceed systematically, to observe or measure only some things and not have to measure everything. The third benefit is to *explain* what is happening, using the terms of the theory. This leads indirectly to empowerment, since the control of the explanatory forces leads to improvement. The final benefit is to put the theory under stress to *improve* it. If the theory doesn't do a good job of predicting, managing, or explaining, it needs to be improved itself. Hence, the quest for theory is intimately entwined with the quest for improvement and mastery. Any innovation that promises good outcomes needs good theory to promote those good outcomes. Our focus is "communal computing" facilities (CCFs), which are innovations meant to accelerate development among the poor. We opted to use the term "communal computing facilities" as opposed to "telecenter," because the telecenter has a specific meaning—generally related to how it is offered and operated. The case we are addressing does not perfectly fit the general definition of a telecenter. The term communal computing has also been used in a similar manner by others (Moshapo & Hanrahan, 2003). Other terms that have been used to describe the concept are "shared computing resources" (Kuriyan & Kitner, 2007), and "public access computing" (Heuertz et al., 2003; Mitra et al., 2005).

The techno-centric mentality that dominated the early years of CCF was full of optimism that the technology, once made available, would attract a lot of users. Contrary to these optimistic views, however, the adoption of CCFs has been low (Roode et al., 2004). Understandably, there have been numerous studies and publications on the factors that have led to the low adoption rates. However, as Roman (2003) points out, these studies have concentrated on addressing the issue on a case-by-case basis and lack theoretical underpinnings. The use of theoretical frameworks would bring more structure and rigor in CCFs research (Ritchie, Spencer, & O'Connor, 2003) and assist those who wish to promote increased usage of CCFs. Hence, the pressing question is "Which framework would be ideal for such a study if the ultimate goal is increased understanding, rigor, and control?"

Scholars have applied many frameworks to assist in understanding the uptake of CCFs among groups such as the urban poor. Bailur (2006), for example, has applied stakeholder theory to analyze the success of telecenter projects in India. In the same volume, Duncombe (2006) applied livelihoods theory to examine the benefits that ICT brings to the livelihoods of groups such as the urban poor. Neither approach directly examined adoption of CCFs. However, we can gain some insight into the *value* of adoption through these studies. For example, Duncombe noted that low-income households spend only 0.6% of their total income on communications. Hence, having free access to the Internet would be particularly significant to such communities. This fact could be used to justify the benefits of free access among the urban poor. However, neither livelihoods theory nor stakeholder theory directly addresses adoption. To do that, we turn to an examination of the value of the DoI approach.

Our quest begins with understanding that there are four unique perspectives and one blended perspective from which to view the phenomenon of technological change. Following Molla and Licker (2005), we isolate the technological, organizational, managerial, and environmental perspectives as well as one combined perspective, the interactionist. Each of the first four perspectives focuses on a set of primary influences on change. These are, respectively, characteristics of the technology itself, characteristics of the organizations experiencing the change of technology, characteristics of those managing the technological change, and characteristics of the environment within which the change is being effected. The interactionist perspective combines

these influences and locates the drivers for change in the *interaction* of these forces.

From our point of view, we are attempting to understand the uptake of CCF among the urban poor. What perspectives might best help us? Clearly neither of the simple perspectives takes enough into account, since there are ample reasons to believe that the technology alone, the organizational context alone, the management of the change alone, and the socioeconomic context alone cannot predict, explain, or empower the uptake of CCF among the urban poor. Instead we seek a perspective that takes all of these into account.

Roman (2003) proposes DoI as a framework for studying CCF adoption. DoI explains the adoption of an innovation based on the perceived attributes of an innovation, the social system in which the innovation is diffusing, communication channels, and the length of time the innovation has been around (Rogers, 2003). According to DoI, there are five attributes of an innovation that contribute to its attractiveness, namely perceived relative advantage, perceived complexity, perceived compatibility, trialability, and observability of the results of adoption. Note that none of these is an objective characteristic of the technology alone, but each involves aspects of the social, economic, and psychological environments. Another important element of DoI is the concept of the consequences of innovation. Adoption research should not stop at the point of adoption; rather it should also consider the consequences the innovation has on society (Rogers, 2003).

Different research findings show that some of the elements of the theory are more important than others in explaining or predicting adoption patterns. Roman concentrated on three elements of the theory: the attributes of the innovation, the communication channel, and the consequences of the innovation. On the attributes, Roman considered only three: relative advantage, compatibility, and complexity.

This article is written in response to Roman's paper. Using a real case study, we would like to show that indeed DoI is a suitable framework for studying the adoption of CCFs. We have previously published the some of results of the study elsewhere (Chigona, et al., 2005; Chigona, et al., 2006). DoI theory has also been used in Kumar and Best (2006) both as a way of presenting the results and interpreting the data. Kumar and Best focused only on the elements Roman used, whereas our article also considers the other elements of DoI theory. We have used DoI in addition to guide our method. The case study used in this article is a CCF initiative in Cape Town, South Africa.

Diffusion of Innovation Theory

DoI seeks to explain the process and factors that influence the adoption of new innovations (Rogers, 2003). Rogers (p. 5) defines diffusion as "a process in which an innovation is communicated through certain channels over time among members of a social system." A concept or a product is an innovation if the adopters perceive it as new (Mark & Poltrock, 2001). Therefore, an innovation does not necessarily have to be new, it only needs to be perceived as new by the would-be adopters. While the concept of CCFs may not be perceived as new in developed countries, it is a new concept in many developing countries. Moreover, the newness of a concept may vary within one country. Regardless of this lack of consistency of perception, we are concerned with the adoption of CCFs by people who *do* perceive CCF as something novel, regardless of any history CCFs might have in the greater society.

According to DoI, diffusion is a process that takes place over time, with antecedent conditions, characteristics of the adoption, and consequences (these aspects will be discussed in detail below). The following four components play key roles: 1) the innovation itself, 2) the communication channels, 3) the social system in which the innovation is situated, and 4) the length of time since the innovation was introduced.

Properties of the Innovation

According to DoI, the likelihood that an innovation will be adopted depends partly on its attributes. The following five attributes are considered in DoI: relative advantage, compatibility, complexity, observability, and trialability. Basically these attributes are economic in the sense that they relate to how much effort must be expended in adopting compared with the benefits of adopting, especially compared with the costs and benefits of not adopting.

Relative advantage is the degree to which an innovation is perceived as being superior to its precursor, which is either the previous way of doing things

(if there is no current way), the current way of doing things, or doing nothing. The superiority of an innovation is not only measured in economic terms but also may also be expressed in terms of enhanced personal status or other benefit terms. The higher the perceived relative advantage, the higher the rate of adoption, all other factors being equal. Note that perceived relative advantage of an innovation involves both perception (i.e., evaluation) of the proposed innovation as well as perceptions of other candidates and the status quo. It is not uniquely tied to objective characteristics of the innovation although, of course, perceptions usually, but not always, are influenced by objective reality. Also, relative advantage must take into account "relative advantage for *what?*" What is the task to which the innovation is being put into operation?

Compatibility is the degree to which an innovation is perceived to be consistent with existing social cultural values, needs, and past experiences of potential adopters. Compatibility is positively correlated with the rate of adoption. In developing countries, cellular telephony is directly compatible with the need for mobility for the urban poor, who often do not have the luxury of long-term fixed addresses and whose lifestyles dictate that they are often in transit and do not have access to fixed lines.

Complexity is the degree to which an innovation is perceived as being difficult to understand and use. This attribute correlates negatively with the rate of adoption.

Observability is the degree to which the results of an innovation are visible to others. In some innovation, it is easy for others to see the results of adoptions from those who have already adopted the technology. However, this is not the case with all innovations. Moore and Benbasat (1991) split observability into two: *result demonstrability* (the ability to demonstrate that positive results have occurred for the user) and *visibility* (the ability to share those demonstrations with others). Observability is positively correlated with the rate of adoption. To the extent that something has to be explained in complicated ways to others (i.e., complexity), it becomes less "observable," too. Language and culture might also affect observability for text-oriented technologies. Abstract or ambiguous innovations are generally difficult to observe and therefore diffuse slowly. Rogers gives safe sex as an example of innovations with low observability due to its ambiguity.

Trialability is the degree to which an innovation may be experimented with on a limited basis before adoption without undue cost. Trialability is sometimes linked to divisibility of an innovation (Niederman, 1998). Trialability/divisibility is "the degree to which an innovation can be adopted in phases, with each phase potentially leading to a greater adoption" (Niederman, 1998, 153). Trialability might also be influenced by cultural values, the task and its associated stresses, and even social influence (particularly where others might be observing the trials). Innovations that can be tried in pieces are inherently more trialable than those for which the entire technology has to be mastered before any use can be made. In these latter cases, the "trials" are often simply unproductive and unconvincing play-acting or marketing.

Moore and Benbasat (1991) added *voluntariness* of use and *image* to Rogers' five attributes. An innovation is most likely to be adopted if individuals perceive that the adoption enhances their images within the social system. Rogers includes this concept under perceived relative advantage. Voluntariness of use is defined as "the degree to which use of innovation is perceived as being voluntary or of free will.

Communication Channels

An innovation can be communicated through mass media or through interpersonal communication. The two channels play different but complementary roles. While many individuals may initially hear about an innovation through mass communication channels, it is the interpersonal communication that is likely to influence adoption decisions (Mark & Poltrock, 2001; Lowery & DeFleur, 1995).

It is interesting to note that under DoI, many of the purported effects of an innovation's characteristics are actually moderated significantly by the presence or roles of others: Relative advantage depends on the task and its definition, observability depends on the ability to communicate results to others, complexity might depend on the ability to talk to oneself what one is doing, and trialability may depend on the social circumstances of the trial. All of these are enhanced if the innovation has an intended use in communication.

Length of Time and Adoption

The adoption curve over time is S-shaped. Depending on when they adopt an innovation, people

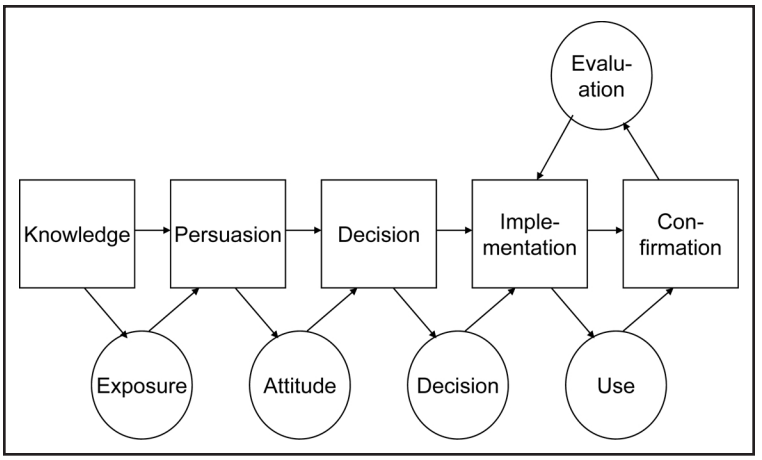

Figure 1. Phases in the innovation-decision process (after Rogers, 2003).

are grouped into innovators (those who adopt at the very earliest times), early adopters, early majority, late majority, and laggards (those who never adopt). Innovators are usually venturesome, and since they are first to adopt, their adoption decision is not influenced by others. Unlike innovators, early adopters are down to earth and often respected by their communities. Due to these characteristics, early adopters often influence others to adopt an innovation. Laggards are the last ones to adopt if at all. In many cases laggards lack financial resources to adopt the innovation but they may eventually be forced to adopt when the cost (economic or otherwise) of not adopting becomes extremely high.

There are five phases in an adoption decision process (Figure 1). In the *knowledge* phase, an individual is exposed to an innovation. An attitude about the innovation, which can be favorable or unfavorable, is formed in the *persuasion* phase. The individual engages in activities that lead to a decision to adopt or reject the innovation in the *decision* phase. The innovation is put to use in the *implementation* phase. Even after deciding to adopt, an individual may, in the *confirmation* phase, evaluate the decision to continue or discontinue use of the innovation. According to Rogers, characteristics of the adopter have the strongest influence during the knowledge phase; those of the innovation, during the persuasion phase. Note that contextual and environmental influences predominate prior to the knowledge phase. These dictate who might be exposed to knowledge about the innovation. Communication channels influence all phases.

Social System

A social system is defined as "a set of interrelated units that are engaged in joint problem solving to accomplish a common goal" (Rogers, 2003, 23). A social system can be categorized along the following three dimensions: "values and norms, system evolution, and homogeneity of the population characteristics" (Gatignon & Robertson, 1985, as cited by Parthasarathy, Jun, & Mittlestaedt, 1997). Therefore the communities that CCFs are targeting can be seen as social systems. It should be noted that social systems may have subsystems within them (Parthasarathy et al., 1997).

Social systems in which the innovation is situated influence diffusion. One way by which a social system influences the diffusion process is through social structures and communication channels within those structures. Since people tend to associate with people who are in some respect similar to themselves (Rogers calls this concept *homophily*), an innovation is most likely to move within populations in subsystems. The tighter the bonds of an individual to the social system, the more likely the individual is to associate with those adopting the innovation, and DoI theory suggests that adoption among individuals who do not associate is therefore likely to be lower. Those who live on the "borders" of a social system can miss out on the information about an innovation and therefore never move to the next stage. According to social identity theory, the likelihood of adoption of an innovation within a system may also be influenced by a sense of belonging. If an innovation is seen to be an in-thing within a subsystem, then members of the subsystem are most likely to adopt it.

Opinion leaders informally influence others to adopt the technology. The word "informally" should be emphasized since opinion leaders, unlike change agents, are not formally engaged to sway people's opinions about an innovation. In most cases opinion leaders are early adopters. Compared with their fol-

lowers, opinion leaders are more exposed to forms of external communication, have higher social status, and are more innovative (Rogers, 2003).

Consequences of Innovation

Rogers (2003) points out that change agents should consider the consequences of the innovation on the community. Consequences can be described along the following three dimensions: 1) desirable versus undesirable, 2) direct versus indirect, and 3) anticipated versus unanticipated. The concept of anticipated versus unanticipated (anticipation of) consequences is similar to that of intended versus unintended (intention of) consequences as used in structuration theory (Giddens, 1984). As an example of unintended/unanticipated consequences Rogers cites the introduction of oral dehydration therapy (ORT) in developing countries. As an intended and desirable consequence of the high rate of adoption, the infant mortality rate dropped; however, this meant an increase in the population in the developing countries and increased pressure on other resources such as schools.

As Rogers (2003) and Roman (2003) note, it is often difficult to accurately predict, identify, and measure consequences of an innovation. Such studies require long-term observation.

An Example

Consider the uptake of cellular telephony among urban poor in a developing country. Here, the relative advantage of cellular telephony would be comparable to its precursor (the fixed telephone line), but it is likely that there *are* no precursors.[2] Hence, DoI would flag any access as relatively more advantageous than none. Cellular telephony is especially popular in developing countries where pay-as-you-go schemes enable the poor to have access without the hurdle of credit checks. There are advantages to providers, who need not install very expensive land facilities. Consider complexity. Cell phones are remarkably easy to use and, of course, getting easier. While the technology behind the cell phone is itself very complex, usage is easy, mimicking interpersonal talk.[3] Cellular telephony is also remarkably observable, since the demonstration is simply watching others communicate. The trialability of cellular telephony means making or receiving calls or text messages with low cost in terms of money and effort. Lack of trialability would show up as embarrassment or high cost, for example. In terms of channels of communication, should one member of the urban poor adopt cellular phones, it is likely that those individuals close to or affiliated with that person will experience cellular phones or at least experience that person's use of cellular phones, hence gaining some knowledge. Opinion leaders would likely be the early adopters of cell phones, and they would demonstrate just how useful cell phones are to others through their own higher social status. However, since this technology is not without cost, it would be unlikely that early opinion leaders of cellular technology would be very poor themselves. There are also many anticipated and unanticipated consequences. For example, the ability of users to coordinate their movements with others is anticipated; what is unanticipated is the creation of mobile cultures overlaying existing cultures. For example, groups of teenagers can stay in contact at all times despite efforts by others to focus their attention on their school assignments.

Background

Data used in this article come from a study conducted on a South African CCF: the Smart Cape Access Project. Most of the findings of the study are presented elsewhere (Chigona et al., 2005; Chigona et al., 2006). In this section we only present a summary of the initiative. The research methodology used in the study is presented in the next section.

Cape Town: The Socioeconomic Situation

South Africa is one of the countries with the highest Internet penetration in sub-Saharan Africa—about 12% of the population has access to the Internet

2. Of course it is possible to conjure up a precursor for almost any innovation involving human behavior. For instance, before computers, people used calculators or slide rules or did figures on paper or in their heads. Our reference to technological innovations limits precursors to technological precursors or at least systematic procedures. "What is the task?" is the important question in determining whether or not there are precursors—and what that precursor is.
3. We note, with some irony, that this particular example is actually its own counterexample, as cell phones grow in complexity with the addition of cameras, Web access, iPhones, and computation. It is, however, the simplicity of cell phone telephone operation, per se, to which we refer.

(Internet World Statistics, 2008). Despite this somewhat rosy picture the country faces an enormous domestic divide mainly based on racial differences (Miller, 1999); the four official racial groups are Blacks (79% of the population), Whites (9.6%), "Coloreds" (8.9%), and Indian/Asians (2.5%) (Statistics South Africa, 2003).

The current distribution of economic resources, including ICT access, among different communities in South Africa is mainly a result of the apartheid policy that was practiced until 1994. Due to the legacy of apartheid, most economic well-being indicators (such as employment rate, level of education, decent accommodation) are still tilted in favor of the white population, and in most cases the black population is the most disadvantaged (Statistics South Africa, 2003; Treiman, 2005). For example, the 2001 census shows that 28% of Blacks are unemployed compared with 4.1% for Whites (Statistics South Africa, 2003); 22.3% of Black Africans had not been to school compared with 1.4% of Whites (ALSA, 2004). In terms of ICT, for example, Miller (1999) notes that while 90% of all Whites had a telephone in their homes, the figure for Blacks was 10%.

Cape Town, the provincial capital of the Western Cape, has a total population of 2.9 million, which is broken down as follows: Colored 48.13%, Black 31%, White 18.7%, and Asian 1.43%. The city's unemployment rate is 19.4% (City of Cape Town, 2002; Statistics South Africa, 2003); 58.5% of the unemployed are Black, 38.1% Colored, 3.1% White, and 0.5% Asian (Statistics South Africa, 2003). As in most cities in the country, different residential areas are dominated by different racial groups (based on the apartheid system). The non-White population mainly lives in the under-serviced parts of the city. It is estimated that 10% of the city population lives in informal settlements (Abbot & Douglas, 1999, as cited by Huchzermeyer, 2002).

A 2002 digital divide assessment commissioned by the Cape Town City Council showed that most of the city's residents had access to telephones whether they are fixed line or cellular (Bridges.org, 2002). However, access to computers and Internet is limited: More than 80% had no access. In a study that did not include disadvantaged populations, residential areas showed that 16% of the residents had access to computers at work and 25% at home (Webcheck, 2001, as cited by Bridges.org, 2002).

The Smart Cape Access Project

The Smart Cape Access Project, an initiative of the Cape Town City Council, provides computer access and Internet connectivity to residents (particularly disadvantaged communities) of the city at no monetary cost (Infonomics South Africa, 2003).

The access points for the project, also known as Smart Cape Points, are located in selected public libraries in the city. Libraries were the location of choice, because they fit the project requirement, which specified that the physical location of the project should be "where people already go for information" (Smart City, 2002, as cited by Infonomics South Africa, 2003). The project, which started in 2001 with six pilot sites, is now expanding to all libraries in the city. According to a library district (zone) manager whom we interviewed, the six pilot sites were selected based on the economic status of the locations (they were all in the disadvantaged areas) and the willingness of the libraries to host the facilities.

Users are not required to pay for the use of computers and access to the Internet and only need a free library membership to use the infrastructure. However, users are required to pay for printing. Due to high demand, use is limited to a maximum of 45 minutes per day. According to one of our respondents, the maximum amount of time was decided after an evaluation study showed that most people do not spend more than 45 minutes per day using the infrastructure.

Research on adoption of innovations often differentiates innovations on the basis of whether they are individual innovations or belong to a cluster of innovations. A cluster consists of one or more distinguishable elements of an innovation that are perceived as being closely interrelated (Rogers, 2003). Adoption of an innovation in a cluster may be affected by the adoption of the other elements of its cluster (van Slyke, Stafford, & Ilie, 2004). Prescott (1997) argues that since the Internet consists of many technologies, it should be considered a cluster of innovations. It is understandable that some would argue that a CCF is not a single innovation, but rather a cluster consisting of several services offered at the center. However, the Smart Cape project is different because it does not offer the other services usually offered at CCFs; all that is offered is com-

Table 1 *Summary of Socioeconomic Status of the Centers Used in the Study*

Center	Social Economical Description
Center A	Mainly refugees from central Africa; formalized low-cost single-unit housing
Center B	Predominantly Colored community; formalized low-cost high-density housing
Center C	Largely Black; extensive informal housing

puter access. Therefore, this study focuses on the adoption of CCFs as a single innovation.

An additional argument in favor of clusters may also be mentioned. Because computers are useful in many ways, it could, by extension, be argued that *they* aren't single innovations. However, our research stresses the *use* of computers (or, to be technically correct, access to the use of computers), rather than a portfolio of specific uses (potentially identified by the classes of applications such as word processing, Internet access, and spreadsheeting). In this case, therefore, it is the CCF itself (i.e., accessing computers through the CCF), rather than a portfolio (i.e., a cluster) of computer applications, that is the innovation being adopted.

Research Methodology

It should be mentioned that we are not affiliated with the City of Cape Town or the Smart Cape project and that the study was not an official evaluation of the project: for an official evaluation refer to Infonomics South Africa (2003). The aims of the study, which took place between July 2004 and January 2007, were twofold: 1) to establish critical success factors for CCFs operating among the disadvantaged urban communities and 2) to identify factors that influence an individual's adoption of the CCFs.

Sample

The study used three centers.[4] The centers were selected using a purposive sampling technique (i.e., a sampling technique in which the researcher picks samples "because they have particular features and characteristics which will enable detailed exploration and understanding of central themes and puzzles which the researcher wishes to study" [Lewis, 2003, 78]). In this case, the sample was selected based on socioeconomic profiles of the locations. A summary of the social-economic status of each location is presented in Table 1.

Data Gathering

Information was gathered using interviews and observations. Most of the interviews were conducted by two graduate student groups as part of their research projects: one in 2004 and the other in 2005. The observations, which were meant to complement and validate the findings from the interviews, were conducted by a research assistant (graduate student) with 1 year of research experience and by a lecturer (one of the authors of this article). To ensure quality information, the research assistant had a meeting with the lecturer before each observation session and was briefed within 24 hours of the observation. Table 2 provides a summary of the data collection process.

Interviews were conducted at all three centers with management, randomly selected users, and nonusers. In this study, a user is defined as a person who has used the facility more than once, and a nonuser is a person who lives within the catchment area of the CCFs, and who is aware of the CCFs but does not use them. Those who were not aware of the project were excluded, because it was felt that they would not provide useful insights on factors that affect the adoption decision of the facilities. In addition, an official of the Cape Town City Council responsible for the Smart Cape Access Project was also interviewed.

One of the key findings of the initial data collection and analysis was that many high school students used the centers. For this reason, we decided to conduct structured interviews with high school students to establish the factors that contribute and affect their usage. This phase was conducted in July 2006 and collected data from high school students at Center C.

Observations, which were conducted only at Center C, were nonintrusive (i.e., we observed the users as they naturally use the system) (Patton, 2002; Shaughnessy & Zechmeister, 1997). The researchers were positioned where they could see the application being used but could not see the actual screen content. This was possible because the com-

4. Agreements with the centers do not allow us to identify them by name.

Table 2 *Summary of data collection procedure*

Time	Activity
July–August 2004	Structured interviews with staff members and 20 users and interviewed member of management at Cape Town City Council
July–August 2005	Structured interviews with management of the three centers, 23 users and 11 non-users
Dec. 2005–Jan. 2006	Observations at Center C
Jan. 2006	Observation at a center in affluent location
Jan. 2006	Interview management and 2 users at Center C
July 2006	Structured interviews 15 high school–going youth at Center C
Jan. 2007	Interview with library district manager. Although she is no longer actively involved with the project, she had been actively involved with the project from inception.

puters are placed on an open space in the library hall and other library users could easily see what a computer user is working on.

The observations paid particular attention to the following items:

- The demographic profile of the users in terms of age and gender
- Social-network influence: whether the users come in groups or individually
- The use of the facilities (i.e., the activity the users were engaged in when they were using the facilities)

The observations were conducted on five separate days: four in the first 2 weeks of December 2005 and one in the second week of January 2006. Each observation session lasted 2½ hours.

In addition, observations were conducted at a Smart Cape Access Project center operating in a library in a relatively advantaged community. This phase was included in the study to check whether the pattern that was observed at Center C was unique to centers operating among the disadvantaged communities. Two observation sessions were conducted with each session lasting 1½ hours. This phase was conducted in the second week of January 2006.

Data Validation

The data were validated in two stages. In January 2006 we discussed our findings with two users (individually) as well as the management of Center C. In January 2007, we had an interview with a manager of one of the library districts. Although she is no longer actively involved in the project, she had been actively involved with the project from its inception. In addition to validating and correcting our interpretation of the data, she provided us with background information on the project.

Data Analysis

In most cases, data analysis in qualitative research involves three main steps: 1) coding or annotating the primary data, 2) grouping together the related codes, and 3) generating the themes from the codes (Patton, 2002; Ritchie et al., 2003). Since the aim of the article was to explore how DoI can be used to explain the adoption pattern of CCFs, the data analysis essentially involved mapping the primary data to the DoI framework. As such it was not necessary to generate new themes: after coding the primary data and grouping the codes, the analysis proceeded to fit the data into the predefined DoI categories. Since the data were not primarily collected with DoI in mind, there are several gaps in the data.

This section discusses how the data fit into the DoI framework. The section begins by looking at the five attributes of innovation before proceeding to the other aspects of the framework, namely communication channels, social systems, length of adoption, and consequences of the innovation.

Attributes of the Innovation

Relative Advantage

The concept of relative advantage is analyzed along two dimensions: 1) relative advantage vis-à-vis having no access at all to ICT (i.e., analyzing the

benefits of ICT access in general), and 2) relative advantage vis-à-vis other forms of access to ICT facilities available to the community.

Compared with having no access at all to ICT, the CCFs offer the residents opportunities to consume a service to which they otherwise would not have access. The main use among the adults was job seeking. Staff at the centers assist users to type their resumes and guide them on how they can job hunt on the Internet. At the time of data collection, Center C was planning to acquire software that can guide the users through the process of compiling their resumes. One unemployed user stated that the CCF "helps in the endeavor to seek employment." Two unemployed users felt that the facilities allowed them to acquire and sustain their computing skills, thereby making them ready to enter the job market: "being unemployed, I must maintain my skills in case I get a job. I will be ready to use computers." The library district manager spoke of a man who got a job overseas after responding to an advertisement that he saw while using a Smart Cape Point.

Over and above employment seeking, the facilities have been offering other services to the communities. Staff at Center C spoke of a man who "used the facilities at the center to apply for a business loan; this helped him to start a [cell phone] business." Center C staff also mentioned that other businessmen use a spreadsheet application at one of the facilities "to do books for their small business."

The facilities also provide advantages to students. It was noted that most high school students use the facilities to complete their school projects. For most of the students these facilities are the only access they have to computing resources. Several of the students indicated that their schools do not have computers. For other students, their schools are far from home, and they cannot afford to go back to school to use computers.

Compared with other access points, the project offers advantages in terms of distance from the respective homes and in terms of cost. There is no Internet café in the Center C township. Most people would need a bus to get to the nearest café. The distance is a hindrance particularly to young users; especially because child safety is one of the prime concerns of most parents in the disadvantaged communities (Children's Institute, 2003). The study shows a clear effect of the distance on adoption: most of the users at all the three centers come from around the centers. As one student remarked, "It's nearer home [than the computer facilities at her school]. I can go home and come back."

The fact that the CCFs offer the services at no cost is an advantage over other services. Most users indicated that this was the main advantage of using the facilities. Cost is especially important because the unemployment rate around the three centers is high. Most users said they would stop using the service if they had to pay for it. Other studies on CCF usage show that the categories of people with limited or no access to financial resources are unlikely to adopt CCFs (Etta & Parvyn-Wamahiu, 2003). In contrast, most of the users at the Smart Cape CCFs were unemployed or high school students. Moreover, Samaai (2005) mentions a project in an area with an equally high unemployment rate that failed because "they were charging for usage."

However, technologically the project's infrastructure does not offer much advantage compared with alternative access points. One of the most common concerns of both the management and the users is the speed of the computers, especially when accessing the Internet. In all the three centers, five computers were connected to the Internet by one dial-up modem. One user stated, "I spent ten minutes of my 45-minute slot opening a single page." This is not an exaggeration; it took one of the coauthors 5 minutes to load a Hotmail Web site. Users find the low speeds frustrating especially because they have limited time to access the computer.

It was also noted that most of the computers do not have USB sockets or floppy disk drives; it is therefore difficult for users to save their work. This concern was particularly raised by students who do their school homework at the facilities. One user at Center C indicated that "when I want to do serious work, I go to an Internet café because here they do not have USB connections and the floppy drives sometimes don't work."

As DoI predicts, relative advantages, such as serving as a job seeking tool, providing access to students for their school work, being accessible from residential areas, and costing nothing promoted adoption of the facilities. Aspects for which the facilities were inferior compared with what was available at alternative sites (e.g., out-of-date or faulty hardware) were noted to have affected the adoption negatively.

Complexity

The issue of complexity can be looked at from the following two perspectives: 1) the complexity of using computers as opposed to performing the tasks manually, and 2) the complexity involved in using Smart Cape CCFs as opposed to the precursor or alternatives (which include internet cafés and school computing facilities).

In terms of use of computers, the main challenge has been lack of training. The Smart Cape project does not offer training to users or potential users. This means that the potential adopters who lack skills perceive the innovation as complex and, as DoI predicts, fail to adopt the technology. One user noted that senior citizens do not use the CCFs because they lack computer skills. It was also noted that the acquisition of skills reduced complexity and led to increases in adoption. At Center C, after noticing a low adoption rate among women, the center management offered courses on the role of ICT and how the technology can be used, particularly in job hunting. The staff member commented that "most of them [the women] did not know that they can apply for a job online." After the training the number of women using the center increased.

Most of the issues of using the Smart Cape CCFs that would be categorized as complexity as opposed to alternative means of access can and have been addressed under relative advantages. Others will be discussed under Compatibility.

Compatibility

Compatibility played a role in the adoption of the innovation. Compatibility was relevant on the following five accounts: compatibility with 1) other forms of technology that the members of the community are exposed to, 2) functions of the hosting institution, 3) the needs of the potential adopters, 4) the financial status of the members of the community, and 5) the "normal" ways of doing things.

Compatibility with other forms of technology.

It is interesting to note that without training, the adoption rate seems to be higher in the urban-based project compared with equivalent rural-based projects (Samaai, 2005). This could be explained by the difference in the level of exposure to technology in general. The urban population is most likely to be confronted with other forms of technology; this is likely to raise their appreciation of what ICT is, what it can do, and how to use it. The same may not be said about their rural counterparts. For instance, cell phone ownership is higher in the urban areas compared with the rural areas. Bridges.org (2003) notes that more than 50% of the Cape Peninsular (Cape Town and the immediate surrounding areas) population own cellular phones, Bizzcommunity (2006) noted that the cell phone ownership among the Black community in metropolitan cities in South Africa had reached 63%—this is in contrast to the national average of 35% (Finmark Trust, 2005). It can be said, therefore, that the compatibility of computing facilities with other technologies that participants were exposed to had a positive impact on adoption.

However, the use of open source software had a negative impact on compatibility and adoption. Most of the users who had prior or alternative access to computers were used to proprietary products and, consequently, found the open source products different and difficult to use. This finding is consistent with the findings of Inusa and Bytheway (2006).

Compatibility with functions of hosting institution. The computing facilities were also compatible with the core function of the libraries where they were hosted (i.e., they were a source of information for the general public). This observation is in line with the findings of Samaai (2005), who noted that CCFs located in public libraries had a higher adoption rate than those located in other types of public facilities such as schools. It is also interesting to note that many adopters became aware of the facilities while using the library. It should be mentioned that other studies have found that locating CCFs in libraries may hinder adoption among those who consider a library a place for intellectuals (Colle & Roman, 2002). There is a need, therefore, for a further study to focus on the nonadopters.

Compatibility with needs of potential adopters.

The CCFs are compatible with the needs of the community. Since the CCFs are located in areas with high unemployment rates, most of the residents cannot afford to pay for the services. Making the service free of charge, therefore, makes the innovation compatible with the economic realities of the communities.

The types of services provided by the CCFs are also compatible with the realities of users. Staff at the centers assist users with creating resumes and

searching for jobs online. This is compatible with the high unemployment rate in the area.

Compatibility with the normal way of doing things. A fifth meaning of the term "compatibility" is compatibility with precursor procedures and skills. It is likely that users of libraries are literate at least to some extent, thus it is likely that these users are used to using library resources to locate information. Hence, compatibility is enhanced by locating the CCF in libraries. The opposite effect of compatibility with "normal" ways of doing things was noted by some of the users who had previous or alternative access to technology. Most of these had used proprietary products and, therefore, found the open source products difficult to use.

The results on compatibility are consistent with DoI (i.e., compatibility led to increase the likelihood of CCF adoption, and lack of compatibility reduced the likelihood). Compatibility with technology to which the urban poor are exposed, the functions of the hosting institution, and the normal way of doing things positively contributed to the adoption. Lack of compatibility with open source software negatively impacted adoption.

Trialability

Considered from the financial perspective, the innovation is trialable. The services are offered at no cost—users only need a free membership to the library. The financial risk in trying the technology is low. As discussed under relative advantage, this had a positive impact on adoption.

However, lack of training denies those with no skills an opportunity to try out the technology. One nonuser at Center A said she had never tried to use the computers because she did not "know where to start from. . . . It could have been easier if someone showed me where to start from." The problem was exacerbated with the time limitations; 45 minutes does not give a novice user sufficient time to try the technology.

Another hindrance to trialability for those with inadequate computing skills was the possible embarrassment. One of the problems noted by most users and staff was that there are often many people sitting around waiting for their turn to use the computers. As one user put it, "it makes me nervous and I feel like I am wasting their time since I am too slow. So I often give up and go home even when I have not finished doing my stuff."

Observability

This question of the impact of observability on adoption can be addressed from the following two angles: 1) from the visibility of the technology or people using the technology, and 2) from the observability of the results of adoption. In terms of visibility of the infrastructure, there are two answers to the question depending on whether one is inside or outside the library. In all the libraries the computers are placed near the main entrance, and it is almost impossible for anyone entering the library not to see them. Moreover, at peak times there is a group of people using and queuing for the computers. The fact that most adopters first learned about the facilities while using the library is a testimony to this.

However, from outside the library it is not easy to notice that there are free computing facilities inside. The only information available is a sign post on the entrance of the library; the sign post is very small and, therefore, difficult to see from a distance "unless one is looking for it" (Center B user). None of the respondents indicated that they had first learned about the facilities from the poster.

There was no evidence to explain the influence of observability of results. This lack of evidence could be due to the abstract nature of the results of adopting CCFs. For instance, how can one observe that an individual got employment because she/he saw an advertisement from the CCF? We can only speculate that the fact that a person has got a job through the Internet is observable (at least for those close to the individual) and would attract new users to the CCFs.

The results of this study are consistent with the DoI position on observability (i.e., visibility enhances adoption of an innovation).

Communication Channels

The two most popular responses to the question "How did you first learn about the facilities?" were "while using the library" and "from personal networks." Very few respondents learned about the facilities through the mass media. The results point to a high degree of homophilous communication. In addition, it was found that most of the users had a relative or a friend who also used the CCFs. It was also observed that most young people came to the facilities in groups. In a similar but separate study,

Samaai (2005) noted that most nonusers actually did not know about the CCFs in their community.

The libraries played an important role in the diffusion of information about the CCFs. The libraries often included information about the computing facilities during the open-day campaigns. However, it is not clear how effective such activities are in reaching those who do not use the library. According to the theory of selective exposure, individuals are likely to expose themselves to messages that are consistent with their attitudes and briefs (Rogers, 2003). It is therefore likely that only people who are interested in libraries attend such events. It is unlikely, therefore, that those who are not interested in libraries will hear about the new innovation.

Mass media was used at the launch of the respective centers. News about the CCFs was covered on national television, city-wide newspaper, and local newspapers. However, after the launch there was no other mass media publicity.

Social System

DoI stipulates that social systems affect diffusion of innovations within social systems; results of this study showed that social systems had an impact not only on who adopted but also on the application adopted. The patterns of adoption and use were slightly different among the three communities. At Center A, which is predominantly a refugee community, e-mail was the most widely used application. Understandably the members of the community use e-mail to keep in touch with family members in other parts of the world. At Center C, most users were primary school students; there was very little usage among the adults. We suspect that this may be due to low levels of literacy among the adults. As noted, the community around Center C is predominantly Black and lives in informal settlements. Therefore, this population is likely to have low levels of literacy (Treiman, 2005; Statistics South Africa, 2003). The low adoption among women and girls may also be a result of the social norms.

Literature indicates that, to maximize the rate of adoption, a CCF must strive to get the community involved in the project (i.e., community buy-in) (Bridges.org, 2002; NTCA, 2000). Another success factor is that there must be opinion leaders who encourage others to use the CCF (Bridges.org, 2002; Ernberg, 1998). The study shows that there was no obvious effort to get community buy-in. In addition, the members of the community as well as the library staff members did not identify any opinion leaders. Contrary to what would be expected, however, the CCFs were successful.

An explanation of what may on face value appear as contradicting to existing literature can be found in the relationship of the library staff and the community with the CCF. The libraries have been around in the communities for a long time and people have gotten used to them (i.e., they were seen as an integral part of the social systems). As one respondent stated, "they are a part of the community." Since the CCFs are hosted in the library and have the support of the library, members of the community found it easy to accept the innovation. In fact most respondents viewed the new innovation as part of the library. At Center C, the community invited a library staff member to a community meeting to explain the details of the project and its benefits to the community. It can be argued, therefore, that in a way the library played the role of an opinion leader and facilitated the community buy-in. This is consistent with those who argue from a social identity theory that bridging the gap between the providers and users of ICT systems can improve the likelihood of adoption (Gefen & Ridings, 2003).

Length of Time and Adoption

At the time of the study the projects had been in operation for less than 3 years. As such, it is premature to draw any useful inferences on the effect of time on adoption. A study using approaches that analyze the adoption process, such as *domestication* of technology, would provide insight into the impact of length of time has on adoption.

Consequences of the Innovation

As noted earlier, it is difficult to identify, let alone measure, the consequences of an innovation. Consequences of an innovation can best be studied over a long period of time (Rogers, 2003). The project is still young and we have not yet invested sufficient time to appreciate its consequences. However, from our results so far, it can be said that there are both desirable and undesirable consequences.

One of the desirable consequences has been the provision of ICT access to residents who could not afford to pay for such a service. This access has allowed the unemployed to actively seek employment. According to a Center C staff member, some of the women who were trained at the center used the

CCF to successfully look for employment. "Some of them managed to get employment through these facilities." In addition, the CCFs are boosting the self-confidence of the residents about their employment potential. Two respondents indicated that using the CCFs allowed them to acquire and sustain computer skills and thereby made them ready to enter the job market.

One undesirable, and probably unintended, consequence is the creation of a *skills divide.* This divide is to a large extent a result of not providing training to users and potential users. It was noted that most of the users had acquired their computer skills from elsewhere other than at the CCFs (e.g., school, home). Few users acquired their skills from the CCFs. This trend means that individuals with skills stand to benefit from the project while individuals who do not have the skills stagnate. We also observed that nonskilled users (mainly schoolgirls) were asking skilled users (usually young boys) to do things for them in exchange for time on the computer. A nonskilled user would get a time slot and ask a skilled user to do the task for a fraction of the time, and skilled individuals would take up the remaining time for their own use (usually playing computer games). This finding is consistent with the statement by Röling et al. (1976, 163, as cited by Roman, 2003). "Diffusion processes lead to inequitable development unless preventative measures are taken."

While it can be argued that housing the CCFs in libraries has affected the operation and adoption of the CCF, it is also true that the CCFs affect the library and its users. While encouraging libraries to include computing facilities, Cisler (1998) warns that since the CCF functionality will attract new kinds of library users, libraries need to reorient their staff to cater to the new breed of users. Staff members indicated that the number of registered library users increased. One staff member noted that the increasing number of registrations meant that computer users would use other library resources while waiting for their turn to use a computer. However, another member of the staff noted that the increase in library users had not resulted in an increase in the materials being loaned out; conversely, there was actually a decrease in materials loaned out.

One clear negative consequence on the libraries is the increase in the noise levels in the library hall. The noise is especially loud when the youth come to play online computer games in the library hall. Some library users find this annoying. One library user at Center C mentioned that "I am used to community libraries, but the noise level in this library is high compared to other libraries." One library user, while appreciating the usefulness of the computers, suggested that "the computers should be moved from the main hall to a smaller room." This consequence echoes Rogers's (p. 442) statement that sometimes the consequences of an innovation affect individuals other than those adopting the technology or innovation.

Conclusions

Theoretical frameworks are needed to bring structure and rigor to CCF adoption studies. In this article we have shown that DoI is a candidate for this area of study. Based on the results of the Smart Cape Access Project, it can be said that DoI was able to explain most of the adoption decisions. However, since the data collection was not conducted with the framework in mind, there are gaps in the data; we are planning follow-up studies that should provide information to fill the gaps.

In terms of the attributes of innovation, the influences on adoption of relative advantage, compatibility, and complexity were easy to deduce. In our case the issue of trialability was based on the fact that the services are offered at no cost, and therefore the risk the user took in trying the technology was small. However, that fact was also coded under relative advantage. This interpretation is consistent with the observation by Moore and Benbasat (1991) that it is advisable not to consider the attributes in isolation, but rather to see how they influence each other. In terms of observability, we were able to identify the effects of visibility. However, the data had no information that would explain the influence of observability of the results.

It has been noted that social systems have an impact on adoption of CCFs. There is a clear difference between the adoption patterns in urban and rural areas. The library, as part of the existing system, also played an important role in the adoption. We also noted the impact of the communication channels on adoption. Due to low use of mass communication media, the innovation is diffusing mainly through interpersonal communication and through those who use the library.

We also noted many other indirect consequences

of the innovation. However, since the innovation is still in its infancy, and since we have not spent a long time on our studies, it is not possible at this point to identify indirect consequences.

One aspect not covered in this article is the economic sustainability of CCFs. The DoI model focuses on individual adoption of an innovation such as a CCF. Whether the innovation can be sustained depends only partly, of course, on whether individuals adopt it. There is an additional requirement that costs be covered. We have made the assumption that costs of an innovation such as the CCF among urban poor would not be borne by the users, who do not frequently possess the means to make such ventures profitable or even economically viable. Supported by donor funds, projects such as CCFs are generally not sustainable per se and need to be converted into commercially viable enterprises for long-term viability. Given the low financial cost to adopters, the question of adoption of this sort of innovation at a higher cost is testable under the DoI framework under relative advantage. ■

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