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Published in:
Regional Studies

Publication date:
2002

Document Version
Publisher's PDF, also known as Version of record

[Link to publication in Tilburg University Research Portal](#)

Citation for published version (APA):
James, M. J. (2002). Universal access to information technology in developing countries. *Regional Studies*, 36(9), 1093-1097.

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Universal Access to Information Technology in Developing Countries

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Assuming, as one must, that access to information technologies in the rural areas of developing countries will be based at the communal rather than the individual level, we examine a variety of technologies that are suited to this purpose. These include wireless technologies for use in schools, low-cost village kiosks, public telephones that facilitate incoming as well as outgoing calls, low-cost computers with removable smart cards that allow a single unit to be shared by many users and the use of school computers for adult education outside the times when they are in classroom use.

Universal access Digital divide
Information technology Rural areas

Introduction

There is now widespread recognition of the fact that in order to spread the benefits of information and communications technologies to the majority of those living in developing countries, other mechanisms need to be found than providing such technologies to each and every household. For, although average income levels in the developed countries are generally such as to make the household a realistic target of policy, this is certainly not the case in the vast majority of developing countries where household income levels are substantially lower and far below the cost of acquiring most of the new technologies. From a policy perspective, this recognition suggests that the developed country goal of serving all potential demand should shift to the more modest objective of bringing these technologies within reach of the population at the community level.¹ And among the new technologies, telecommunications have received perhaps the most attention in this regard and the following quotation well illustrates the shift in focus in this sector from the level of the individual household to the level of the community as a whole. Thus:

For telecommunications to aid the wider development of poorer countries, special concern must be given to providing general access, issues which are quite different from the developed world where a majority have access to telephones. While universal service (a telephone in every home) will not be achievable in most countries soon, a realistic goal is to work for universal access, where a useable telephone is within reach of the whole population.... To provide universal access, a range of public phone operators or telecentres can be used (BENJAMIN and DAHMS, 1999).

Table 1. *Varying concepts of universal access in developing countries*

Criteria	Definition	Example
Population	A telephone for every permanent settlement of x population	In Ghana, defined as a telephone in every locality of more than 500 people
Distance	A telephone within x km	In Burkina Faso, defined as a telephone every 20 km
Time	A telephone within x minutes	In South Africa, proposed as a telephone within a 30 minute travelling distance

Source: INTERNATIONAL TELECOMMUNICATIONS UNION, 1998.

In itself, however, even a widespread policy switch in favour of universal access will not necessarily enable all households, especially those described as living in poverty in isolated rural areas, to avail themselves of the new opportunities thus afforded them. For it may often still be the case that the price of communal access to information and communications technologies falls outside the range of what individuals can afford, a problem which is likely to be especially acute in the case of the Internet, requiring as it does a range of costly hardware and software, such as computers, modems and so on. To this extent, therefore, policy makers will need to focus on ways of cutting the costs of providing communal access to the new technologies.² Attention will need to be paid, among other factors, to the new technologies themselves, many of which are unsuited in terms of price, design and input requirements to developing countries in general and isolated rural areas in particular. In this article, we shall focus, accordingly, on the technological aspects of promoting universal access³ and shall pay particular attention to the role that the location and design of information and communication technologies would play in such a policy (though, of course, there are also many non-technological factors involved). First, however, let us examine the concept of universal access in somewhat more detail.

Universal access

By definition, the question of what should count as reasonable access to a particular technology is open to interpretation and cannot be specified in any objective way. Indeed, as shown in Table 1 with respect to telephones, developing countries differ even in regard to the criteria by which accessibility is defined (namely, population, distance and time).

'Other countries' as noted by BENJAMIN and DAHMS, 1999:

... focus on getting at least one line into all villages and localities, such as Mexico, Thailand and Poland.

The national goals can be a mix of different elements,

for example China has a policy of 'one family, one telephone' in urban areas and a telephone in every village.

The same authors also emphasize that:

These targets change with time – as one target is met, universal access is redefined at a higher level. For example, in India the principle is, 'easier and quicker and increasing access to a public telephone for people who cannot take a private subscription' – and the definitions change as the network increases, currently any village over 2,500 or a distance of 5 km qualify for a public telephone (*ibid.*).

Note that while we have thus far been concerned only with the definition of universal access to telephones, similar issues obviously arise in relation to other technologies such as the computer and the Internet. And with respect to all these technologies, the definition that is relevant at one stage of development will not necessarily be the same at other stages. For instance, as one access goal is met, more ambitious targets will tend to be set by the country in question.

At any one moment in time, however, it is important to have standard measures of access so that one can compare, say, Internet access across different developing countries (MINGES, 2002). At present such comparisons are difficult, if not entirely impossible.

The technological dimensions of promoting universal access

One of the most important determinants of the cost of communal access to information and communications technologies has to do with where such technologies are actually located.⁴ It seems, in particular, that considerable cost reductions can be effected by relying on existing communal institutions such as schools, post offices and libraries.

The locational dimension. One of the most interesting examples in this regard is the scheme initiated by the Indian postal service, known as e-Post, which effectively provides low-cost email service to people without home computers (indeed, customers are not even required to send the mails themselves). What happens is that customers initially:

... hand a postal worker a message meant for a snail-mail address. The postal worker types the message into a computer and e-mails it to the post office nearest the intended recipient, where the message is printed out, placed in a sealed envelope and delivered by a carrier.

Since its introduction [in 2001] ... the service, which costs 10 rupees [21 US cents] a message, has become popular in relatively remote locations ... where home computers and Internet access are not common.

The Department of Posts also offers Hybrid Mail, which works in much the same way, except that messages are transmitted between post offices through a satellite network and then printed out and hand delivered (RAI, 2001).

Note that the remarkably low cost of this service is

made possible not only by the use of computers already operating in an existing institution, but also by the innovative use of low-cost unskilled couriers who deliver the message to its final destination.⁵

Schools represent a particularly attractive location for enhancing community access to information and communications technologies, as illustrated perhaps most clearly in the case of computers. On the one hand, research has shown that the unit costs of such technology are heavily dependent on the level at which it is actually used.⁶ On the other hand, 'even when computers are fully used during a school day this will often amount to five or six hours usage a day for five days of the week and for under 40 weeks of the year' (CAWThERA, 2001). Unfortunately, however:

Schools are rarely good at encouraging community usage of their facilities ... However, in addition to the increased efficiency and the corresponding reduction in unit costs that can occur when computers are used for 10–12 hours a day, this additional usage gives schools the opportunity to facilitate and develop good school/community relationships. Good school/community relationships are one of the factors which research shows can improve educational outcomes (*ibid.*).

Fortunately, however, the idea of using computers and other information and communications technologies for the benefit of the wider community has not gone entirely unnoticed in policy circles. Indeed, in the form of so-called school-based community telecentres, just such an idea has been used to great effect in a major programme established by World Links.⁷ Under the aegis of this programme, some 800 Internet Learning Centres have been created and a number of these in turn are open to the community outside normal school hours:

World Links first piloted this concept in Zimbabwe. At the ... community learning center ... over half of the 'clients' are adult learners who come to receive basic computer literacy training. Another important user group for this facility is the Zimbabwe Open University, where over three hundred students use the center to access their course material and interact with professors online. Finally, approximately 70 percent of the users of this center in Zimbabwe are women. The success of these pilots suggests that developing countries should encourage schools to open up to the community as a means of bridging the digital divide between urban and rural areas of the country (HAWKINS, 2001).

Our final example in the locational context of promoting universal access concerns yet another type of institution and is drawn from India at the time of her transition from electromechanical to digital switching telecommunications, as described by PITRODA, 1993. The directors of the project decided that universal access would not be served best by expensive coin-operated telephones, but rather by equipping ordinary instruments with small meters and then placing them

in the hands of, 'entrepreneurs who set them up on tables in bazaars, on street corners, or in cafes or shops whose owners feel they attract customers.... The phones are in such constant use that, in most cases, the revenue is enough to support a family' (*ibid.*, p. 78).

Technologies appropriate to universal access. In the previous section we were mainly concerned with the question of where a given technology should best be located in order to promote universal access. We now consider the types of information and communications technologies that will best further this objective. We shall organize our discussion around three forms of technology, namely, software, telecommunications and computer hardware, although as we shall see these categories are often related rather than distinct.

1. *Software.* Certain institutions in developing countries such as schools, orphanages and libraries often receive donations of refurbished, relatively dated computers from non-governmental organizations (NGOs) based in the developed countries. Computer Aid International, for example, is a not-for-profit institution in the UK, which uses volunteers from that country to recycle donated computers for use in schools and community organizations in developing countries.⁸

For many, if not most functions in these institutions – which often have to do with the acquisition of basic computing skills – the donated computers are perfectly adequate and they can also be made to run at very low cost on open-source (free), as opposed to proprietary forms of software (such as Microsoft Windows), which often require more recent hardware. In this case, institutions such as schools can lower the costs of access to an absolute minimum by combining donated computers with free software (as contrasted, most tellingly, with the case where expensive, recent hardware vintages are combined with equally recent versions of proprietary software).⁹

The Mexico case is illustrative in this regard because the government of that country decided in 1998 to install the Linux system in 140,000 school laboratories across the country. Apart from the money that would otherwise have had to be spent on expensive proprietary licenses, the Mexicans also recognized that Linux would enable them to continue to use older and less expensive computer hardware equipment.¹⁰

Even in the US, moreover, some schools are accepting donations of computers from other schools (such as 486s and Pentium 75s) that are too slow to run Windows software. These computers, however, can and are being operated by the Linux system instead. The more general point here is that the required degree of complexity (and hence vintage) of a computer depends on the use(s) to which it is put. For the acquisition of basic computing capabilities or word

processing functions, older computers are usually more than adequate.¹¹

2. *Telecommunications.* Wireless technologies represent a major breakthrough in countries where copper wire connectivity is currently limited and unlikely to promote universal access in the future: 'The telecommunications infrastructure is so poor in many African countries, for instance, that fixed line dial-up connectivity will never be a viable solution' (HAWKINS, 2001, p. 40). Wireless technologies can be used to promote universal access in such countries in at least three different communal settings, the first of which is schools:

Wireless technologies present a great opportunity for schools to connect both local area networks (LANs) and wide area networks (WANs) at a much lower cost than existing wired technologies. Wireless LANs save older schools and schools with a number of buildings dispersed across a campus the need to lay spools of Ethernet cable. Wireless LANs also provide the teacher with greater mobility to bring the lab to the classroom as opposed to bringing the class to the computer lab.

WANs with wireless connections to the Internet also allow schools to bypass the local telephone network and connect directly to an Internet Service Provider (ISP). This direct connection allows schools to avoid the local per minute rates charged by local telephone companies and budget their connectivity costs based on a fixed monthly rate. Also, the wireless connections ... allow for greater bandwidth than a dial-up modem connection. For instance, in Uganda the schools involved in the World Links program moved from a fixed line dial-up connection in which their monthly bills were around US\$250/month with a throughput connection rate of around 14.4 kilobits per second (kps). At this monthly cost, schools were only able to connect for around an hour per day. Moving to a wireless spread spectrum connection the schools were able to increase throughput to around 256 kps, pay a monthly fee of around US\$200/month and have a permanent connection to the Internet for 24 hours a day (CAWThERA, 2001, p. 41).

Wireless technologies have also been used to promote access to the Internet through village kiosks, as is illustrated perhaps most forcefully in India, where local scientists have designed an especially low cost wireless local loop system known as CorDect. Said to reduce the cost of per line telephone connection from Rs 40,000 to Rs 10,000 this technology forms part of an ongoing effort by an Indian firm called N-Logue to provide cheap Internet kiosks to small towns and rural areas, at a cost of only Rs 40,000 (US\$800) apiece.¹² With the help of a Webcam, some of these kiosks have recently been put to innovative use in a number of areas that are crucial to the well-being of village inhabitants. In one case, for example, the Webcam is being used to send the medical histories (including photographs) of villagers to an eye hospital some 40 km away.¹³ A specialist then reviews the material

and calls back for an online consultation with the patient, following which an appointment may be made at the hospital itself. In another example, photographs made by a Webcam of diseased vegetables were used as the basis for an online diagnosis and suggestions for remedial treatment by an agricultural college.

For many of the poorest groups living in developing countries, however, the most immediate problem is to gain access merely to basic telephony and from this point of view the application of wireless technology to pay-phones seems to offer a significant new opportunity to advance the quest for universal access.¹⁴ Indeed, it is striking that hundreds of wireless pay-phones were successfully installed in Tanzania, one of the world's poorest countries, by an American firm, Adesemi Communications International:

Their wireless system allows the flexibility to install pay-phones where they are most needed, regardless of whether landlines exist. Instead of using coins, users can purchase Adesecards in denominations as small as 45 cents. Minimizing vandalism and maximizing theft protection, these cards have proven far superior to coins. (*Readiness for the Networked World*, available at: www.readinessguide.org)

The wireless system also enables individual users to purchase low-cost beepers connected to voice mailboxes. The customer's beeper would alert him to voice mail messages which could then be retrieved by using the nearest Adesemi pay-phone.¹⁵

Something similar to the Adesemi model has also been introduced in Brazil, where:

Telebahia has instituted a service where people can subscribe to receive a telephone number attached to an automatic answering service (without a separate telephone line). Received calls can be retrieved by phoning the service's number and entering a security code, which is akin to the cellular phone 'voice mail' service.

This has proven very successful and has provided an incoming call service, which *other universal access systems do not do so well* (BENJAMIN and DAHMS, 1999).

These two examples from Tanzania and Brazil, illustrate the important point that universal access to telephones does not necessarily provide users with only the possibility of making outgoing calls. By enabling users to receive incoming calls as well, these examples show that universal access can indeed become closer to universal service (see more on this below).

3. *Computers.* We have already described how a combination of donated (used) computers and open-source software such as Linux, can help schools in developing countries (and developed ones too, for that matter) to promote the acquisition of basic computing skills among as many pupils as possible. Low-cost computing in schools and other poor communal institutions is also being promoted by innovations *designed specifically for this purpose* (although the design still incorporates open-

source as distinct from proprietary software).¹⁶ Most notably, for example:

The emphasis on community sharing of computing resources is ... at the core of India's 'simputer' ('simple inexpensive mobile computer'). The simputer also uses Linux but in a hand-held computer designed to be used even by those unable to read. Slated to cost about US\$200, the simputer has a built in Web browser and text-to-speech program which is capable of reading back Web pages in Indian languages such as Hindi, Kannada and Tamil. Input is through a stylus and a program called tapatap which works by having the user connect dots to form characters. One of the interesting innovations of the simputer is the use of a removable smart card which holds personal data for individuals, allowing a single device to be shared by many people (GODWIN-JONES, 2002, p. 5).

Thus, as in the case of the wireless payphones in Tanzania, from which users were able to retrieve incoming calls, so too does the simputer manage to impart to the communal user some of the *advantages of personal ownership* of the technology. The same can also be said of the automatic answering service without a separate telephone line in Brazil cited above. These are all examples, therefore, of how the new technologies *themselves* can be designed in ways that promote universal access.

The simputer is not however the only computer designed to cost only a few hundred dollars (or less than half the price of a standard multimedia PC). For, as indicated in a recent UNESCO publication:

... what will likely have a big impact on Telecentre start-up and operating costs is the Network Computer (NC). This is similar to a PC but has no moving parts and relies on a central server for all its software and data storage ... Because these machines are simpler to manufacture, they can be obtained and maintained at a significantly lower cost than a standard PC (JENSEN and ESTERHUYSEN, 2001).

Conclusions

As its point of departure this article recognized that for the vast majority of developing countries, the goal of policy should be to promote universal access, as opposed to individual ownership of information and communications technologies. Even with this more limited goal, however, we suggested that such technologies will need to be provided in cheaper and more appropriate forms than is usually the case. In some cases this will require the design of entirely new technologies, while in other cases universal access can be promoted simply by using existing technologies in different ways or making institutions work in an innovative manner.

These points were illustrated not only in relation to basic telephony and telecommunications but included

Table 2. Promoting universal access to IT: selected examples

Type of IT	Mechanism of influence	Nature of institution
Telephony	Wireless telephones with incoming call facility	Pay phones
Email	Written messages converted to email and delivered by courier to destination	Post office
Telecommunication	WLANs and WANs (wireless)	Schools
Computer	Use of schools outside of class hours	Community groups
Computer	Cheap computer with smart card for individual access	Schools, telecentres
Internet	Network computers lower cost compared to ordinary PC	Telecentres

also computers and the Internet. Table 2 contains a summary of some of the ways in which universal access to these technologies was promoted, as described above.

Notes

1. The fullest discussion of this is probably to be found in INTERNATIONAL TELECOMMUNICATIONS UNION, 1998.
2. This case has been most forcefully argued by JHUNJHUNWALA, 2001, in the Indian context.
3. In this article we focus only on the technological aspects of the issue. For a broader perspective of the problems and policies, see BEST and McCLAY, 2001.
4. *Ibid.*
5. According to a personal communication from Mr Sadsivan of the Indian Postal Service, the purpose of the courier service 'is to leverage our advantage of "last mile walk"' (received 26 November 2001).
6. CAWThERA, 2001, has performed these calculations for a number of schools in South Africa.
7. See the World Links homepage at: www.worldbank.org/worldlinks/english.
8. See also the World Computer exchange at: www.worldcomputerexchange.org.
9. On the open-source movement in developing countries, see JAMES, 2001.
10. *Ibid.* See also MURRAY, 1999.
11. In the Nakaseke Multipurpose Community Telecenter in Uganda, half the computers are Pentium IIs, while the other half are donated 486s (see MAYANJA, 2001).
12. The N-Logue case has recently been described in *Nature*, vol. 15, 24 January 2002.
13. As described in BBC News Online, 'Connecting the villages', 14 June 2002.
14. Readiness for the Networked World, available at: www.readinessguide.org/examples.html.
15. Unfortunately, in spite of its initial success, the firm was forced to close down at the end of the 1990s, partly because of worsening relations with the Tanzanian government (see MADDY, 2000).
16. The Brazilian government has also commissioned a low-cost 'Volkscomputer'.

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