Information and Communication Technologies (ICTs) for Rural Development in Developing Countries

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1. Introduction: the role of ICTs in an interconnected world

Nowadays, we are living in a chaotic period of transition to a new age characterized by global competition, rampant change, faster flow of information and communication, increasing business complexity and pervasive globalisation. This new environment is marked by more far-reaching technological advances and by a knowledge-driven economy, emphasising the fact that the current contribution of knowledge is very much the dynamo of economy.

Knowledge plays a crucial role in fostering innovation and, at the same time, innovation has become central to achievements in the business world where new challenges are always emerging.

Technological innovations, especially those in Information and Communication Technologies (ICTs), delivered the Information Age and converted it into the Knowledge Age[1]. By revolutionising the way societies interact,

Abstract

Rural areas of the developing world are the last frontier of the information technology revolution. In these areas, telephone and Internet access is very limited if compared with developed countries. The presence of very few means of electronic communication with the outside world is just one source of rural communities and economies isolation from the forces of national and global integration, albeit an important one.

In recent years, numerous interesting experiments have been carried out to extend low-cost telephone and Internet access to low-income rural communities.

But how can Information and Communication Technology contribute to rural development? What are the channels through which impacts can be realized, and what are the practical means for realizing potential benefits?

This paper analyses two main ongoing projects that aim at providing ICT-based services to rural populations in Maharashtra (India) and Morocco. The goal of such projects is to reach the commercial sustainability that supports scalability and, therefore, more widespread benefits.

The analysis highlights the common building blocks required for successful implementation and the relative strengths and weaknesses of different approaches.

Keywords: rural development, information technology, economic growth, India, Morocco.

Résumé

Les zones rurales des pays en développement représentent la dernière frontière de la révolution des technologies de l'information. Dans ces zones, l'accès au réseau (téléphone et Internet) est très limité par rapport aux pays développés. La présence de très peu de moyens de communication électronique est l'une des raisons principales expliquant l'isolement des économies et des communautés rurales par rapport aux forces d'intégration nationale et internationale.

Ces dernières années, bon nombre d'expériences intéressantes ont été mises en œuvre pour permettre aux communautés rurale à faible revenu d'avoir accès au téléphone et à Internet à bas coûts. Mais comment la technologie de l'information et de la communication peut-elle contribuer au développement économique? Quels sont les canaux par lesquels des impacts peuvent se produire? Et quels sont les moyens pratiques par lesquels les bénéfices potentiels peuvent se réaliser?

Cet article passe en revue deux projets en cours dont le but ultime est de fournir aux populations rurales de Maharashtra (Inde) et du Maroc des services à base des technologies de l'information et de la communication. L'objectif de ses projets est de produire une durabilité commerciale capable de supporter des avantages plus répandus.

L'analyse met en évidence aussi bien les ingrédients communs nécessaires pour mettre sur pied un programme de succès que les point de forces et de faiblesse des différentes approches existantes.

***Mots-clés**: développement rural, technologie de l'information, croissance économique, Inde, Maroc.*

conduct their businesses and compete in international markets, ICTs are setting the world economies and the development agendas.

ICTs consist of hardware, software, networks and media for collection, storage, processing, transmission and presentation of information (including voice, data, text and images). This simple and unconstrained definition of ICTs encompasses the oldest as well as the newest ICTs (mainly mobile and internet) and, as a result, promotes the widest participation of countries across the globe.

Information goods typically have the characteristic that one person's use of them does not reduce their availability for another person. Thus, many people can display messages or news, simultaneously or sequentially. Standard economic characterizations can be used to classify the different kinds of information.

For example, entertainment, personal communications and sometimes news are final goods.

Educational material, job announcements or specific news (weather news for farmers, for instance) are intermediate goods, typically used for improving income-earning opportunities.

ICTs are dramatically increasing the share ability of information – by enabling societies to produce, have access

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[1] Pasternack B.A. and Viscio A.J., 1998. *The Centerless Corporation*, Asia Pacific Journal of Human Resources.

to, adapt and apply greater amounts of information in a more rapid manner and at reduced costs – and they are enhancing business productivity and economic activity.

In the framework of rapidly developing information and communication technologies, the Milan Declaration on Communication and Human Rights[2] (1998) has asserted that communication media have a responsibility to help sustain the diversity of the world's cultures, languages and economies, and that they should be supported by legislative, administrative, and financial measures.

In the spirit of the Milan Declaration, ICTs are proving to contribute to strengthening democracy, increasing social participation, competing in the global marketplace, removing barriers to modernisation and making poor populations the main stakeholders of the sustainable development process.

The purpose of this paper is to provide a snapshot of ICTs in the developing countries. By presenting two ongoing projects in India and Morocco, the intent is to analyse the benefit of ICTs usage in rural development and to assess the socio-economic benefit deriving from their functioning.

2. ICTs, economic growth and development

Today, we truly live in a global village, but it is a village with privileged information "haves" and many information "have-nots". To face the unprecedented challenges brought on by the changing global economy, dynamic political contexts, environment degradation and demographic pressures, and to make critical decisions, people at all levels of society - especially the food-insecure and the organizations that serve and represent them – should be able to have easy access to critical information and to communicate.
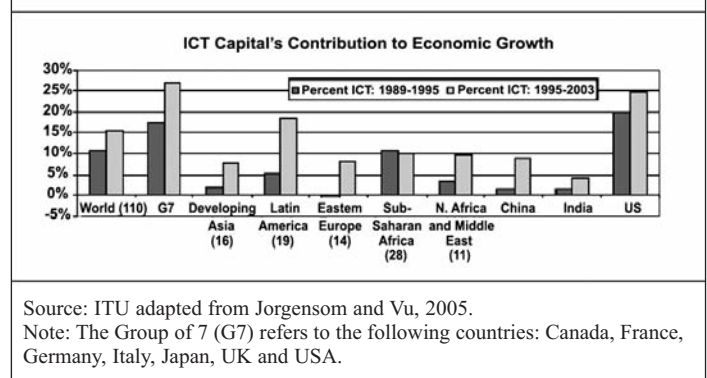
In assessing the potential for ICTs to promote an economic growth to the benefit of the poor, two central questions remain to be answered. First, is there a definite causal relationship between ICTs and the economic growth? Second, is the resulting growth in favour of the poor? And, if not, what conditions could make it so?

Several comparative studies have been carried out to analyse the difference in productivity gains in different countries and regions of the world. While the extent of the impact may differ, there is a general consensus that ICTs have a clear impact on economic growth by increasing the productivity.

A comprehensive international study[3] comparing the periods 1989-1995 with 1995-2003 uses separate measures of ICT investment, non-ICT investment, and several measures of labour in order to determine the correlation between changes in ICT investment levels and GDP growth across different regions. According to this study, the group that benefited the most from ICTs was the G7, where almost one third (27%) of the GDP growth that occurred from 1995-2003 was due to ICT investment. However, in major developing and transition countries, ICT capital played a smaller (although increasing) role. Sub-Sahara Africa shows similar economic impact from ICT capital growth over time – about 10% – while most other groups have lately showed a greater impact. Latin America jumped considerably from the first time period to the second (Figure 1).

Figure 1 – *ICT's contribution to economic growth.*

Source: ITU adapted from Jorgensom and Vu, 2005.
Note: The Group of 7 (G7) refers to the following countries: Canada, France, Germany, Italy, Japan, UK and USA.

The results suggest that the contribution of ICT to economic growth depends on a number of factors including the market's regulatory framework and the ability of countries to develop skills and transform their organisational environment.

Significant network investment and expansion are needed before ICTs can begin to effectively affect growth in low-income countries.

As far as development is concerned, information and infrastructures are essential for bringing about social and economic change. ICTs promote greater inclusion of individuals within networks and, even more important, they increase the diversity of participants by overcoming the barriers of physical distance and social standing. The immediacy and reach of ICTs also promote faster, more efficient, and ultimately better decision-making across all fields of endeavour.

The role of ICTs in people's lives goes beyond the issue of access and infrastructure as these tools have become important in improving health services, in environmental monitoring, in bridging the gaps of the rich and the poor in various countries, in empowering women, and so on. The figure below tries to conceptualise the social and economic development that ICTs help in bringing about in developing countries where distance and illiteracy are barriers to the improving of living conditions.

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[2] http://na.amarc.org/?p=The_Milan_Declaration.
[3] International Telecommunication Union, "World Telecommunication Development Report 2006. Measuring ICT for social and economic development", Executive Summary, 2007.

Figure 2 – *ICT-based Development Model..*
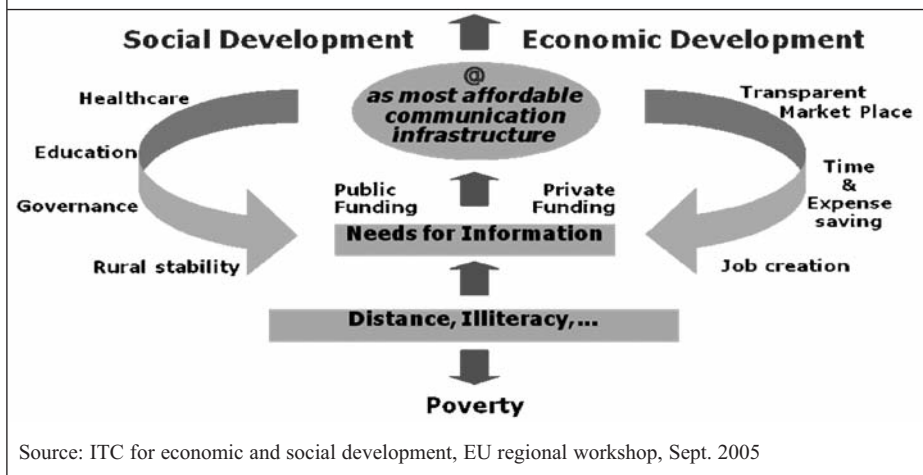
Source: ITC for economic and social development, EU regional workshop, Sept. 2005

For example, the impact of ICTs is witnessed in many aspects such as:

- *Natural disasters management in low-income countries.* For example, the World Bank's hazard management programme in high-risk areas of Andhra Pradesh (India) involves ICT components in cyclone warning, communication and response, awareness raising, education and community involvement in hazard reduction activities.

- *Efficiency of government.* The Automated Systems for Customs Data (Asycuda), developed by UNCTAD, is now used by over 70 developing countries to manage tariff collection and reduce frontier corruption. The system speeds up goods movement, reduces transport expenses, and costs US$ 2 million to install (Kenny *et al.*, 2000).

- *Children education.* In Mexico, over 700,000 secondary-school students in remote villages now have access to the *Telesecundaria* program, which provides televised classes and a comprehensive curriculum through closed-circuit television, satellite transmissions, and teleconferencing between students and teachers. Studies have found that the program is only 16 % more expensive per pupil served than normal urban secondary schools, while students benefit from much smaller student-to-teacher ratios (De Moura and others, 1999).

- *Access to cultural resources.* ICTs have also played an important role in preserving and identifying threatened or marginalized cultural artefacts and traditions.

Some commentators, however, hold much more sceptical views of the benefits of ICTs for development. They argue that access to ICTs largely depends on education, income, and wealth and that the so-called *digital divide* is only a part of a much broader development divide.

Limited education, inappropriate language skills or lack of resources could prevent disadvantaged segments of the population from accessing ICTs, ultimately exacerbating information gaps and increasing income inequality between and within countries. It is often argued that developing countries have other, more pressing investment priorities, such as food, safe water, education, and public health, and that devoting limited resources to ICTs must be justified on the basis of its opportunity costs relative to other development agendas.

3. Potential of ICTs for rural development

Though in decline, agriculture remains the direct and indirect base for the economic livelihoods of the majority of the world's population (IFAD, 2001).

According to Albert Waterson, as quoted by Cohen (1987), the purpose of rural development is

"*...to improve the standard of living of the rural population through a multi-sectorial approach including agriculture, industry, and social facilities*".

Rural communities require information *inter alia* on supply of inputs, new technologies, early warning systems (drought, pests, diseases), credit, market prices and their competitors.

The success of the Green Revolution in Asia and the Near East indicates that giving rural communities access to knowledge, technology and services will contribute to expanding and energising agriculture.

Traditional media and new ICTs have played a major role in diffusing information to rural communities, and have much more potential. There is a strong need to connect rural communities, research and extension networks and to provide access to the much needed knowledge, technology and services (Forno, 1999).

So far, traditional media have been used very successfully in developing countries and rural radio in particular has played a major role in delivering agricultural messages. Print, video, television, films, slides, pictures, drama, dance, folklore, group discussions, exhibitions and demonstrations have also been used to speed up the flow of information (Munyua, 2000).

New ICTs[4], however, have the potential of getting vast amounts of information to rural populations in a more timely, comprehensive and cost-effective manner, and could be used together with traditional media.

This is the reason why, recently, scholars have started to speak of "*e-rural development*", which is:

"*… the provision of information, knowledge and business services to the people living in rural areas for improving their livelihoods using a variety of electronic means of communication.*[5]"

ICTs have the capacity to transcend physical distance and to provide communication between extended communities

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[4] Mainly Internet and mobile phones.
[5] http://www.unescap.org/icstd/applications/ruralICT/Building%20eComunity%20Centres%20Report.pdf

and integration with wider social and economic networks. The increases in processing speed and reductions in cost that are driving the digital revolution are based on a presumption of unsatisfied demand for information. As the capacity to supply more information, at a reduced cost, grows so the demand for information is seen to rise as the 'information' society develops. The transformational changes to society and the economy that result from shifting towards an information society lead and transform the classical concept of rural development into "*e-rural development*".

3.1 Rural Information needs and ICT applications in rural contexts

A study on the information needs and information seeking behaviour of rural dwellers, conducted with the *Participatory rural appraisal (PRA) method* [6] in many rural communities around the world, indicate the following as main rural information needs (Momodu, 2002):

- *Agricultural Information* – it includes information on pesticides, herbicides, storage, information on 'where to purchase fertilizers' and 'how to use them', information on speedboats, net making;

- *Health Information* – it includes information on how to handle the outbreak of certain epidemics, where to get the best treatment for different ailments, how to get good health facilities;

- *Political Information* – it includes information on traditional leadership, civic rights, political parties, voting rights, etc.;

- *Community Development Information* – it includes information on viable self-help projects, how to mobilize people for the projects, what government agencies to contact and to lobby, etc.;

- *Educational Information* – it includes information on school calendar, opportunities for educational self-development, higher education, adult education, continuing education, etc.

Furthermore, rural dwellers also require information on economic (industries, services, marketing, etc.), social (education, religion, culture, etc.) and environmental (natural resources, ownership rights, etc.) issues.

ICTs can play a major role in providing accurate information and can have numerous applications in a rural context:

Table 1 – *Examples of ICTs applications in rural contexts.*

Education	Agriculture	Sustainable livelihoods
Offline multimedia e-learning tools in CD-ROMs etc	Access to market information through portals, radio, mobile phones	Exploring employment opportunities
E-learning using chat and video-conferencing facility	Expert advice on farming, animal husbandry, fishing, dairying etc.	Income opportunities for infokiosk entrepreneurs
Distance education through internet; capacity building of rural teachers	Detection of catch fish zone using satellite tracking systems	Payment of bills through infokiosk
Radio broadcast for educational contents	Knowledge sharing of indigenous farming practices	Money transactions with non-resident Indians
Health	*Community development*	*Small business development*
Telemedicine applications e.g. remote diagnosis and expert medical consultations	Interactive portals with local content in native languages, web-based newspaper	Micro-credit financing
Improved health recording system	Local culture preserved and flourished through community radio	E-commerce for local artisans
Better delivery of training modules for In-service training of semi-skilled health workers using ICT	Local jobs, matrimonial portals, Interaction with family members living in cities, abroad	Improving logistics, e.g. pre-arranging payment and delivery details before transactions
Better monitoring and knowledge sharing on disease and famine	Facilitate knowledge sharing among community, local government and grassroots NGOs	Market information, marketing of products
Governance	*Emergency Situations*	*Environmental*
Lodging complaints and grievances to state and redressal	Calling police, fire, and ambulance and location and rescue of victims in emergency	Weather forecast
Payment of state services	Emergency assistance in vehicle breakdown	Neighbourhood mapping, natural resource management
Applications for certificates, Copy of land records	Radio broadcasts (esp. using ham radio) in natural calamities	Satellite based tracking of bush fires
Information on state schemes e.g. credit and below poverty line amenities	Disseminating early warning from national and international disaster warning systems via local infokiosks	Local planning using GIS

Source: ITU (2000: 21); Senthilkumaran S. and Arunachalam S. (2002). Rajora, Rajesh (2002).

a) they can initiate new agricultural and rural business such as e-commerce, real estate business for satellite offices, rural tourism, and virtual corporation of small-scale farms;

b) they can support policy-making and evaluation on optimal farm production and agro-environmental resources management by using tools such as geographic information systems (GIS);

c) they can improve farm management and farming technologies by efficient farm management, risk management, effective information or knowledge transfer, realizing competitive and sustainable farming with safe products. For example, farmers must make critical decisions such as what to and when to plant, and how to manage pests, while considering off-farm factors such as environmental impacts, market access, and industry standards;

d) finally, ICTs can provide systems and tools to secure food traceability and reliability that became an emerging is-

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[6] Participatory rural appraisal (PRA) is an approach used by non-governmental organizations (NGOs) and other agencies involved in international development. The approach aims at incorporating the knowledge and opinions of rural people in the planning and management of development projects and programmes.

sue concerning farm products since serious contamination such as chicken flu has been detected.

3.2 Rural information initiatives and efficient data acquisitions

Most of the successful ICTs initiatives in many developing are normally realized thanks to infrastructures like:

- *Rural kiosks* - sometimes referred to as telecentres, they can be considered a sort of Internet cafes for rural villages, with one or more connected PCs available for shared use by village residents. Rural kiosks typically offer a broad range of services and applications specialized for rural areas, whereas urban cafés tend to purely focus on Internet access and standard computer applications. Kiosks are initiated by various kiosk project agencies, which identify one or more people per rural village to act as a kiosk operator. In many cases, the kiosk operator is also the kiosk owner, in which case the agency takes on a franchise model, with operators as franchisees or rural entrepreneurs.

- *Community Technology Learning Centres* – they are centres within an elementary, middle, or high school building that provides educational, recreational, health, and social service programs for residents of all ages within a local community.

- *Distance Learning Centres*- they are centres that provide distance learning services, including the development and delivery of courses using online technology.

- *Rural Information and Knowledge Centres* – they are multi-service community information centres which provide access to internet, e-mail, telephones, fax, photocopy, computer training classes and other ICT services as well act as a hub of local, national and global information resources to provide an catalytic effect for the rural communities in poverty reduction, social and economic development while aiming at providing these services in a long-term, sustainable manner.

Such Information Centres give the rural people the possibility to fulfil their information needs at a reduced cost, thus fostering a process of knowledge acquisition and consequently a process of development.

To solve the problem of acquiring different agricultural data in an efficient and low cost way, some systems have been recently implemented.

For example, Kouno et al. (1998 and 2000) developed a system combined with a web camera and a metrological robot to record a farm-working journal. The web camera automatically collects crop images used to remotely analyse plant growth and condition. Application of web camera to agriculture is now very common as reasonably cheap cameras and easy-to-use software become available.

Sugawara (2001) developed a mobile-phone-based farm-working journal to collect field data.

The software is web-based and one can directly upload farming data to a database from the fields.

Recently, in Asia a field monitoring system called Field Server has been developed[7].

A Field Server has originally ordinal sensors such as temperature, solar radiation, moisture and soil temperature. It has very flexible interface and can optionally have several types of sensor such as a web camera, an infrared sensor, wind speed, wind direction and leaf wetness. In addition to its sensing functions, Field Server can serve as a wireless LAN access point so that each Field Server can establish a wireless network with other Field Servers. This indicates that a whole region can be covered by the Internet accessible wireless hot spot, having several Field Servers deployed and just one link point to the Internet in the region. Latest version of the Field Server is completely autonomous without any requirement for electric supply.

A Field Server is remarkably cheap (<300 US$) and as accurate as an ordinal expensive weather robot as a sensing system. Using its wireless LAN hotspot function, this can easily be used in rural areas.

Field data acquisitions will become even more important because of the recent movement toward traceability of agricultural products, in which information must be easily traced to the original farming conditions, e.g. varieties, pesticide spray, harvest dates and producer names.

Anyway, it is certainly difficult to predict the future, not only regarding the kind of technologies that will emerge, but also regarding the reaction of the consumers: what they will adopt and for what purposes, and what they will reject. Increasingly, the examples of ICT applications in rural contexts are developing: a strong participatory bottom up approach should be fostered and implemented.

An enabling regulatory and policy environment is required for the ICT sector, including coherent national plans that integrate ICT-based development. They should help to build national and regional internet backbones and community access points; adopt enabling policies for telecommunications and electronic commerce; encourage the creation and dissemination of locally relevant content and applications that fit with the cultural and social context, reflecting the linguistic diversity; significantly expand education and training programs, both in general and with regard to ICT in particular; and help to create a facilitative environment and access to ICT for the civil society, private sector and government. (Drake 2001).

Care should be taken so that ICT programs are not just technology-driven but respond to the needs of the poor, when it comes to content, language, skills, design, and price. It is important to address the sectors and areas that are of direct relevance to poverty reduction and where the use of ICTs can make a difference.

Local communities should be involved in the design of universal access programs through consultations, surveys and demand studies. Hardware too could be developed in

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[7] http://model.job.affrc.go.jp/FieldServer/FieldServerEn/default.htm

close consultation with the poor, and in line with the developing country conditions, responding to various constraints such as lack of mains energy supply or interrupted supply. Techniques such as voice mail translation of content and i-con-based telephones could be used.

Such research and development already exists in developing countries. India and Indonesia are developing their own customized, low-cost IT terminals and devices.

4. Two case studies: ICTs for rural development in India e Morocco

4.1. Warana: a Rural Community Adopting ICTs (India)

An example of the issues involved with the adoption of ICTs by a rural community is given by the experience of the Warana Group of Co-operatives (WGC), which is using ICTs to streamline the operations connected with sugar cane growing and harvesting.

Villages are the lifelines of India - and the concept of a fully automated Indian village was like a dream till some time back. It turned into reality on the initiative of Warana that is a well-developed rural area located 30 kilometres northwest of the city of Kolhapur, in Maharashtra, one of the richest Indian states[8].

Much of Warana's success is due to the presence of a strong co-operative movement, the WGC. About 50,000 farmers live in 100 villages spread in the 25,000-sq kilometre area covered by the co-operative. The main economic activity is sugar cane growing and processing.

ICT was brought to this area by the Warana "Wired Village" project, launched in 1998 as a collaboration between the National Informatics Centre (NIC), the Government of Maharashtra, the Warana Vibhag Shikshan Mandal (Education Department). The right conditions to bring ICTs to Warana existed both in terms of human development and of infrastructure[9] as, for instance, there is uninterrupted power supply in the area.

The project aims at bringing agricultural, market and educational information to 70 villages around Warana and at giving villagers access to information in local language about crops and agricultural market prices, employment schemes from the government of Maharashtra, and educational opportunities.

There are 54 functioning village information kiosks that are facilitating the sugar cane production process at three stages: first, during the yearly registration for plantation when changes to property are recorded; second, with the issuance of harvesting permits; and third, with payments information. Farmers can go to the village information kiosks to receive payment slips. The sugar co-operative pays them for their crops in four instalments that are credited directly to their bank accounts. The co-operative publishes payment dates on a local paper, so farmers know when it is their turn to go to the kiosks. Moreover, farmers can purchase fertilizer at deposits located next to the kiosks in cash or by using credit. If they buy using credit, they get a receipt for their purchase at the kiosk. Money spent on transport of the crop to the sugar factory is also entered in the system.

Village information kiosks have operators who enter data into computers and are generally open between 10 a.m. and 6 p.m. Depending on the size of the village served by a kiosk, between 30 and 100 farmers visit the kiosk daily. Village kiosks have a PC with a printer and most are connected to the sugar administrative building via wireless telephony. The project has already increased the efficiency of the sugar cane growing and harvesting process, both in terms of time saved by the farmers on administrative transactions and in terms of monetary gains.

The estimated cost of the project is around $600,000 (Rs 2.6 crores). Of the total cost of the project 50 percent is being borne by the Central Government, 40 percent by the Government of Maharashtra and the remaining 10 percent by the Warana.

4.2 Fez area government project – the eFez Project (Morocco)

In Morocco, ICT was initially viewed in 1995 as an enabling mechanism to liberalise the economy and thereby enable Morocco to participate more effectively in the global economy[10]. It was hoped to slow the emigration of skilled workers, especially to Europe, as well as to create employment opportunities.

By 1996, there were already some 50 cyber cafés, an estimated 10,000 internet subscribers, some 50 websites, 1.4 million fixed telephone lines and an estimated 100,000 mobile phones.

Morocco's ITC penetration has been increasing steady and stands at around 1.6% per year but the high costs of Net access, PCs and ISP subscription rates are the main reasons why most Moroccans do not have home access.

In this frame, several initiatives have been launched to spread the availability and use of the Internet and to be more responsive to local needs.

E-government is an essential part of this strategy, but to date almost all Moroccan government web sites are largely informational, since they describe a department's roles and functions, but do not allow citizens to have electronic access to services.

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[8] Per capita income in Maharashtra stands at Rs. 19,207, which compares to an Indian average of Rs. 12,278 (Government of Maharashtra 2001). In terms of progress in raising average household consumption, Maharashtra was the fourth best performer among Indian states over the 1957-1991 period. The growth process, however, was associated with adverse distributional impacts from the point of view of the poor (Datt and Ravallion 1998). As a result, in 1993-94 the percentage of the rural population living below the poverty line stood at a high 38.6 percent, slightly above the national average of 37.5 percent

[9] In Warana, there is a strong local IT capacity to build the project. The Engineering College has a computer laboratory with around 200 PCs, where each student can practice two hours per day, and it offers courses in software development (Java, C++, etc.).

[10] http://www.american.edu/initeb/ae0641a/morocco.htm

Most government services, such as getting a passport or acquiring the papers required to register to vote, still can only be accessed through government offices in the capital, Rabat, or in big cities like Casablanca.

In the developing context of Morocco, the eFez project, launched by the municipality of Fez in partnership with the research team of the ICT-for-Development Laboratory (ICT4D Lab) at Al Akhawayn University in Ifrane and funded by the IDRC, has proved to be a local e-Government success story.

By making simplified processes accessible through GSM phones (widely used in Morocco), Personal Digital Assistants (PDAs) and personal computers, the *eFez* helps giving all citizens of the urban and rural areas around Fez equal access to services, reducing bureaucratic delays, making administrative procedures more transparent and visible, and using government human resources more efficiently.

In order to allow users to access services and request documents (such as residency certificates, birth certificates, and marital status certificates), the Fez Wilaya (local administration) has installed free public digital kiosks in different areas. Following such a participatory and iterative methodological approach, eFez is succeeding in building a citizen-centric e-government system that is accessible, usable and acceptable among Fez local community members, regardless of their degree of basic literacy and/or familiarity with ICT use.

5. Conclusions

The importance of knowledge for development is well recognised (World Bank, 1999).

Knowledge is a central foundation of human and economic development. Technological revolution in ICTs has led to the emergence of a knowledge economy but the inability of developing countries to maximise the benefits of this revolution is a significant barrier to their participation in this knowledge economy.

Information and communication activities are fundamental elements of any development activity, especially in the less developed countries and in rural areas.

The ICTs' benefits are multiple and can enhance rural development initiatives in the following key areas:

a) Managing, storing, and sharing information

ICTs offer unprecedented information storage capacity, increase in processing power and speed, coupled with dramatic reductions in costs. ICTs can facilitate the improvement of existing information management processes by improving the easy access, transparency, accountability, efficiency, speed of delivery and providing new information sharing opportunities through affordability, availability and ease of use. ICTs can help addressing good governance concerns of greater administrative efficiency by improving existing formal information systems operated by local government and development agencies and also facilitate improved cataloguing, storing and sharing of locally relevant information. The extended multi-media capabilities of new technologies offer the potential for storage and presentation of information in formats more appropriate to local contexts and therefore encourage greater integration of different information systems. Above all ICTs offer potential for decentralisation of information systems, decreasing dependency and empowering the rural poor by devolving control over information and knowledge.

b) Access to more information, especially public information

The context of rural development has rapidly changed in recent years.

In terms of market opportunities, emerging agricultural technologies are increasingly information intensive and the poor rurals must now cope with increasingly sophisticated input and output markets. Most smallholders and the rural institutions that represent them are badly equipped to cope with the vagaries of the open market. Improving the information management and decision-making capacity of these institutions is essential if they are willing to 'make markets work for the poor'. ICTs offer huge potential in support of improved education and training and need to be harnessed to build long term decision-making capacity in rural areas. ICTs can also support improved provision of short-term information required by the rural poor for livelihood strategies.

Furthermore the poor are increasingly expected to take on responsibility for management and financing of rural services, e.g. water supplies, and to participate in recently decentralised systems of governance; ICTs offer them considerable potential to increase the benefits and reduce the opportunity costs of participation.

c) Creating linkages for partnerships in information sharing (mutual, two-way, participatory)

As noted above ICTs can help empowering poor people to take control of their knowledge environment. This can lead to improved sharing of information locally resulting in greater choices for livelihood strategies, e.g. cataloguing and sharing experience between farmers. Local information exchange can help the poor rurals to gather into groups, articulate needs, defend interests and to increase bargaining power. ICTs can help pro-poor institutions listen to the poor, engage in more meaningful dialogue and build consensus and mutual understanding around development objectives. ICTs provide practical opportunities for improved information exchange between different groups and new and innovative knowledge partnerships.

Clearly, there are constraints to the application of ICTs in rural development and many of these reflect long-standing development problems. The main constraints concern the inequitable access to information, the costs of ICT in terms of infrastructure, hardware, telecommunication tariffs, and content, the lack of "digital literacy" in developing coun-

tries as well as the lack of robust regulatory framework for ICTs.

Being aware that ICTs provide a unique opportunity to move beyond centralized models of planning, management and governance, developing countries must anyway be careful not to conceive of ICTs as a sort of panacea. Simply layering these technologies on existing systems, bureaucracies and processes will not achieve development objectives. Sustainable ICT projects must be locally owned and accompanied by human capacity development, to ensure the ability of individuals and communities to use, maintain, and fully benefit from their usage.

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