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Perspectives and case study of Iringa, Tanzania

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Abstract

Since the late 1990s, the “mobile revolution” in Africa has created a huge number of new jobs and micro-entrepreneurs providing critical maintenance for the continental ICT infrastructure, as well as new income opportunities at the base of the pyramid. This research analyses how such opportunities are created and what their impact is on the contribution of ICT to development, and it also develops forward-looking perspectives to enhance how ICT can be accompanied by inclusive innovation practices that effectively address rural and urban poverty in developing countries.

The research project included extensive field research in Iringa, Tanzania, which was chosen as the case study locale, as it typifies, in many respects, the rural social, cultural, economic and geographic landscape in Tanzania and Sub-Saharan Africa.

The description of ICT-related social and economic opportunities, which include Internet cafés, mobile phone sales, repairs and related services, SIM-card and phone-time voucher vending, and services for local telecommunication base stations, is a central objective of this report. Local ICT service ecology has significant poverty-alleviating impacts, and we also review the underlying skills, competencies and micro-entrepreneurial strategies to identify what enables low-income communities and people to seize these social and economic opportunities.

A second key objective of the research project was to map the local ICT innovation ecosystem in Iringa, and to describe how the technical ICT infrastructure conditions the available pro-poor social and economic opportunities. Here our research points out that the technical and economic limitations of local ICT innovation ecosystems weighs heavily on the ability of rural communities to capitalise on the latest waves of ICT technology, and we develop perspectives on technology foresight and roadmapping practices that would pay heightened attention to pro-poor technology opportunities.

This research project has been undertaken as an “African Local Innovation Ecosystems” project, which was commissioned by the Ministry for Foreign Affairs of Finland with the objective of developing new perspectives and recommendations for the Finnish Development Policy. The authors are responsible for all mistakes, omissions, findings, interpretations, conclusions and recommendations.

Keywords ICT, innovation, inclusive innovation, ecosystems, micro-entrepreneurship, development, Tanzania, Africa

Contents

List of abbreviations

2G	Second generation cell phone technology
3G	Third generation cell phone technology
AfDB	African Development Bank
COSTECH	Tanzania Commission for Science and Technology
DTBi	Dar Teknohama Business Incubator
DSL	Digital subscriber line
EUR	Euro
GPS	Global positioning system
GSM	Global system for mobile communications
GTUG	Google Technology User Group
ICT	Information and communication technologies
ICT4D	Information and communication technologies for development
ILO	International Labour Organization
IPR	Intellectual Property Rights
MNC	Multinational corporation
MSMEs	Micro, small and medium enterprises
NGO	Non-governmental organisation
NSCP	National Schools Connectivity Plan
NMB	National Microfinance Bank
NICTBB	National ICT Backbone
OECD	Organisation for Economic Cooperation and Development
UNCTAD	United Nations Conference on Trade and Development

OS	Operating system
PPP	Public private partnership
POP	Point-of-presence
R&D	Research and development
SIM card	Subscriber identity module card
SMS	Short message service
TCRA	Tanzania Communications Regulatory Authority
Tsh	Tanzanian Shilling
TTCL	Tanzania Telecommunications Corporation Limited
TV	Television
WiFi	Wireless fidelity
Wi-MAX	Worldwide interoperability for microwave access

1. Introduction – ICT4D and development

Mounting evidence and experience demonstrates that ICT can play a critical role in the development of poor countries. The benefits of improved ICT infrastructure, device diffusion and related services contribute to the economic growth of the whole of Africa and its countries, and improve the livelihoods of particular communities and individuals. Indeed, the huge success of mobile telephony in Africa over the last decade, documented recently in so many publications (e.g. AfDB/OECD, 2009; Williams et al., 2011; UNCTAD, 2011; Aker & Mbiti, 2011) that it will be not repeated here, has become a celebrated case of how ICT can make a broad-ranging difference to the continent's development. At the same time, prompted by the accelerating digital convergence, there is a growing concern how this success can be repeated in the case of the Internet and future digital technologies (Heeks, 2008). Recently, the World Bank (Williams et al., 2011, p. 183) has argued that the two most important objectives for ICT in Africa are to expand network coverage to the rural areas, and to make affordable Internet available to all.

While the role of infrastructure investments and the roll-out of ICT technologies and services advocated by the World Bank and other major ICT development agencies are necessary to enable its contribution to development in Africa and elsewhere, these ambitious investment and infrastructure programmes raise broader questions about the actual mechanisms by which ICT engenders development. A growing number of observers and scholars argue that the ICT4D community, comprising donors, recipients, NGOs, practitioners and others, are not sufficiently drawing conclusions and lessons from the previous ICT4D initiatives for new ones (Donner, 2008; Heeks 2010; Aker & Mbiti 2010; Kleine & Unwin, 2009). At heart, these critics and others (Baskaran & Muchie, 2006; Toivanen 2011) argue that the local conditions for ICT uptake, implementation and impacts are not appreciated sufficiently as producing economic and developmental benefits.

The issue here is to decide what category of impacts one chooses to look at. Following largely established categories, Aker & Mbiti (2010) list the main avenues by which ICT advances development:

1. Enhanced access and use of information (search cost)
2. Improvement of a firm's productivity by allowing better management of value-chains

3. Creation of local ICT-related jobs in rural and urban areas
4. Enhanced communication among social networks, reducing exposure to risks (natural disasters, political violence, etc.)
5. Enhanced delivery of services (financial, health, education, etc.) via m- and e-delivery platforms.

In their review of the literature on the economic impacts of ICT in developing countries, Aker and Mbiti also point out that macro-economic assessments, especially because such evaluations suffer from inherent data reliability problems, provide few insights into how grass-root phenomena take place or how concerned instruments and policies could be improved. Research on other development avenues is relatively rich, they conclude, but too little is known about how ICT plays out in local communities (third avenue).

An evaluation of ICT4D initiatives showcases similar problems, Richard Heeks has argued (2010). According to him, "the poor quality of ICT4D impact assessment to date derives from its lack of conceptual foundations." Heeks (2010) has proposed a four-domain model for evaluation of ICT4D:

1. Readiness: particularly infrastructure and technology diffusion
2. Availability: implementation of ICT4D initiatives enhancing access, e.g. to Internet and phones
3. Uptake: the processes by which access to technology is turned into actual usage
4. Impacts, which can be divided further into:
   a. Outputs: the micro-level behavioural changes associated with technology use
   b. Outcomes: the wider costs and benefits associated with ICT
   c. Development impacts: the contribution of ICT to broader development goals.

According to Heeks, readiness dominates the evaluation and impact assessment framework, and too little effort has been put into developing perspectives on impacts at local level. A central theme in this critique is that our insight into the actual local dynamics of ICT, such as user behaviour, impact on economic strategies, job creation and entrepreneurial opportunities, as well as re-configuration of social relationships and many other micro-level social, economic and cultural phenomena, is under-appreciated and under-researched.

In the context of a rural African city, Iringa in Tanzania, this constitutes the key objective for our research, namely to understand how ICT facilitates and enables different types of economic and social activities and relationships, which in aggregate can be said to be "development". We have adopted a research design that investigates in depth the local texture and conditions, which allows us to cast light on how the impact of ICT unfolds at the micro-level of African society.

This report is organised as follows. The introduction reviews briefly our conceptual framework and details our research questions, and it also describes our methods and research material. The second chapter describes and analyses in

detail the social and economic opportunities created by ICT in Iringa, mostly micro-entrepreneurial activities, and tries to establish how these could be used to developed new perspectives for pro-poor ICT initiatives. The third section presents the results of our mapping of Iringa's local ICT ecosystem, and discusses in detail how the local African ICT ecosystems are different, mostly less tense or narrower than in rich countries. The fourth chapter considers the use of foresight in advancing ICT in Africa, and places our case study in a broader global technology framework. The final chapter summarises our conclusions and discusses briefly the policy implications of our research.

1.1 Entrepreneurship and ICT in a poverty alleviation context

Entrepreneurship that benefits the poor has different forms. It can be a large-scale multinational corporation (MNC) implementing a BOP business strategy or a corporate social responsibility project, a small or medium-sized company from a rich country or a developing country company doing BOP business or being contracted by an MNC, or an non-government organization (NGO) conducting its benevolent objectives through a business entity, or something else. The point is that there is no one-size-fits-all description of how entrepreneurship can be pro-poor.

The challenges of discussing the role of the private sector in development cooperation are multiple. On one hand, it easily creates the impression of making money at the cost of the poor, although the pioneers of the "base of the pyramid" concept have ingeniously proved how a business strategy focused on low-income consumers can and does contribute to sustainable and pro-poor development (Prahalad, 2005; Kramer et al., 2007; Kandachar & Halme, 2008).

A fundamental departure point in pro-poor activities is that they sincerely and primarily aim to reduce poverty, and that they acknowledge poverty as a multidimensional condition. Importantly, pro-poor activities aim to empower the poor and remove different, often highly specific, deprivation conditions, such as lack of access to health services, food, education, civil rights, and – especially in the context of ICT – access to information, communication, and knowledge (UNCTAD, 2008; Toivanen, 2011; Banerjee & Duflo, 2011).

Enhanced access of the poor to information, communication and knowledge is typically an objective of ICT4D projects, and it is one of the key reasons why we can say that ICT is beneficial for development. Furthermore, such empowerment also easily provides impetus for entrepreneurship among the poor, as embodied in micro-entrepreneurship, further amplifying the development impacts of ICT4D projects.

A standard approach to defining small and micro-enterprises is to classify as such enterprises with fewer than 10 employees (Donner & Escobar 2010). Another way is to look at the strategy and entrepreneurial opportunities. Micro-entrepreneurship is a category of entrepreneurship denoting business opportunities too minuscule and burdensome to be taken up by established business organisations in scattered low-income markets, often because of marginal costs too high

for big organisations. In contrast, for the poor, embedded in poor communities, who have almost no fixed costs associated with a business organisation, they represent a viable opportunity for a livelihood and an avenue for upward social mobility (Banerjee & Duflo, 2011; Biesenbach et al., 2009; Dalglish, 2008).

Micro-entrepreneurship is certainly one of the important avenues of impact for ICT, yet there is relatively little research on it (Donner, 2008; Heeks, 2010; Unwin et al., 2011). Furthermore, the literature tends to look more at the impact of ICT uptake on existing micro-entrepreneurs rather than on the creation of new entrepreneurial aspects or job creation. In his extensive review of ICT4D research, including more than 200 studies, Donner (2008) identified only a handful of micro-entrepreneur studies. Most of these investigated productivity improvements caused by the use of cell phones by existing micro-entrepreneurs, shared use (a village phone), or micro-finance. In their recent review of mobile phone use in micro and small enterprises in developing countries, which covered 14 case studies, Donner & Escobari (2010) concluded that the benefits of mobile phone use accrue to existing firms rather than new ones. While this is already a somewhat off-beat conclusion given the usual proposition of ICT4D, more worryingly, Donner & Escobari found “surprisingly little evidence that mobiles can help people start new enterprises.” However, only two studies covered this topic and had conflicting conclusions.

Yet business promotion and the creation of new entrepreneurial opportunities are key focus areas for ICT4D initiatives, as shown by Unwin et al. (2010) in their recent review of the impacts of ICT4D on poverty. In the context of the local ICT ecosystem, micro-entrepreneurship is critical for different ICT phenomena to become permanent fixtures of the local community, as the micro-entrepreneur secures an immediate livelihood by continuing the business. Thus, u-take by micro-entrepreneurs is an important measure of sustainability if contrasted with donor-funded activities. Furthermore, uptake by micro-entrepreneurs may strengthen user feedback and opportunities for co-creation of innovations, may amplify the diffusion of ICT, and in summary may consolidate ICT as a fixture or an institution within the local community, and thereby utilise its pro-poor effects (Heeks, 2008; Romijn & Caniëls, 2011; Toivanen et al., 2012).

The sustainability of ICT in developing countries, especially in local communities and among the poor, continues to be a major challenge and highly complex (Unwin et al., 2011). A central sustainability issue is that of finance, which, in the case of ICT, has the same dilemmas as all donor-funded development: on the one hand, donor-driven projects allow ICT-induced development where there is no finance available for such projects, and without donor intervention, no projects would take place at all. On the other hand, donor dependency may adversely affect local ICT entrepreneurs and their business opportunities, and may tie the sustainability of the project to continued donor funding (Unwin et al., 2011).

An important evaluation conclusion has been that, all too often, ICT4D projects advance too fast for the pace of local communities and stakeholders, even when ICT is implemented through public-private partnerships (Hosman & Fife, 2008). Looking at telecentres in Western Africa, Rega (2010) concluded that the mecha-

nism and practices to embed telecentres into local social fabric were important in securing their sustainability. While financial aspects are important for telecentre survival and sustainability, skills and entrepreneurial strategies also play an important role, as Best & Kumar (2008) have shown in their review of telecentres in rural India. According to them, rural Indian telecentres owned and run by people with some prior training in computers, or which had a separate training operator, had better survival rates than others.

Skills, and especially skills creation and capacity building, are one of the key issues in ICT in developing countries, and one of the most potent avenues for establishing lasting impacts from ICT4D projects (Walton et al., 2005). Mariscal (2005) has argued that the creation of new ICT-related skills for lay-users in developing countries builds-up social capital, and thereby improves take-up of new technologies and their impact on poverty. In subsequent research, Mariscal et al. (2009) looked in more detail how ICT-related skills training helped to narrow the economic and social gaps faced by marginalised groups in Latin American countries, by making youth more employable, and concluded that such skills building is essential if ICT4D is to move beyond simple connectivity.

In a review of how ICT can be pro-poor in Tanzania, Zaipuna Yonah (2005) argued that capacities, or skills, were a major third enabling component, along with connectivity and affordability. A user's language ability, literacy, and technical abilities are key demand-side factors affecting the take-up and implementation of ICT, and are all too often railroaded by technological considerations in ICT4D, Yonah concluded.

Looking at the role of ICT innovations for the Senegalese economy and society, Konté & Ngong (2012) concluded that the profit motif seems to subside for social and cultural objectives. Adoption, use and creation of ICT innovations, including local services and product vending, are deeply embedded in local informal economic practices, and the direct use of ICT focuses on adaptation to local living conditions. Kondé and Ngong also presented a category of informal ICT services for Senegal, and pointed out that most service providers and vendors, typically micro-entrepreneurs, would benefit from basic education and targeted ICT training in order to improve their entrepreneurial strategies and income.

The fact that so many ICT activities reside within the "informal economy" is fundamental to our approach, as this conditions to a large degree what ICT innovations and related entrepreneurs can do. According to the International Labour Organization, "the term 'informal economy' refers to all economic activities by workers and economic units that are – in law or in practice – not covered or insufficiently covered by formal arrangements. Their activities are not included in the law, which means that they are operating outside the formal reach of the law; or they are not covered in practice, which means that – although they are operating within the formal reach of the law, the law is not applied or not enforced; or the law discourages compliance because it is inappropriate, burdensome, or imposes excessive costs." Moreover, in developing countries, the informal sector accounts for about three quarters of non-agricultural employment, making it central to any development efforts (ILO 2012).

In conclusion, the literature suggests that demand-side factors, such as micro-entrepreneurs, local community and skills, play important roles in breathing life into local rural ICT ecosystems and maintaining their sustainability, but we do not have an actual conceptual model of how relationships and interactions occur in this context. Particularly, there is no explicit policy or strategy framework of how to engage local communities, marginalised groups, aspiring micro-entrepreneurs, and so forth with ICT, apart from the belief that more ICT will benefit the local community and its members throughout.

A particular objective of this research is to develop perspectives on skills-building and micro-entrepreneurship incentives that can be integrated in ICT4D as pro-poor measures. This, we believe, establishes wider arrays of local development impacts and outcomes than traditional ICT4D programming, and should also work to improve the sustainability of ICT4D projects by strengthening take-up and ownership by poor communities.

1.2 The new ICT ecosystem

For the study of innovation, skills and economic opportunities in ICT, the new ICT ecosystem model proposed by Fransman (2007) is a useful conceptual framework, and also one that we have adapted for our study. It is a layer-based hierarchy of technological, economic and social entities and their relationships (Figure 1), whose adaptation to developing countries we have discussed in earlier concept paper (Toivanen, 2011) and offer here only in a condensed discussion. Going to the technical, economic and social analysis of relationships within the sectoral system of ICT, Fransman argues that each actor, whether a person, firm or an entire nation, assumes a position and unique relationships in a hierarchically organised ecosystem. Anyone desiring to create and implement an effective strategy within the system must consider whether relationships with other actors will be competitive or symbiotic.

A key feature prompting the emergence of the new ICT ecosystem has been digital convergence. It is new because of the changes leveraged by the Internet, which is increasingly interconnecting all forms of digital communication and data storage. It is also an attempt to come to terms with the incessant change and transformation of ICT, which renders many established classifications and frameworks obsolete, such as distinctions between telecommunications, information technology, the Internet and media.

Indeed, an innovation systems framework can be applied on multiple levels, most often nationally, but in this study we apply it at the local ICT ecosystem level, as developed in our earlier concept paper (Toivanen, 2011). The key argument in this work on developing country ICT ecosystems has been that the specific locational demand-side factors, especially users, are essential in reaching the full benefit of ICT. Furthermore, we argued that “by mapping and identifying the nature of emerging global digital space, Sub-Saharan African countries can better target their national policies and goals against the socio-technical infrastructure being

built. In so doing, ICT and information society strategies should be planned and implemented against an analysis of the fit between national environments and the global sectoral system of ICT. Only [by] careful consideration of local circumstances [can ICT strategies] effectively deliver on expectations of sustainable long-term effects on social and economic development."

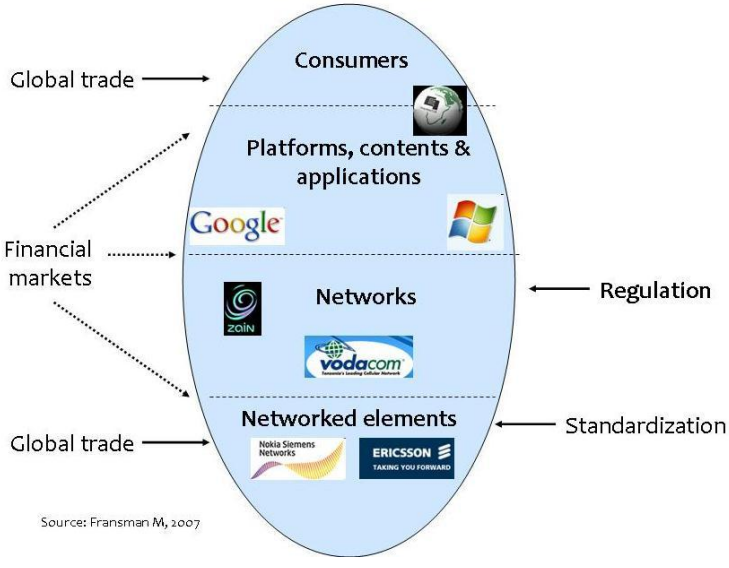

Figure 1. The new ICT ecosystem.

Building on this, we develop here perspectives of how an innovation system framework can be applied to analyse and improve local ICT environments, such as in Iringa in Tanzania. When doing so, we must acknowledge that the application of an innovation system approach in developing countries faces several conceptual challenges, which undermine a straightforward transfer of models and insights. Among these key challenges are:

- **Developing country economies are highly informal**. Many economic activities, including innovation, are undertaken by organisations or individuals that are outside the official economy, thereby undermining the potential and possibilities of policy interventions.
- **Poverty reduction is a key political and social challenge**, and innovation is required to address that. In contrast, OECD country innovation models focus on the creation of research-based innovation and fast-growing technology entrepreneurs, and thereby focus more on the educated elite.
- **A lack of supporting institutions and organisations**. Few developing countries have in place well-functioning and concise science, technology

and innovation policy governance, not to mention a well-networked matrix of universities, research organisations, laboratories, and so forth.

- **The nature of relevant knowledge and skills** in developing countries is highly different, reducing the strategic importance of frontier knowledge and technology. Innovation in developing countries usually focuses on capacity building, and must thus be constructed against the local state of the art and context, often involving basic literacy skills, the employment of indigenous knowledge, the upgrading of artisanal or cooperative work and business methods, and so on.

The governing, institutional and organisational issues aside, one key short-coming of the present innovation systems for developing countries is that there is very little conceptual or empirical work with insight into how the local level innovation systems, or ecosystems, actually work. In fact, to make Fransman's model feasible, we have to include in it the base-of-the-pyramid ICT business and technology ecology comprising mobile phone shops, phone mechanics, Internet cafés, SIM-card and air-time vendors, and telecommunication base stations and related services.

Thus, although ICT as a sectoral or ecosystem is throughout globalised, it assumes different forms in different regions and nations. Particularly in the context of development, it is important to emphasise that regional and national factors shape the way ICT is created and applied, giving rise to distinct and unique regional systems. The regional differences are compounded in the context of development in Sub-Saharan Africa, where poverty is a continental phenomenon but varies greatly in local forms and expressions, and local base-of-the-pyramid business and technology are important ecologies.

1.3 Research methods and data

The research has employed desk research and extensive observational field research techniques to collect evidence to document the status of ICT infrastructure in Iringa, as well as to uncover social, cultural and other behavioural dynamics bearing upon the use of ICT in Iringa. Field research methods have included observations, interviews, and data collection, whereas data has included photographs, recorded and typed interviews, field notes (Ngogo, 2011), and other material.

Field research in Tanzania was conducted upon receipt of a research permit from the Tanzanian Commission for Science and Technology, and was carried out by a VTT and Aalto University team. Field research was locally assisted by Dr. Andrew Mollel from Tumaini University.

Much of the research evidence was collected during four individual field research trips to Tanzania in summer 2011. Jukka Hyvönen visited Iringa and Dar es Salaam on a 12-day visit to Tanzania in June, and again in August 2011. For field research, Elikana Ngogo was in Tanzania from 5th June to 13th September

2011. Edward Mutafungwa visited Dar es Salaam and Iringa for three weeks in August-September 2011.

Edward Mutafungwa conducted 18 semi-structured interviews, as well as measurements to characterise the quality of user experience for commercial wireless Internet services at different points of interest (universities, hospitals, markets, etc.) in Iringa. These interviews are listed in Appendix A, numbered from 200 upwards. Elikana Ngogo and Jukka Hyvönen conducted a combined total of 80 semi-structured interviews, as well as extensive observational work in Iringa and Dar es Salaam. These interviews are numbered in Appendix A from 1–200. The interviewees ranged from high-ranking government officials to entrepreneurs, ICT professionals, local users and authorities. A primary focus in the interview setting was to uncover local (i.e. specific Iringa) dynamics related to ICT infrastructure, the use of ICT, and the entrepreneurial opportunities associated with ICT within Iringa.

Most interviews were taped and are in the process of being transcribed. Additional documentation was undertaken through observation, note writing, as well as extensive photography and occasionally video. All field research activities were recorded and consolidated in a field research diary, as well as in a project-specific archive that stores all the evidence cited here or collected during the field research.

1.4 Key research questions and objectives

The overarching objective of this research project has been to identify the local level processes, mechanisms, and practices by which ICT addresses or stands to address poverty in an effective way, and preferably in a direct way. Secondarily, the project has aimed to place local African ICT developments within a global technology context, and to highlight how technical features of the local African ICT ecosystem enable and constrain social, economic and entrepreneurial opportunities.

From a policy perspective, the research has been commissioned by the Finnish Ministry for Foreign Affairs to develop new perspectives for its ICT and innovation focused development cooperation, and in particular to develop measures, mechanisms and practices that can be used to harness ICT for development in poor and challenged countries and communities.

The research work has focused on two major issues: ICT-created social and economic opportunities, and analysis of the local ICT innovation ecosystem in Iringa, Tanzania. These are explored in more detail below.

1.4.1 ICT-created social and economic opportunities

A key research focus for this report is to explore how local ICT infrastructure and consumption create new social and economic opportunities that address poverty. As outlined above, this can occur in multiple ways and often through the use of

ICT, but here we restrict ourselves to investigating how such opportunities are created for micro-entrepreneurs or local communities providing ICT-related services. These include, but are not restricted, to: Internet cafés, computer support, sale of phones and accessories, phone repair and maintenance, SIM-card and airtime voucher sales, telecommunication base station services (energy, security, maintenance and repair, construction), and so forth.

The key research question is to identify and describe what types of micro-entrepreneurial opportunities in these categories are available, or created, within the local ICT innovation ecosystem in Iringa. Furthermore, we aim to describe how such opportunities can be pro-poor, that is, how people from low-income and low-education groups can seize these opportunities, and what basic capabilities, such as education, skills and social networks, enable people to exploit such opportunities. Lastly, we consider how local micro-entrepreneur ecologies maintain local ICT innovation ecosystems and their overall role in the sustainability of ICT.

The objective here is to identify concrete activities and measures for private companies and policy-makers to devise pro-poor ICT, and micro-entrepreneur and skills-training initiatives, which strengthen and deepen local ICT uptake processes. We believe that by focusing on the use of ICT, as well as the social and economic opportunities created by it, ICT4D and national ICT policies can move beyond an investment and infrastructure perspective, and begin to amplify the impacts of ICT through usage and related services.

This theme is examined in detail in Chapter 2, ICT-created pro-poor economic and social opportunities, which presents the results of our field research activities in Iringa.

1.4.2 Local ICT innovation ecosystem mapping

The aim of mapping the local ICT ecosystem is to identify and describe the technical ICT infrastructure reality that frames all social and economic opportunities in Iringa. All too often, we are faced with the situation that business, government, donors, and even local users have expected too much from the technical novelty, coverage, availability, affordability and reliability from the rural African ICT ecosystems. It is an essential reality check to verify the actual conditions of the Iringa ICT ecosystem.

This work has included mapping of the mobile signal coverage, the availability of Internet access, the availability of computers, the range of different phone devices, user behaviour and expectations, electricity supply, and so forth. Measurement and assessment of these aspects are important factors conditioning how individual people, as well as organisations, relate to the opportunities provided by ICT.

The objective of this work is to consider in detail what types of technical, availability, reliability, and affordability issues have a bearing upon the creation and emergence of pro-poor aspects of ICT in rural African communities. By verifying and analysing the technical reality in Iringa, we also develop perspectives on how

to consider inclusive and pro-poor aspects in future planning of ICT activities, as well as how these issues could be embedded in specific technology foresights and roadmaps for developing countries.

1.5 The Iringa region

In order to carry out our research objectives, we selected Iringa for the locale for our case study about local rural African ICT innovation systems. Located in the interior of Tanzania, Iringa typifies in many respects the rural social, cultural, economic and geographic landscape in Tanzania and Sub-Saharan Africa. While we do not claim that our case study projects all of Africa as such, we argue that some of the central research findings and conclusions bear broadly upon ICT and development, not least because of the characteristics of our case study locale.

Iringa is one of the seven districts of the West Highlands of Tanzania, about 500 kilometres south-west from Dar es Salaam. It is known as one of the major grain baskets of Southern Tanzania, and it has a rich history and local culture. Iringa is named after the Hehe tribe word 'Lilinga', meaning fortress. When Germans colonised the region, they met resistance from the Hehe tribe under the leadership of Chief Mkwawa, concentrated at the fortress in Kalenga, and consequently the Germans gave this name to the region.

Figure 2. Map of Tanzania (CIA, 2012).

In 2002, the Iringa region (Figure 2. & 3.) had a population of almost 1.5 million people, and by 2010, a little over 1.7 million. In 2002, the Iringa Urban had about 100.000 inhabitants, and Iringa Rural 250,000, with the rest of population in other local districts (NBS, 2002). Typically for rural Africa, agriculture is the largest sec-

tor of the local economy, followed by livestock keeping and fishing. Maize is the major staple food crop. Other food crops of great importance include round potatoes, sweet potatoes and beans. Local trade in these and other rural products and services is a central part of the local economy. Industrial activities, manufacturing, and exports, play a modest, if not minuscule, role in the local economy. These activities are concentrated on the processing of agricultural products. Telecom infrastructure services have developed mainly in urban settlements. Iringa is connected by road, air and railway to other locations, with bus transport capturing most inter-city traffic.

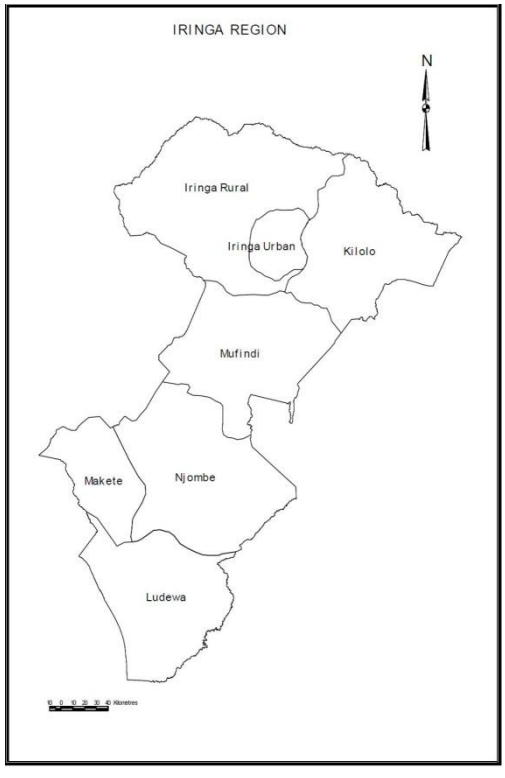

Figure 3. The Iringa region and its major districts.

The Iringa region is characterised by significant hydropower resources, and the region is a concentration for several nationally important hydropower plants and reservoirs. Despite this, only about 6% of local households have access to grid electricity in Iringa, and the local power supply is characterised by frequent power blackouts.

There are three universities located in Iringa Urban, and they play an important role in the city's economic, social and cultural development. Two are private universities: Tumaini Iringa University College-IUCO and Ruaha University College-

RUCO. Mkwawa University College-MUCE is government owned. Additionally, the region has a branch of the Open University of Tanzania. Iringa Urban also has about 33 vocational training centres, mostly located in Njombe district and with an enrolment capacity of about 4000 students. The region's 7 districts have about 200 ordinary and 29 advanced level secondary schools, 900 primary schools and 70 vocational training centres. The schools are government, community, private and missionary owned.

In summary, Iringa Urban typifies an economic, educational, and social centre of a larger rural region. It is internationally relatively well known, not least because of the connections of the local universities, and provides a very good setting for our efforts to understand the dynamics of local ICT innovation ecosystems in rural Africa.

2. ICT-created pro-poor economic and social opportunities

One of the most apparent consequences of the African mobile phone revolution is the mushrooming of local phone businesses and service ecologies in cities and rural centres alike. Shops selling and repairing mobiles are to be found on every busy street corner and market, and street vendors offering SIM cards and air-time vouchers are ubiquitous in street life. Internet cafés are important social institutions everywhere, and likewise, people all over the continent have adapted to living side-by-side with telecommunication base stations. Combined, these represent ICT-enabled social and economic opportunities that did not exist before mobile phones became every-day items for ordinary Africans, and now provide the sole income or important additional income for a huge number – we lack any serious estimates – of African micro-entrepreneurs.

Mobile phones and ICT do shape the dynamics and structure of national economies. In some countries, ICT-related R&D and manufacturing create jobs; in most countries, the use of ICT enhances the productivity of companies, government and private people, and finally whole new industries are needed to distribute, sell and service the ICT infrastructure and devices. As discussed above, the new jobs and entrepreneurial opportunities created by ICT in Africa have received relatively little attention until now, although these represent important economic and social potential (Toivanen et al., 2012).

In what follows, we identify, describe and analyse ICT-related jobs and micro-entrepreneurial opportunities in the Iringa region. Internet café entrepreneurs, mobile phone mechanics, and SIM-card vendors are all new types of entrepreneurs in Africa, introduced in tandem with the mobile phone revolution, and our aim is to consider their potential in developing pro-poor ICT and entrepreneurial strategies and policies.

2.1 Internet café entrepreneurs in Iringa

Internet café's, or telecentres as they are also referred to, are, along with mobile phones, the most apparent representation of the information society in most African cities, and have figured centrally in donor-funded ICT. Offering affordable

access to computers and the Internet, they can have a significant impact on regions where the overall ICT infrastructure is poor, and on ICT access for the poor, although some (Mwesige, 2004) have argued they, too, can enhance the digital gap between African users (Eban Etta & Parvyn-Wamahiu, 2003; Mwesige, 2004).

In the Iringa region, Internet café's constitute a central part of the local ICT system (Figure 4.). In August 2011, the region had about 12 Internet cafés, some managed by private entrepreneurs, a few by NGOs, and some by government agencies, such as the Post Office (Table 1). In addition to fixed and wireless Internet access, these Internet café's provided computer training and office services, and often seek to promote the broader use of the Internet in the region. New services are usually developed in response to requests from local users and clientele, enhancing the fit between Internet access and local needs. This helps to embed Internet cafés in the local social fabric, and improves their sustainability (Rega, 2010).

Figure 4. Advertisement for local Internet café in Iringa.

While financial aspects are important for Internet café survival and sustainability, skills and entrepreneurial strategies also play an important role, as Best & Kumar (2008) have shown in their review of telecentres in rural India. According to them, rural Indian telecentres that were owned and run by people with some prior training in computers, or that had a separate training operator, had better survival rates than others. Thus, a closer look at the role of entrepreneurs and management of

Internet cafés is necessary to understand how their role plays out in the local society and how Internet access can be utilised more effectively in rural African locales.

Table 1. The Internet cafés of Iringa.

Internet café	Established	Owner	Computers
MR Hotel	2000	Entrepreneur	8
IringaNET	2003	Entrepreneur	16
Internet@Posta	2004	Tanzania Postal Corporation	10
SkyNet Café	2006	Entrepreneur	5
Tumaini	2007	Entrepreneur	19
Vonda	2008	Entrepreneur	7
TZ CC	2009	Tanzania Chamber of Commerce	12
Dogran General Supplies	2009	Entrepreneur	7
Nguki	2010	Entrepreneur	4
NeemaCraft	2010	Anglican Church (Ruaha)	11
JM Internet café	2010	Entrepreneur	5
CCDO	2011	Child Care Development Organisation	17

The majority of the Internet cafés in Iringa are for-profit establishments, independent of donor funding or large corporate funds, and whose owner depends on them for a livelihood or significant income. In an important manner, the Iringa Internet café entrepreneurs have seized the economic opportunities offered by ICT in the region, and enforced the link between the local social and economic fabric and technology. To better understand how this connection has emerged, and what the key elements have been in its formation, we analyse in more detail the history, background, education, and ICT skills of individual Internet café entrepreneurs, and especially how they came to seize the economic opportunities presented by ICT.

The founding manager of IringaNET, a local market and technology leader, provides an illustrative case. Born into a family with an entrepreneurial history and roots in Iringa, he got interested in computers in the early 1990s. His first personal computer inspired him to study the technology, but without access to relevant education locally, he turned to studying independently with manuals and tutorials and through learning by doing. Today, clearly computer proficient, he is self-educated and lacks a formal education in the field (Interview 07).

The local university has, in many ways, been central to introducing computers and the Internet in Iringa, and it has played an important, though indirect, role in fostering Internet café entrepreneurship, too. The founding manager of Nguki Internet café holds a permanent job as the director of ICT at the local university and has a Bachelor's degree in ICT from a Finnish polytechnic and a Master's from a Finnish university. He, too, started computing in the 1990s, but gained access to computing courses at school, and has gained formal higher education in the field. Moreover, he leads the university ICT department, and thus is highly proficient in very demanding and complex ICT issues (Interview 10). The universi-

ty connection is also a characteristic of the founder of the Vonda Internet Café, who is a lecturer at the local university (Interview 33).

Box 1. IringaNET and peak use seasons

IringaNET has 16 computers with Internet access, and provides broadband WiFi connections to customers with their own laptops. University students constitute the most frequent customers, whose primary activities are email, Facebook, downloading music, and searching for and printing educational materials.

Two important seasonal peaks at the café are the time to submit student applications to the Loan Board Authority, and for school students when the National Examination Council publishes the Secondary Examination results on its website.

The founding of Internet cafés is not the only, although an important, economic opportunity created by ICT in Iringa. The local cafés have also created several jobs, ranging from simple clerical tasks to more demanding technical jobs. Here, too, we can observe how early access to computer education and skill formation are important background factors, say, for operators of the cafés. The Child Care Development Organization (CCDO) maintains one of the largest Internet cafés in Iringa. The organisation's core objective is to restore human security to the most vulnerable children in Tanzania, who suffer from poverty and discrimination, and it provides basic and vocational education, life skills and counselling, as well as ICT skills training for orphans in Iringa. Its operator is a university student who holds a diploma in computer science (Interview 42). The operators of Vonda Internet Café share a similar background. They have finished formal schooling and are enrolled at universities or colleges, and have gained specific IT certificates from specialised courses (Interview 34).

The services provided by Internet cafés have a wide impact on communities and individual people, especially if the cafés enable Internet access and ICT use that would not otherwise be possible. Here we have analysed in detail the character of entrepreneurial and employment opportunities associated with Internet cafés, both having significant impacts on the sustainability of local ICT infrastructures and services.

A private sector for-profit set-up is the central form of organisation for the majority of Iringa cafés, although some are organised by NGOs and large national companies. Entrepreneur-led cafés are market, service and technology leaders, and their ability to self-finance operations independently enhances the sustainability of the local Internet infrastructure.

ICT skills and education are important factors enabling an individual to seize the entrepreneurial or employment opportunities associated with Internet cafés. Several of our interviewees mentioned elementary and middle school introductions to computers as significant motivational factors, not to mention access to college, polytechnic or university-level education in the field. Evidently, early familiarisation with computers is an important factor in enabling individuals to launch an Internet café business or gain employment in one.

Although the majority of Iringa cafés are run by for-profit entrepreneurs, their business viability is closely linked to understanding local needs, requiring that the cafés are embedded in the local social and cultural fabric. Universities play an important role in Iringa, and the cafés pay heightened attention to the user behaviour of university students, who are often the most technologically advanced user group, and graduating school students. Moreover, some of the cafés emphasised their social and educational mission in Iringa, reflected in the need to educate the local community about the possibilities of the Internet economy, and to promote ICT among the most vulnerable population groups.

Skills, and social and economic opportunities associated with Internet cafés in Iringa, are important socio-economic factors maintaining the local ICT innovation ecosystem. Their identification and recognition are also key factors for any efforts by the private sector or government in developing the local environment.

2.2 Micro-entrepreneurship in phone maintenance and repair

Box 2. Mobile phone repair challenges

Most phones can be repaired. Original Nokia brand phones made in Finland, Hungary, China, India and Korea are relatively easy to repair, especially with the available repair kits. Nokia phones are a minority in Iringa because they are relatively expensive, and most people prefer cheap Chinese phones. The lifespan of these is usually very short, often only two months, our interviewees claim.

A phone's international mobile equipment identity (IMEI) code is critical for repair. If this cannot be identified, it is difficult to repair the phone. The IMEI code is read through the computer repair kit. If it is lost, mechanics can try to reformat the phone, but this does not always work.

A significant challenge is the availability of spare parts, such as speakers. If these need to be ordered from Dar es Salaam, the price of the repair becomes so high that it does not make sense, and people purchase cheap Chinese phones instead.

Many repairers give a guarantee of their work in the case of original brand phones, but not for the cheap Chinese phones, which are generally vulnerable to malfunction and breakage.

The wholesale adoption of mobile phones has given rise to a substantial maintenance and repair industry in Africa, embodying today a critical element of the continent's ICT infrastructure. For individual African users, for whom mobile phones often involve heavy investment, the provision of such services is essential in securing cost-effective sustainability of their devices in the cases of malfunction, break-down, or SIM-card lock-up that are frequent because of phone sharing among multiple people. Indeed, pretty much everywhere in Africa, local clusters of mobile phone maintenance and repair services have emerged in tandem with increasing subscription rates, being today a common fixture of street and market life and the backbone of the local ICT innovation ecosystems (Aker et al., 2010; Jackson et al., 2012).

Figure 5. Mobile Phone Repair Mahiwa Street, Mwembetogwa/Makorongoni.

These maintenance and repair services represent significant local social and economic opportunities, often so lucrative that people move "up" to these positions from other micro-entrepreneur activities, such as selling fish or coal. (Figure 5.) Because these activities are so important for the overall ICT infrastructure, and because they can have significant impacts on the economic and social lives of individual micro-entrepreneurs, they are also significant in securing real development impacts of ICT maintenance, and repair services tend to fall to a large degree within the informal economy populated by micro-entrepreneurs and other base-of-the-pyramid actors (Chipchase, 2006). Typically, micro-entrepreneurs who seize these ICT opportunities come from poor or low-income families, and have little or no formal preparatory education, as they usually learn the trade through apprenticeship or learning by doing. Moreover, the business itself typifies the informal African economy, as it is usually done in cash in little stands along popular trade streets, and often involves informal social networks (Jackson et al., 2012).

The local mobile phone repair ecology is apparent in the centre of Iringa Urban, too, where multiple shops and stalls are visible and highly busy during daytime hours. In addition to repair services, these shops provide charging services, airtime vouchers, phone accessories, and the opportunity to place service calls using their phones. Close to the Iringa bus station, these shops are so busy that they refused to give us interviews during business hours, and attended to business so

seriously that several of them also had an attendant sleeping at the shop in case a customer requested services (Ngogo, 2011).

Box 3. Common problems and services

The opening of a locked phone, often the result of people sharing SIM cards and phones, is one of the most common tasks for mobile phone repair shops. Prices for unlocking a phone range between 5,000 and 20,000 Tsh.

Almost all the components of an original brand phone can be replaced, but this is often subject to price and availability.

Phones that have been dropped in water are fixed by washing them with gasoline and then drying them with a blower.

Phones that stop working because they have been dropped on the ground are fixed by smearing flask, which is oil, on integrated circuits and then drying it. This usually re-establishes connections between integrated circuits.

Repair mechanics also instruct people how to use phones, and especially how to access the Internet from mobile phones. Other common services include the possibility to place service calls and charge batteries, and the sale of air-time, phones and phone accessories.

The micro-entrepreneur hierarchy of different businesses and the role played by skills are visible in an illustrative personal history offered by Matthias K., a repair micro-entrepreneur we interviewed (Interview 73), and who runs a successful and busy business with his family and two employees**.** Born in Iringa Rural in the 1960s, he graduated from primary school but left schooling at the age of 12 to move for work to Iringa town. At 16, he returned to school, but as his parents could not afford the schooling, he started to sell fish at the Iringa market in about 1980. Six years of fish selling earned him enough to buy a taxi, which was a business he maintained for three years until he started a food shop. In about 1992, this business became unprofitable, and he moved to Tunduru region to sell mining products, but this failed too, and he returned to Iringa Urban in 1997, where he soon ventured into the mobile phone repair business (Interview 73).

Observing the increasing number of mobile phones in Iringa at that time, Matthias K. befriended an Indian who had a mobile phone repair business. Applying the mechanic skills that he learned while driving a taxi, Matthias K. began to learn mobile phone repairs from his friend, and as this moved from the city, he eventually took over the actual business. At that moment, Matthias K. was still without relevant or comprehensive mobile phone repair skills, and thus asked to learn from the first mobile phone repairer in Iringa, Mr. Nuhu. He agreed to a one-month apprenticeship for a payment of 170,000 Tsh, and taught Matthias K. so called “traditional” methods of repairing phones, which included using matchsticks to heat integrated circuits in order to remove parts for repair. Upon learning the basics, Matthias K. purchased repair equipment, such as a blower, spanner and computer, and launched his business (Interview 73).

A computer, a specialist repair kit, and basic hand-tools like screwdrivers, blowers and soldering guns are the essential tools for mobile phone mechanics. The computer enables the mechanic to trace a fault in case of the breakdown of a

Box 4. The first and only female mobile phone mechanic

The mobile phone repair trade is almost exclusively occupied by men, but Mrs. Kalengela is the first and only female mobile phone mechanic in Iringa. She is married to a son of Matthias K., and has learned the trade from his husband and father-in-law. After her children had grown up enough to be cared for by other people, they instructed her how to use computers to repair phones, as well as how to download software and files from the Internet. Through a family apprenticeship, she has learned to repair almost everything in phones, such as phones that have dropped in water or broken apart as they have fallen on the ground, and problems with the screen, microphone, speakers or ringer. Her work is an important part of the family's micro-entrepreneurial strategy.

circuit, and also allows access to critical online repair knowledge bases and the download of specialist files and software. Computers are essential in diagnosing problems of broken phones, and also in fixing them, for example, if a phone needs to be re-formatted or have software re-installed (Interview 64).

Learning to use computers and the Internet also proved critical for the launch of Matthias K's career in mobile phone repair. Computers played an important role in fixing error messages and other issues in phones, and as Mr. Nuhu did not know how to use computers, Matthias K. travelled to Dar es Salaam, where he acquired specialist software programs and training from experienced mobile phone mechanics. Once back in Iringa, Matthias K. attempted to use the software to fix a common problem with the Nokia 3310 handset, an error message called "contact service", only to discover that it did not work. He returned to Dar es Salaam, invoking his network of mobile phone mechanics, and learned from one how to use the Internet and access the GMS hosting forum that teaches and demonstrates how mechanics have successfully addressed difficult mobile phone problems. This second visit to Dar es Salaam provided Matthias K. with the necessary skills and knowledge to launch his mobile phone repair business successfully (Interview 73).

The ability to access and use the Internet-based GSM hosting forum (http://forum.gsmhosting.com) proved critical for the micro-entrepreneurial aspirations of Matthias K., as for so many other developed and developing country mobile phone mechanics. The GSM hosting forum is a huge online user chat forum, which specialises in how to fix and repair problems in mobile phone handsets. It covers virtually all mobile phone models, and users post detailed descriptions – often literally pictures – of problems or malfunctions, as well as similarly detailed instructions on how to fix mechanical or software problems. The forum embodies an enormous, global, crowd-sourced and user-driven knowledge base, which provides valuable and practical knowledge to people interested in repairing mobile phones.

Access to this knowledge base proved critical for Matthias K's knowledge and skills in repairing mobile phones, and his business quickly began to flourish and propel his economic and social position. The mobile phone repair business allowed him to buy a house in the respected Iringa region, and to see that his children completed their schooling, which one of them completed by studying law at

the University of Dar es Salaam, and the other by pursuing a Bachelor's degree in IT in Arusha. He has also trained children and others to repair phones, and they have then gone on to establish their own phone repair shops (Interview 73).

Figure 6. Matthias's GSM Mobile Phone Repair shop.

Mobile phone maintenance and repair is an essential element in the local and continental African ICT innovation ecosystem. Easily available and affordable services ensure that mobile devices are operable and reliable for end users, and create essential technical services but also build trust and social capital within the broader ICT infrastructure. The local maintenance and repair ecology also includes significant economic and social opportunities, and thus involves important potential for achieving development goals and pro-poor effects with ICT. While numbers concerning the economic and social impact of local ICT repair ecologies are not available, and would probably be hard to come by, they do have apparent broader economic significance, so common a fixture of African street life they are, and so important is their service for the whole ICT infrastructure.

The service ecology is mostly populated by micro-entrepreneurs who have or are struggling with the challenges of poverty. (Figure 6. & 7.). Scarce financial resources, a lack of formal schooling, not to mention targeted technical training, and possibly broader challenges of empowerment and social inclusion, are all issues that are familiar to many of the mobile phone mechanics. Even with success, mobile phone mechanics remain within the informal economy, as their clientele consists mostly of the base of the pyramid and relies heavily on informal social networks for upgrading skills, accessing new knowledge, acquiring spare parts and attracting customers.

Skills play a fundamental role in enabling micro-entrepreneurial strategies in phone repair and maintenance. Training in basic skills is often learned in appren-

ticeship, either against payment or within a close social network, such as families or friendships. Acquisition of the technical capacities and the necessary hardware and software tools, as well as access to Internet-supported learning and knowledge bases, are critical enablers for individual mechanic careers.

Figure 7. Repairing a mobile phone at Kalengela GSM Mobile Repair Shop.

2.3 SIM-card vendors

Like mobile phone shops, SIM-card vendors are nowadays ubiquitous in African street life. The easy trade in air time is a fundamental enabler of the continent's ICT revolution, as it allows people to purchase talk time, and to access different types of services, such as m-banking, which require user identification and are key features of the mobile revolution in Africa. SIM-card selling also provides employment and income opportunities for a significant number of Africans, and often especially for people from social or economic groups that suffer from poverty or its imminent threat. SIM-card vending is also typically located within the informal economy (Rangaswamy & Nair, 2010; Brouwer, 2010).

Box 5. Background and future plans of an Iringa street SIM-card vendor

Mr. Mpotwa is a 22-year-old SIM-card vendor for Airtel. He has attended secondary school for three years, and joined Zantel in 2010, where his job was to register new customers and distribute top-up vouchers. After a year, he switched to work with Airtel (Interview 12).

He does not know how to use the Internet. He has had some computer lessons at school, but the school did not have any actual computers. He hopes to accrue enough capital to start his own mobile phone shop (Interview 12).

In Tanzania, a mobile phone subscription is secured through two steps. First, one should register a SIM card with one of the operators, such as Vodacom or Tigo. Secondly, one needs to purchase air-time vouchers, which start selling at a minimum of Tsh 500, to gain air time. These steps are easiest done with a SIM-card vendor, who in Iringa are typically privately employed by mobile phone operators to sell SIM cards and act as agents to register new clients for these companies. (Figure 8. & 9.)However, they can sell top-up vouchers of any company. These companies supply them with working tools, such as a table, a chair, a dust bin and uniforms. The companies are responsible for selecting a market position for them to work from, and for paying licence fees to the municipal council.

Figure 8. SIM-card vendor in Iringa.

The majority of street SIM-card vendors are male, and Brouwer (2010) has shown that their social and educational backgrounds in Maputo, Mozambique, are often highly similar. Street vendors often have some formal schooling, and come from low-income neighbourhoods of Maputo, and thus are experienced in dealing with poverty. In Iringa, as in Maputo, the supply of this informal workforce allows national telephone operators to meet the demand for new SIM cards and air time through a wide-reaching distribution network that is also relatively cost effective.

The control of the business model and the underlying skill set essentially define street vending of SIM cards. Once a person is recruited to sell SIM cards, the operators provide short training, say for a week, instructing in how to register new customers and sell the different types of vouchers. Operators also possibly supply a table, a chair and an umbrella for street vending, and also point out the position for street vending. The operators usually provide two persons for each vending place, allowing vendors to have lunch without interrupting street sales, but the busiest, and highest selling places in Iringa, can have up to 7 sales persons (Interview 12).

Figure 9. SIM-card vendors in Iringa.

Obviously, the best street vending places are to be found where the people are: Iringa centre, market, post office, and so on. The local agents of phone operators decide where street vendors are positioned, and can change the location of individual vendors to attract more business or to respond to shifts in demand.

SIM-card and air-time voucher vendors work strictly on a commission basis, thus facing the risk of low or non-existent sales and having the heavy incentive to boost sales. Each sale is recorded under the unique code of the vendor, forming the control system of the operator, and the commission is calculated and automatically paid into vendors' m-banking accounts. SIM-card registration is free, and most money is earned from selling vouchers. Our interviewees reported daily sales of between 10 and 20 new lines, each costing 500 Tsh, whereas air-time sales are more frequent (Interview 12).

Air-time vouchers are the primary sales trade, and operators provide different variations and offers to lure customers. Zantel, for example, was offering special offers that provided 10% extra air time, and a variety of different offers is a key marketing tactic of the operators. Air-time vouchers are not always in steady supply, and some of our interviewees complained that sometimes popular vouchers can be out of stock for a week up to a month, especially the most popular vouchers, such as Zain's "Airtel Rusha" (Interview 12).

Street SIM-card and air-time voucher vendors do not have many opportunities to diversify or expand their business, but some of them included Internet connection in their limited product selection. However, these sell very little. They also provide customer service, and are often perceived by customers as the representative of the operator, which is something that the brief training often addresses. This is especially true when customers report lost SIM-card numbers, which the vendor needs to report to the operator's local office and customer care. When delays or problems emerge in operator service, the vendor typically receives the customer complaints, although he does not have any power over the handling of the situation (Interview 12).

In Iringa, as well as pretty much everywhere in Africa, SIM cards and air time can be purchased from mobile-phone shops and mechanics, too. Rangaswamy and Nair (2010) have demonstrated that such micro-entrepreneurs in Mumbai played an important role in the evolution of the local ICT ecosystem, as the shopkeepers sought to diversify and expand the range of their services and products. In Iringa, several of the small mobile-phone and accessories shops provide practically all the services that street vendors do, augmenting their other revenues with operator commissions.

Street vendors have practically no room for actual micro-entrepreneurial activity and are basically commission-based employees of national operators. They depend on the operators for essential skills, vending equipment and business strategy. Yet, as their ubiquitous street presence suggests, they have an important role in servicing and maintaining the local mobile-phone ecologies.

Moreover, street vending often offers the first steps in a career towards micro-entrepreneurship or studying, as the vendors often come from low-income social

groups and have the objective of improving their lives, as the history and future plans of one Iringa vendor, in Box 5, and Brouwer's (2010) research suggest.

2.4 Telecommunication base stations in Iringa

Telecommunication base stations, or towers, are one of the most common fixtures of African ICT infrastructure, dotting cities and rural landscapes alike. Although they are usually completely owned and operated by national or multinational phone operators, they, too, can embody significant economic and social opportunities for local communities. Our review of telecommunication towers in the Iringa Urban region identified several social, economic and cultural issues surrounding the telecommunication towers, but we did not find any evidence of the towers offering any significant local micro-entrepreneurial opportunities. Instead, they appeared to offer economic opportunities to national and multinational service companies.

Figure 10. Three base stations on top of a hill in Ipamba. At the front, the altar used in religious ceremonies that are organised on the hill top.

The local social and economic opportunities associated with telecommunication towers relate to relatively few things: sale and rental of land for tower sites, provision of maintenance and service for the tower ICT and energy equipment, of which local energy solutions constitute a significant proportion (Suni, 2010), and finally security services. We identified about 31 telecommunication base-station sites in the Iringa municipality area, the majority of which were rented by operators from either formally or informally confirmed owners. In the region, the best place for base stations is the local highest point, the 1,786 high Mafifi Mountain, which stands about 200 metres above the average Iringa elevation, and where 8 towers are located. (Figure 10., 11., 12, & 13.)

Figure 11. Mwangata base-station tower.

The erection of base stations often closes traditionally open spaces with high fences, and opens up a number of social, economic and cultural relations with the local community. The planned site may disturb local traditional customs and even beliefs, and may trigger resistance. Once construction is about to start, new processes and local employment opportunities emerge. The site needs roads to be

built, reviews by constructors and land surveyors, as well as by municipal authorities, and environmental impact assessment, and so on. Local people are employed typically for construction work, and women sell food to construction workers and so forth.

Figure 12. Mwangata base-station tower.

However, once the building phase is over, local opportunities wither or disappear. Some local work may be offered for security services, typically for guards. Instead, difficult issues often emerge. Local people often raise the fear of radiation, a theme that is vibrant in Iringa (Daily News, 25th June 2011) and that often fuels strong emotions in rural villages and cities. The noise and smell from possible diesel base-station electricity generators is regarded as a nuisance as well, as is the sudden appearance of base-station service crews, especially at night (Ngogo, 2011, p. 2).

When placed within communities, base-station towers are central landmarks, as shown in Figures 11 and 12 of the Mwangata base-station tower. This is locat-

ed practically in the middle of people, with houses only few metres away, and was in fact built on a plot whose inhabitant died. It has high fences with barbed wire, and the full equipment of a normal base station, including diesel generators that disturb local people. When we asked the local people what they thought of the tower, they said that they were concerned that it would shorten their lives, although they could not clarify how. They also complained about the diesel generators (Ngogo, 2011).

Figure 13. Mlandege Samora base station.

Base-station connections to the local community are very apparent at the top of the hill of Ipamba, which houses three base stations (Figure 10). The hill top has been a traditional site for Christian ceremonies, which still continue today. Among the base stations, one can observe today an altar, and the path uphill is populated

with smaller altars used in religious processions. According to local people, the erection of the base stations has not disturbed religious celebrations, which continue as before. Local people were employed during the construction phase of the base stations, but once finished, all services and maintenance is provided by outsiders.

The service and maintenance of base stations offers some local employment opportunities, depending to what degree operators rely on remote operation. Most Iringa towers are controlled remotely from Dar es Salaam, and local or regional field engineers, who are employed by operators, are responsible for responding to alarms, and some of them are responsible for controlling service quality daily with a signal drop test. Field engineers carry out service on the advice of remote operation centres, and check that the failure alarms are working properly (Ngogo, 2011).

A large local source of potential economic and social pro-poor opportunities is the supply of energy, especially energy back-up, as discussed in detail by Suni (2010). Most base stations are connected to the national electricity grid, but in developing countries, they need to have reliable back-up solutions for power blackouts. Usually, this is a diesel generator on the site, but Suni has analysed in detail several alternative scenarios, which include not only power back-up but also the steady supply of base-station energy from local renewable sources. Her study argued that the use of local renewable sources for base-station energy generation, especially if this involves organisational solutions of benefit to the community, such as cooperatives and other arrangements, could be economically feasible and enhance local acceptance of base stations. Selling or sharing the base-station electricity with local people, in particular in off-grid communities, would also be an important pro-poor aspect of base-station technologies, she demonstrated (Suni, 2010, p. 85–86).

In Iringa, operators have subcontracted power supply. Power supply is relatively unstable, as the national power company, Tanesco, is suffering from low generation capacity caused by drought and infrastructure problems. Thus, power rationing and blackouts occur weekly, posing the most serious challenge for the local mobile-phone network. Tanesco does not compensate operators for service interruptions, and thus they have devised power back-up solutions for each tower (Ngogo, 2011).

Maintenance generators for TIGO are subcontracted to SINCRO, a South African company, whose staff refill site generators, service them, and so on. SINCRO is one of the leading African electricity equipment and service vendors, and their local staff are technically proficient.

Thus, our field research and analysis of local conditions did not identify any relevant initiatives to create locally significant social or economic opportunities around the towers. This, naturally, does not exclude the possibility of such activities and it may be necessary that, both in Iringa Urban and Iringa Rural, more attention is paid to securing such possibilities for local cooperatives, micro-entrepreneurs or purely employment opportunities.

3. An ICT innovation ecosystem in rural Africa: Iringa case study

We undertook field research with the aim of mapping the actual features of the local ICT innovation ecosystem in the region of Iringa in western Tanzania, and in particular the Iringa municipality. Supplementary research was carried out in Dar es Salaam by virtue of its concentration of policy-makers and industry leaders. Moreover, as the main urban centre and primary economic hub of the country, Dar es Salaam provides some essential benchmarks for observing the rural-urban divide in terms of local ICT adoption and innovation.

The objective of mapping the local ICT ecosystem was to discover the technical reality that conditions local micro-entrepreneurs and users, as well as to cast light on the future possibilities for ICT initiatives in Iringa and similar locales.

A key finding of this work was that the local technical ICT ecosystem is radically different from rich countries, something quite expected, and falls short of local expectations. The local technical infrastructure is narrow both in mobile telephony coverage and broadband, limiting users' ability to access Internet-based services or to move towards co-creation models. Scarcity of devices and price thresholds continue to prevent access, too. Electricity supply, or more accurately power blackouts, presents a continued challenge, too.

A description of the local ICT innovation ecosystem provides an important framework for our consideration of pro-poor social and economic opportunities in the context of ICT, as the technical infrastructure and reality is a key enabling factor.

3.1 Network infrastructure

The network infrastructure development in Iringa is summarised by looking at three network segments: backbone, fixed access and mobile access.

***Backbone network*:** The NICTBB network includes a point of presence (POP) in the centre of the Iringa town area, which effectively enables operators and network providers to terminate or originate high-speed traffic to/from the Iringa POP at speeds of up to 10 Gbps (TTCL, 2011). While this is still undoubtedly a significant achievement, there is still an urgent need to extend the local reach of the

NICTBB within Iringa by construction of a metro fibre network that connects different institutions and other local facilities. Otherwise, the continued use of legacy terrestrial radio or copper links for metro connectivity would make the local stakeholders fail to utilise the benefits of the NICTBB, and its capacity will remain grossly under-utilised. In Dar es Salaam, the government and a consortium of three mobile operators (Zantel, Airtel and Tigo) are constructing a metro fibre network under a PPP arrangement (Interview 202; Interview 213). These consortium members are motivated by the need to provide high-capacity backhaul to ease congestion in their mobile network sites in Dar es Salaam and possibility to derive revenue from selling the spare capacity to large enterprise customers. In the case of Iringa, similar motivating factors are yet to be identified for the commercial operators.

***Fixed access*:** TTCL's fixed network assets in Iringa include 2500 fixed copper lines, which corresponds to a fixed-line penetration of around 0.2% (below the national average of 0.35%). Moreover, a significant proportion of those lines connect enterprise or institutional customers, rather than private customers. The prospects of these fixed lines looked grim following the popularity of mobile services. However, digital subscriber line (DSL) upgrades to provide broadband Internet over copper cables revived interest in the copper lines and current line occupancy at the Iringa town telephone exchange is 100% (TTCL, 2011). However, fixed copper lines in Iringa are limited in terms of both penetration and performance, due to ageing and the distance of customers from the local exchange (see the example case of Tumaini University). As a result, competing operators are offering fixed wireless access solutions (e.g. fixed WiMAX) for Internet café owners, banks and other medium-sized enterprises or multinational companies with branches in Iringa.

Box 6. Computers at Tumaini University

Tumaini University is Iringa's largest university with 3500 students, and provides basic computing skills for all students, to enable them to carry out online activities, such as applying for university loans, submitting assignments and retrieving learning resources. The university currently has around 300 desktop computers, with only 80 connected to the Internet. Internet access for the whole institution is provided via a dedicated DSL connection (from fixed operator TTCL), supporting a real measured speed of only around 500 kbps (Interview 209). These constraints have led to one of every three students acquiring their own personal laptop and resorting to obtaining Internet access from commercial sources.

***Mobile access*:** The Iringa urban district is covered by networks from five different mobile operators. As of the period of the Iringa field research (August 2011), these included: Airtel (2G network), tiGO (2G network), TTCL (2G network), Vodacom (2G and 3G networks) and Zantel (3G network). Considering the aforementioned limited penetration of the fixed-access networks in Iringa, these mobile networks provide a valuable alternative to enable Internet access for subscribers in the region. Prior to deployment of the 3G networks, IringaNet, a local Internet

café owner, dominated the local market by providing a public Internet service in the centre of Iringa town (Interview 201). However, the mobile 3G services are proving a more popular choice, due to relatively lower prices, faster connection speeds (up to 10 times faster from our observations) and wider availability across the Iringa urban district.

3.2 Devices

3.2.1 Internet-enabled handsets

The success of mobile services in Tanzania has meant that penetration of mobile phones in Tanzanian households is only exceeded by that of radios (InterMedia, 2010). Now, as mobile networks provide the majority of Tanzanians with a chance of (most likely their first) broadband Internet experience, the end-user devices that enable that experience are examined further. For that purpose, we consider three mobile-phone categories for the discussion: low-end phones, feature phones and smartphones. The low-end phones are only capable of supporting the most basic mobile services (voice and SMS) and lack Internet access capabilities, whereas both feature phones and smartphones are able to provide Internet connectivity over 2G and/or 3G mobile networks (possibly even Wi-Fi networks). Furthermore, feature phones have proprietary operating system (OS) firmware with support for third-party Java or BREW applications. Smartphones provide even further improvements compared to feature phones, with larger displays, faster processors and computer-like capabilities with OS platforms (e.g. Android, Windows Mobile) that allow for more powerful applications (with better integration to the phone user interface).

The low-end phones have proved to be simple to use and very effective for users accessing basic voice and messaging services that only require 2G network coverage, which is now available in almost all inhabited areas in the country (Interview 211). Furthermore, the relatively rugged designs and longer battery life of low-end phones are suited to conditions in suburban, small town and rural areas of Tanzania, where the work and living conditions are rougher and access to electricity is very limited. However, 3G network coverage is now expanding to some of those areas (as is evident in Iringa) and there is a continuously increasing awareness of Internet access, and the contagious effect of social media applications, and recognition of other benefits from being connected to the Internet.

Early adoption of mobile Internet handsets in Tanzania has constituted mostly feature phones. For instance, monitoring reports by mobile browser provider Opera Software (Opera Software, 2011) indicate that the top five Internet handsets accessing the web from Tanzania are all 2G feature phones (see Figure 14). This observation is consistent with observations from local mobile operators, who have also noted from their network management data that only 5–10% of handsets connecting to their networks are 3G enabled (Interview 202).

Figure 14. Top 5 Internet handsets for Tanzania as of June 2011. (Source: Opera Software, 2011.)

3.2.2 Price barrier

The most significant barrier to end-user adoption of 3G-enabled handsets is the price, as illustrated by the comparison example of Table 2, where a contemporary smartphone would be up to 25 times more expensive than a popular low-end model. Advanced feature phones and smartphones allow users to benefit from high-speed 3G or Wi-Fi network connectivity, better device performance, more memory space, location-based services (using GPS), high-quality video and a rich selection of applications from app stores. However, these benefits contribute to placing these handsets at price points that are beyond reach for most Tanzanians. It was noticeable during the field research that, in Iringa (a small town with a relatively low average income), the main regional Vodacom shop did not have in stock any handset above 250,000 Tsh (120 EUR), while upmarket Vodacom outlets in Dar es Salaam stocked most of the latest Smartphone models. The most advanced Internet handset was an obscure 2G feature phone from a relatively unknown Asian device vendor.

Therefore, medium-priced (2G) feature phones (such the Nokia 2220 in Table 2.) are still the most affordable Internet access devices. The rapid smartphone adoption rates in developed economies (where post-paid subscribers are a majority) are mostly attributed to heavy subsidies from operators, who then recoup the handset cost through subscribers paying for data packages over the contract period (Entner, 2011). By contrast, in Tanzania, over 90% of the subscribers are on prepaid contracts, which make it unfeasible for operators to subsidise the more expensive handsets (Interview 202). These factors, combined with very limited disposable income, mean that the handset replacement cycles (the frequency at which consumers replace their devices) can last for several years (Entner, 2011), thus denying the end users the opportunity to be innovative with features available in evolving handset models. However, the current quest by device manufacturers to produce low-cost smartphones offers hope for the future. For instance, subsi-

dies by Safaricom (a Kenyan mobile operator) on the relatively low-cost Huawei Ideos U8150 smartphone (Android OS, 2G/3G/Wi-Fi Internet) made it available to subscribers at a retail price of less than 80 EUR, making it one of the best selling Internet handsets in Kenya for 2011.

Table 2. Example comparison of three different mobile phones available through Vodacom's outlets. (Source: Vodacom, 2010; GSMArena, 2010).

	Low-end phone	Feature phone	Smartphone
Example	Motorola WX160 	Nokia 2220 	Samsung Galaxy S 
Price	Tshs 33,500 (17 EUR)	Tshs 101,000 (51 EUR)	Tshs 929,000 (465 EUR)
Basic features	SMS, FM radio	SMS/MMS, FM radio, One camera	SMS/MMS, FM radio, Two cameras
Internet	None	2G (GPRS/EDGE)	2G (GPRS/EDGE) 3G (WCDMA/HSPA), WiFi
GPS	None	None	Yes
Third Party Apps	None	Java	Android, Java
Software platform	Proprietary	S40	Android OS
Battery	Stand-by up to 400 h, Talk time up to 8 h	Stand-by up to 480 h, Talk time up to 5 h 20 min	Stand-by up to 750 h (2G) /576 h (3G) Talk time up to 13 h 30 min (2G) / 6 h 30 min (3G)

3.3 Content, application and services

3.3.1 Content creation and localisation

The Tanzania Communications Regulatory Authority (TCRA) adopts the following definition for content, as stated in the Electronic and Postal Communications Act of 2010 (TCRA, 2010):

> "Content means information in the form of speech or other sound, data, text or images whether still or moving, except where transmitted in private communications."

Although the above definition of content encompasses all forms of electronic information, the content providers have mainly been assumed to be TV and radio broadcasters. This is apparent from the fact that all the 72 content service providers licensed by the TCRA are TV and radio broadcasters (three of them being

local Iringa broadcasters). To that end, the content localisation objective focuses on maximising local Tanzanian productions in the programming of different broadcasters. The local district or regional broadcasters (e.g. Iringa Municipal Council TV) aim to further localise programming by including content from those areas.

Box 7. Blogging from Iringa

Mjengwa Blogspot (local content provider): Mjengwa Blogspot is photo-blogging site maintained by Majid Mjengwa, an Iringa-based journalist and instructor. A significant portion of the photos and discussions posted on the blog are about Iringa. The blog has become one of the most visited sites in Tanzania, contributing to the increased awareness of Iringa and related news items (Mjengwa, 2011). Mr. Mjengwa initially faced many challenges in updating the blog, as he was dependent on Internet cafes for access. Now Mr. Mjengwa owns a smartphone and is able to capture photos and use always-available 3G Internet access to share his content via his blog and Facebook. According to Mr. Mjengwa, this instant content sharing capability would have been unimaginable in the days when printed newspapers would take several days to appear on the Iringa news-stands. Mr. Mjengwa now gives regular courses to fellow journalists in Iringa and other parts of Tanzania on the potential of social media in local journalism.

However, the on-demand content retrieval and spontaneous content-sharing over the Internet, and the user clustering (e.g. according to common interests) enabled by social media platforms, are significantly changing the dynamics of content creation and dissemination. This Internet-enabled reality provides an opening for many content provider types (organisations or individuals, foreign or local, etc.) in a space previously dominated by providers of linear (TV and radio) broadcasts with rigid programme schedules and asymmetric content delivery (content provider to viewer only). Moreover, the increased penetration of advanced mobile handsets (capable of replaying sound, images, video etc.) is changing the way content is consumed by end users, particularly in Tanzania, where growth of TV penetration is relatively slow (InterMedia, 2010). Content localisation through the combined effects of the Internet and proliferation of mobile Internet devices multiplies the opportunities for local users or communities as producers of content, and enables the tailoring of content to address local development needs. Therefore, it is imperative that the national content creation and localisation drive is also geared towards targeting the mobile platform with mobile web content. Content presented for the mobile web accounts for mobile device limitations of in terms of screen size and battery life, which are not encountered in conventional desktop computing platforms.

From the Tanzania perspective, as well as the rest of East Africa, there are clear indications that the magnitude of this task, generating local mobile web content, remains enormous (Hersman, 2011), yet it is absolutely essential in meeting ICT policy objectives. For instance, the monitoring statistics from providers of the Opera mobile browser indicate that no local content provider is included in the top ten sites accessed from mobile handsets in Tanzania (Opera Software, 2011). The list includes international platforms for social media (Facebook, Twitter, YouTube,

and Wikipedia), portals (Yahoo!, Microsoft Live), email (Gmail, Hotmail) and news (BBC, CNN), which are optimised for mobile devices for unlimited global reach. While the social media platforms may include a strong local dimension by virtue of content generated by Tanzania users, the rest are distinctly international in terms of their target audience and subject matter. This further highlights the scarcity of local content on the web (and to a larger extent, the mobile web), which is a shortcoming that is more acute compared to current local TV and radio content.

3.3.2 Local ICT services industry

The local ICT sector in Tanzania includes a broad spectrum of services (data hosting, network engineering services, mobile value-added services, IT security etc.) provided by large multinational corporations or MNCs (Vodacom, IBM, Helios Towers etc.) and local micro, small and medium-sized enterprises (MSMEs). For this rest of the report, we adopt the MSME definitions based on the categorisation proposed by the Tanzania SME Development Policy 2002 (MoIT, 2002). Examples of MSMEs include IT firms like InfoTech, which were first to market immediately following the liberalisation of the ICT sector in the early 1990s (Interview 206), and those subcontractors, such as Datacom Africa, that emerged to provide services (e.g. network planning and optimisation) for the mobile MNCs (Interview 212).

The local mobile operators have now also embraced third-party content, service and application developments by adapting an open-garden model, which has laid the foundations for further cooperation with MSMEs (both local and international). The most successful mobile services (in terms of both user numbers and transaction volumes) have been in the mobile money segment. These mobile money services are deployed on platforms provided mostly from overseas, such as Vodacom's M-Pesa platform from Sagentia (UK), or the National Microfinance Bank (NMB) mobile service enabled by Rabo Mobiel (Netherlands). In some rare cases, local platform vendors have also penetrated this competitive market, notably E-Fulusi Africa (http://efulusi.com/), who provided the platform for Zantel's ZPesa service. These mobile money services and other legacy mobile value-added services and premium mobile content have so far been text-based, making them accessible from even the most basic low-end GSM handsets.

However, the increased penetration of advanced feature phones and smartphones has triggered a new crop of local MSMEs (e.g. Push Mobile Media (http://www.push.co.tz/) looking to produce multimedia content, applications and services that exploit the capabilities offered by those mobile devices This has clearly invigorated the ICT sector and has contributed to a majority of the ICT start-ups in Tanzania (Interview 208). This underlines the importance of the ICT sector in contributing to the employment creation objectives of the Tanzania SME Development Policy 2002 and the MKUKUTA strategies (National Strategy for Growth and Reduction of Poverty) (MoIT, 2002; MoFEA, 2010).

3.3.3 ICT entrepreneurship challenges and existing interventions

While admittedly there are some local ICT MSME success stories (as noted in the examples in the previous section), the majority, however, have faced significant challenges at start-up and/or in the operational phase, which has weakened them or consigned them to failure. Considering the fact that Tanzania's transition from state-controlled to free-market economy is relatively recent in global terms, the local operating environment is still very difficult for private MSMEs across all sectors (formal and informal). The noted challenges include (MoIT, 2002):

- Poor infrastructure, lack of adequate tools and technologies, and hence the dominance of low-quality legacy appliances
- Limited or no access to financing due to the perception of MSMEs as being high-risk; an inability to fulfil collateral requirements, and so on.
- A lack of sufficient financial, technical and managerial skills
- Complex and typically confusing taxes and levies
- Unhelpful and variable obstacles to business licensing and formalisation of enterprises and
- A lack of market information and business contacts with external markets.

Box 8. ICT training for micro-entrepreneurs

Mugerezi Spatial Technologies (MUST) College: Launched in 2011 by InfoBridge, a Dar es Salaam-based SME specialising in geographical information systems (GIS), the MUST College exemplifies human capacity building for generating micro entrepreneurs using contemporary ICT solutions. MUST courses include a 9-month GIS vocational education training programme (focusing on mobile GIS), which specifically targets secondary school leavers with few prospects of progressing to higher learning institutions. This addresses the great demand for mapping technicians, as fine-grained map data for Tanzania is scarce and in high demand for planning purposes in both the public and private sectors. Upon completion of the 9-month training programme, a student is armed with basic mobile GIS skillsets that not only improve employment prospects, but also motivate self-employment. The training programme is currently only available in Dar es Salaam but the demand for this training has been great and there are plans to open training centres in the different regions of Tanzania (Interview 207).

It is worth noting that most of these challenges are still very prominent for MSMEs in Tanzania's ICT sector. This was clearly the general consensus noted from the research project field interviews with various MSME stakeholders (Interview 203; Interview 205; Interview 206; Interview 207; Interview 210; Interview 212). In addition to those challenges mentioned above, the ICT MSMEs have had to contend with:

- Weak intellectual property rights (IPR) protection
- Difficulty in accessing mobile operator service delivery platforms and/or mobile short codes to deliver their services
- A lack of suitable venues for germinating ideas and fostering high-quality innovations
- Formidable (and sometimes unfair) competition from external entities
- Increased vulnerability to strategic shifts at the other end of the value network (e.g. cancelled subcontracting deals due to changes in fortunes of the MNCs) and
- Limited capacity to keep up with the global technology paradigm shifts.

To overcome some of these challenges, stakeholders in the Tanzania ICT sector have adopted the approach of ICT incubators and innovation spaces, an intervention that has also proved effective in some of the neighbouring East African countries (Excelsior Firm, 2011). To that end, the Tanzania Commission for Science and Technology (COSTECH) is now hosting the Dar Teknohama Business Incubator (DTBi), which currently includes around 20 ICT SMEs, who benefit from office space, mentoring, networking opportunities, financing opportunities and so on (Interview 214). Furthermore, the Finnish–Tanzanian ICT cooperation programme TANZICT has recently opened up a very active innovation space in Dar es Salaam and plans to inaugurate facilities for pre-incubation start-ups. Moreover, current and future ICT entrepreneurs in Dar es Salaam are able to benefit from networking opportunities through gatherings by the likes of Mobile Monday Dar (http://mobilemonday.co.tz/), BarCampDar http://barcampdar.co.tz/ and the Dar es Salaam Google Technology User Group (GTUG) http://dar.gtugs.org/ (Interview 205).

3.4 Final consumption

3.4.1 User profiles and usage trends

The adoption of ICT solutions among Tanzania users has followed the familiar pattern of innovators and early adapters, typically comprising young/middle-aged, educated, and relatively wealthy users in major urban areas. The adoption rate of basic mobile services in Tanzania has exceeded expectations and now the accessibility of social media services on mobile devices will further drive adoption of Internet-enabled mobile devices, particularly among young (roughly 16–30 years old) educated users. The appeal of social media (specifically Facebook) to this particular demographic, even in places like Iringa, has taken many local ICT stakeholders by surprise (Interview 209). Although the current appeal of Facebook among this user group may be purely for socialising, it nonetheless breeds an

appreciation of the Internet and increases users' confidence in the basic skills required for operating and maintaining Internet devices.

Based on the aforementioned assumptions, a typical user probably has at least secondary education. Secondary school leavers (typically 19 years old or older) represent a significant majority of the newly graduated students entering the local job market annually. Most are absorbed into the formal and informal micro enterprise sector, due to the scarcity of employment opportunities in the public sector following market economy reforms. Users with secondary-level education are now more than likely to be the early adopters of mobile Internet technologies within a household, and are therefore key drivers of adoption within their family units.

Box 9. Early adopters

Heri Urio (end user, early adopter): Heri is a teenage boarding school student at the Tosamaganga Secondary School, located on the outskirts of Iringa town. Heri is from an educated middle-class family and is enthusiastic about mobile technology, to the extent that he already owns a smartphone and is regularly looking up new applications (for learning, games etc.) from the Android Marketplace. To that end, Heri is still a rarity among his peers at his school, as most are still to be exposed to the opportunities available via smartphones or could not afford them in any case. Although the smartphone is clearly a useful learning tool, it has been challenging for Heri to keep the smartphone in school, as the school prohibits ownership of phones by students. So now Heri and his peers hide their phones in the bush next to school and only access them in their free time.

Therefore, deliberate attempts to promote ICT solutions within secondary schools will not only produce better-groomed micro-entrepreneurs, but will also boost the preparedness of those students that proceed to university and other higher learning institutions. The National Schools Connectivity Plan (NSCP), made for the Government of Tanzania, also prioritises secondary schools (Msimang, 2010). With Tanzania having more than 4500 secondary schools spread over a large area, this task is daunting. However, in places such as the Iringa urban district, most secondary schools in the area have reasonably good coverage from mobile broadband networks (observed from research project network measurements), and hence a mobile Internet approach appears to be the most feasible going forward.

3.4.2 Persistent challenges for end users

Affordability: The challenge posed by the high cost of mobile Internet devices was discussed in Section 3.2.2. Mobile broadband Internet access can also be costly, especially when it exceeds the allotted volume cap for a particular data package. For example, the price per kB of data used for Vodacom's Cheka Internet package (500 Tsh per day for a 20 MB package) increases almost by a factor of 50 when the allotted 20 MB is used before midnight. Moreover, carriers apply throttling (reducing a user's data rate) when use of the bundle is exceeded.

Box 10. Personal image and ICT

Ms. Yahya, a 22-year-old mobile phone sales person, has her second mobile phone, a Nokia, which she chose because of her friend's recommendation and its reputedly long-lasting battery. Now she charges the battery every third day.

Communicating with friends and family was difficult before she got the mobile phone, and she appeared out-dated. Now she spends about 1000 Tsh on air time daily.

She does not know how to use computers and has never tried. Because of this, she feels she is missing something, as her friends ask when she will appear on Facebook so that they can send her messages (Interview 43).

Access to Electricity: The lack of a readily available power supply for re-charging mobile Internet devices is increasingly noted as a major hurdle for adoption, especially as they consume more power due to larger displays, applications continuously running in the background, and so on (Wang et al. 2011). In Tanzania, the penetration of mobile Internet access is fast outstripping that of electricity, particularly in rural areas where electricity penetration is less than 3% (Eberhard et al., 2011). Whilst about 40% of the urban population has access to electricity, the supply of electricity can be highly unreliable due to frequent blackouts, because Tanzania's electricity demand greatly exceeds generation capacity (Eberhard et al., 2011).

Complexity: Low-end mobile handsets achieved unprecedented adoption due to simplicity in design and usage. By contrast, Internet-enabled handsets, tablet computers and so on, provide more sophisticated features, but also demand more from the user to be able to operate them and fully exploit the available features. The concept of learning by doing is the only way to overcome this barrier and further emphasises the need for users to be introduced to these technologies at an early age, and preferably in a school environment

Social norms: This is an often overlooked obstacle, particularly when considering the introduction of certain ICT solutions in schools. In a number of revealing encounters during the research project's field visits to secondary schools in Iringa, our suggestion to teachers that students would be more productive if equipped with smartphones was met with negative, if not hostile, reactions. This is borne out of the belief that social connectivity enabled by mobile phones would promote behaviour among students that goes against social norms. In some cases, attitudes of teachers softened significantly when we demonstrated the ebook applications available on our showcase smartphone, as this suddenly highlighted a potential antidote to the chronic scarcity of books in schools. The social dimension of these ICT solutions will have to be addressed by all stakeholders if adoption and innovation are to succeed in schools and beyond.

4. Conclusions

ICT-related social and economic opportunities are rife in Iringa, and based on our research, also more broadly in Africa and developing countries, and have a direct bearing on the livelihoods of low-income and low-skilled people and families. Micro-entrepreneurs selling phones, vending SIM cards and air time, repairing and servicing phones, hosting Internet cafés, and building and servicing telecommunication base stations, accumulate locally significant social and economic activities, and are also critical for the maintenance of the local and continental ICT infrastructure.

The technical reality of the local ICT innovation ecosystem, as our review concluded, greatly conditions how such opportunities are available to local users and entrepreneurs, often in limiting way. A key finding of this mapping of the local ICT innovation ecosystem was that it is radically different from rich countries, something quite expected perhaps, and also falls short of local expectations. The local technical infrastructure is narrow both in mobile telephony coverage and bandwidth, limiting users' ability to access phone and Internet-based services or to move towards co-creation models. The scarcity of devices and price thresholds also continue to prevent access. Electricity supply, or more accurately power blackouts, presents a continued challenge, too.

These findings provide an important framework for our consideration of the pro-poor social and economic opportunities in the context of ICT, as the technical infrastructure in reality is a key enabling factor. Many of the micro-entrepreneurial cases we have reviewed here reveal life histories in which people have escaped poverty and, by gradually building up a skills base, have established themselves as local ICT micro-entrepreneurs, often having moved to these positions from less lucrative micro-entrepreneurial activities, such as fish selling. For individuals and families, this type of social and economic ascendancy has brought about significant improvements, often bringing about huge second-generation benefits.

Although many of our interviewees had had the benefit of schooling, most of them were characteristically "self-made", having acquired skills through social networks or in paid apprenticeships. This was especially true in mobile phone shops, for mechanics, and in SIM-card and air-time vending. Some had enjoyed government-supported education, but few cited these types of activities as critical for their upward mobility. This is in line with the reviews and analysis of ICT4D

efforts in developing countries, which have argued that the focus is too much on investment, infrastructure and technology diffusion, and that too little attention is paid to the benefits of use and generation of local social and employment opportunities, such as jobs and micro-entrepreneurs.

ICT-related pro-poor micro-entrepreneurship is a viable and considerable form of addressing poverty in Africa, and more should be done to explore how to stimulate local job creation and micro-entrepreneurship through government and donor-advanced ICT for development initiatives.

5. Recommendations

The research and considerations of this report have a bearing in multiple ways on how ICT is advanced in developing countries, as well as on how we conceptualise the contribution of ICT to development and poverty alleviation. Our key results relate to the possibilities of creating pro-poor employment and micro-entrepreneurial opportunities within local ICT innovation ecosystems, how we measure and evaluate the contribution of ICT to poverty alleviation, and finally how pro-poor aspects of ICT and innovation initiatives could be strengthened by paying more attention to pro-poor issues in technology foresight and roadmapping, as well as in general in strategic planning for development cooperation.

This research project was undertaken as commissioned research by the Ministry for Foreign Affairs of Finland, and its key objective has been to develop evidence-based perspectives on how to employ innovations and ICT in development cooperation, as well as to offer focused policy recommendations. Naturally, our recommendations, like the report as a whole, do not necessarily represent the views and opinions of the Ministry for Foreign Affairs, and the authors remain solely responsible for all views, findings, interpretations, conclusions and recommendations in the report.

Our research work offers several possibilities to inform development cooperation practice and policy, the key area being perhaps that we seek to sensitise people to recognising the new models of how ICT can directly alleviate poverty. By discussing and demonstrating at length where potential intervention areas are, as well as by framing the conceptual problem and issues, we hope to draw policy-makers' and practitioners' attention to the new approaches. Our specific recommendations for development cooperation policy are elaborated below:

1. **Clarification and development of the impact assessment framework of the pro-poor aspects of ICT and innovation.** The prevalent approach to evaluating the development effects of ICT and innovation continues to be heavily economic and national in framework, and to focus on investments and infrastructure. Yet, in terms of considering the actual poverty alleviation effects of ICT and innovations, such as upward social mobility, empowerment, gender effects, skills building among the urban and rural poor, job creation and enabling of micro-entrepreneurship, the current impact assessment

frameworks are largely inadequate, as demonstrated in our review. The **development of an impact hierarchy**, distinguishing effectively between economic, social, and cultural impacts (as specified above), as well as between different geographical units (regional, national, local), would enhance the assessment of pro-poor and inclusive aspects of ICT, and would also clarify the focus of the planning and implementation of initiatives. Such an impact framework would also clarify how different social and economic groups stand in relation to the emerging ICT and innovation systems, and their effective strategies are in order to benefit from the initiatives. Moreover, a broader evaluation and impact assessment framework **would fit ICT4D more adequately in Finland's new Development Policy Programme**, as **connections between ICT and poverty reduction, freedom, empowerment, civil rights, and environmentally sustainable growth models would be made more concrete**.

2. **The development of concrete local, micro-level mechanisms and practices by which ICT and innovations are pro-poor and effectively address the MDG goals.** Because much direct poverty alleviation in Africa targets the people and communities within the informal economy, ICT4D activities and measures need to do more to reach this sector, and the development of concrete instruments, practices and frameworks enabling this approach are necessary. Of particular imporatance would be the ***elaboration of more concrete pro-poor and inclusive ICT and innovation practices to be implemented and scaled in development cooperation programming***. These should go beyond mere supply of technical infrastructure and technical advisory services, and point out **how programmes can reach poor and low-educated communities with skills enhancing and micro-entrepreneurship enabling activities.** *Possible practical avenues include* **skills-training based practices** that seek to move low-skilled micro-entrepreneurs or ICT employees towards micro-entrepreneurial strategies that rely on more advanced skills and knowledge, as well as **practices that foster new relationships between multinational companies and local people** (e.g. telecom towers and services). A **guidebook** or sourcebook, or the manual cataloguing and **exemplifying of these types of activities and instruments, would benefit the planning and implementation of ICT and innovation projects in developing countries**.

3. **The development of pro-poor and inclusive technology foresight and roadmapping practices.** Although it is a pervasive general purpose technology, with effects throughout the economy and society, **ICT generates pro-poor and socially inclusive outcomes only in limited sections of the ICT innovation ecosystem**. As our research has indicated, the technical, social and economic features of the local ICT innovation ecosystem greatly condition local users, job creation and micro-entrepreneurial opportunities. Most importantly, these activities can have the most direct impacts on the

livelihoods of the poor, and not only in a narrow economic sense, but in a broader developmental perspective that includes empowerment, equality, skills, and gender, for example. While it is relatively easy to obtain a broad overview of the future of global ICT technologies, such macro-level scenarios do not provide sophisticated understanding of how ICT, or technology in general, may be pro-poor and socially inclusive. Furthermore, as our literature review demonstrates, there is a concern that the gap between developing and rich countries may be widening due to the unfolding digital convergence of ICT technologies and businesses. In this context, an improved understanding of where the emerging new ICT ecosystems have the most potential for cultural, social and economic pro-poor connections is of importance. The development of a **pro-poor and inclusive technology foresight and roadmapping practice** would specifically enhance the investigation and identification of the future concrete opportunities for ICT, and other technologies, to create direct pro-poor impacts at the grass-roots level of challenged communities, and thereby strengthen the potential of ICT and innovation-focused development cooperation to address poverty credibly. Also, such targeted and highly **focused foresight and roadmapping exercises would align ICT4D more within Finland's new Development Policy Programme and its strategic priorities.**

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Appendix A: List of interviews

Interview 07; Mr Awadh, Faisal. IringaNET, Owner of the internet café. 16.6.2011.

Interview 08; Ms Ahmedy, Mulk. IringaNET, Operator of the internet café. 16.6.2011.

Interview 10; Mr Ngumbuke, Frederick. Tumaini University/Nguki Internet café. ICT Director/Owner of the internet café. 17.6.2011.

Interview 12; Mr Mpotwa, Mrisho. ZAIN. SIM-card vendor. 30.6.2011.

Interview 27; Mr Mathias. Fundi Simu. Owner of a mobile phone repair shop. 5.8.2011.

Interview 33; Ms Rwakatale, Kelly. Ndova Internet Café. Operator of the internet café. 12.08.2011.

Interview 34; Ms Makweta, Rukia. Ndova Internet Café. Operator of the internet café. 12.08.2011.

Interview 42; Mr. Mwangaile, Benaya. CCDO ICT Center Internet Café. Operator of the internet café.

Interview 43; Ms. Yahya, Hawa. 3-In-One-Enterprises. Seller. 15.8.2011.

Interview 64; Ms. Kalengela, Luckiness. Kalengela Phone Repair. Managing Director. 24.8.2011.

Interview 73; Mr. Kalengela, Mathias. Kalengela GSM Mobile Phone Repairs. Owner of the mobile phone repair shop. 28.8.2011.

Interview 201; Mr. Faisal Awadh, Owner of IringaNet, 20 August 2011.

Interview 202; Mr. Jerome Albou, Chief Technology Officer, tiGO Tanzania Limited, 6 September 2011.

Interview 203; Dr. Peter Chitamu, Chairman and Co-Founder, Sasatel, 2 September 2011.

Interview 204; Mr. Priscus Kiwango, Director of e-Government, President's Office-Public Service Management, 7 September 2011.

Interview 205; Mr. Joachim Mangilima, Founder/Coordinator, Dar es Salaam Google Technology User Group (GTUG), 5 September 2011.

Interview 206; Ali Mufuruki, Chairman, Infotech Investment Group/WANANCHI Group (SimbaNET), 5 September 2011.

Interview 207; Mr. Edwin Mugerezi, Managing Director InfoBridge Consultants Limited/ Mugerezi Spatial Technologies (MUST) College, 2 September 2011.

Interview 208; Mr. Innocent Mungy, Manager Corporate Communications, Tanzania Communications Regulatory Authority, 8 September 2011.

Interview 209; with Frederick Ngumbuke, Head of ICT, Tumaini, 19 August 2011.

Interview 210; Prof. George Oreku, Head of ICT and Technology Transfer, Tanzania Industrial Research Development Organisation (TIRDO), 29 August 2011.

Interview 211; Mr. Peter Ulanga, Fund Manager, Universal Communications Access Fund (UCAF), 2 September 2011.

Interview 212; Mr. Leopold Rweyemamy, Managing Director, Datacom Africa, 29 August 2011.

Interview 213; Dr. Zaipunah Yonah, Director of ICT, Ministry of Communications, Science and Technology, 9 September 2011.

Interview 214; Mr. Makange Mramba, Finance Director, Dar Teknohama/ICT Business Incubator, 6 September 2011.

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