

**AFRICAN ECONOMIC RESEARCH CONSORTIUM
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**A Review of Methodology for Assessing
ICT Impact on Development and Economic
Transformation**

**Prof. Samuel Wangwe
Daima Associates
Dar es Salaam
Tanzania
swangwe@daima.co.tz**

**Contribution to the AERC Project on The Impact of ICTs on
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A REVIEW OF METHODOLOGY FOR ASSESSING ICT IMPACT ON DEVELOPMENT AND ECONOMIC TRANSFORMATION

1.0 BACKGROUND AND CONTEXT

The process of technological innovation in the late 20th century has led to significant developments in new technologies such as biotechnology, new materials and microelectronics together with innovations in software development. The combination of advanced microelectronics and innovations in software development has led to systemic technologies which have come to form a pervasive cluster of information and communication technologies (Mansell, 1994)¹. As information and communication technologies (ICTs) diffuse into all branches of the economy their impact has come to be very pervasive. The pervasiveness of the ICTs is posing the challenge of assessing their impact on economic development and transformation. The purpose of this chapter is to review the methodology for assessing this impact.

ICT refer to a myriad of stand-alone media, including telephone and mobile telephony, radio, television, video, tele-text, voice information systems and fax, as well as computer-mediated networks that link a personal computer to the Internet. ICT is an integrated system that incorporates the technology and infrastructure required to store, manipulate, deliver and transmit information, the legal and economic institutions required to regulate ICT access and usage, and the social and inter-personal structures which allow information to be shared, facilitate access to the ICT infrastructure, and through which innovation takes place.

The ICTs will be disaggregated into ICT producing activities and ICT using activities. ICT producing industries will be categorized into ICT producing manufacturing activities and ICT producing service activities. According to SNA Rev 3 ICT producing manufacturing are those which manufacture products intended to fulfill the function of information processing and communication or must use electronic processing to detect, measure or record physical phenomena or control of physical process. ICT producing services are those which produce services that are meant to enable the function of information processing and communication by electronic means.

¹ Mansell, R. (Ed.).The Management of Information and Communication Technologies: Emerging Patterns of Control. Science Policy Research Unit. Published by The Association for Information Management, London, 1994.

The degree of competitiveness is largely determined by the extent to which economy rests on three pillars: 'knowledge', 'information' and 'technology'. These are terms which lack precise meanings. The framework paper by Nissanke has addressed these terms as follows:

- The term "Knowledge' refers to the scientific and technical knowledge in areas such as computer science, information technology, engineering and manufacturing.
- The term 'technology' refers to the means and the processes used in the application of scientific and technical knowledge to improve or modify our natural environment, or to innovate the things that we have already produced, in order to satisfy perceived materialistic human needs, from the production of things that we need and the comforts that we take for granted in our day-to-day life to taking care of our environment.
- The term "'Information' complements 'knowledge' but it refers to knowledge about 'attributes' of different aspects of our material life such as the quality of a product or a service, market information such as cost and prices, the performance of a worker or a company, the facilities provided by a bank or a development agency, track record of an entrepreneur or trustworthiness of a borrower, trustworthiness of a system, safety of a plant, the state of climate, etc.

Thus, all three concepts, knowledge, information and technology, play an indispensable role in any development effort undertaken towards a knowledge-based economy. The strengths and weaknesses of the three concepts serve as a gauge to identify how far, and in which direction, African countries are likely to move in order to transform their economies into knowledge-based ones.

A common definition of technological capability as adopted in the framework paper by Nissanke the ability of a given country to make use of the knowledge to acquire, assimilate, adapt, and change existing technologies and develop new products and processes to meet development objectives. The dimensions of technological capability include:

- human resources capability, encompassing the ability of humans to understand technical processes, acquire the knowledge about them, interpret and adapt it to suit the local conditions and apply it creatively to the solution of practical problems,

- process and management capability (in relation to industrial plants and processes),
- institutional infrastructure capability, implying the existence of certain specific institutions that facilitate the integration of technical knowledge possessed by the society as a whole into a coherent framework and thus its application in a complementary and productive manner for the benefit of the society as a whole. The concept of institutional infrastructure implies a common purpose shared by the society drawing its strength from the psychological motives and the political aspirations of the society,
- technological infrastructure capability, and
- financial capability.

2.0 THE OBJECTIVE OF THE STUDY AND RESEARCH QUESTIONS

2.1 Objectives

The objective of this study is to investigate the impact and implications of ICTs on economic development and transformation in Africa.

Assessing the impact of ICT will address two dimensions

- (i) Identifying the impact of ICT production and use in production and growth generating activities and specific sectors that could lead to economic development and transformation in Africa
- (ii) Exploring options and possibilities of harnessing ICT to more effectively impact on economic development and transformation in Africa.

The use of ICT to enhance economic development and transformation in Africa will entail addressing the impact of ICT on changing the structure of the African economy (composition of agriculture, industry and services), expanding economic and social development opportunities, facilitating diversification, exploring options for building competitive advantages, facilitating efficient functioning and responsiveness of institutions (including markets) with a view to creating vibrant markets and institutions.

To address effectively the impact of the pervasive diffusion of ICTs the study will explore structural as well as cost factors, the influence of ICTs on growth and factor productivity and the impact influence on employment and investment. The impact of ICTs on poverty reduction and on raising the standard and quality of life of the poor will be explored including addressing indirect impact on poverty through growth and productivity in activities in which the poor are most actively engaged. The impact of ICTS on governance will be addressed including its implications on access to public knowledge that can influence governance structures towards more democratic and participatory processes and towards raising levels of awareness on the way development agendas are negotiated. Related questions will be raised as a ways in which ICTs may have come to play an important role in mediating communication and information relationships in business and everyday life as well as implications of public policy. The extent to which public policy and ICT options are balanced with other socio-economic objectives will be explored. In this context, the study will

explore whether the ICT policy exists and if it does explore the extent to which it is integrated into relevant socioeconomic development policies and strategies.

2.2 Research Questions

Examples of research questions that could be asked include the following

- What is the impact of ICT on breaking barriers to knowledge, information and on reducing information or knowledge gaps in production, organization and distribution? These could be disaggregated into more specific aspects of ICT (e.g. Internet, telephony) and how they impact on specific activities in different sectors i.e. agriculture, tourism.
- What is the impact of ICT on governance e.g. on participation as regards specific ICT components and sectors?
- What is the impact of ICT on economic opportunity such as in trade, business activities and interaction in respect of specific ICT components and sectors ?
- What is the status of official statistics on ICT and the extent to which the available data are reliable, accurate and are comparable internationally?
- Undertake the analysis of the link between ICT and development goals such as poverty reduction, economic growth and competitiveness. Specific questions could include: What is the relationship of poverty and ICTs?, How is ICT actually benefiting the poor (directly and indirectly)? What/where are the impacts of ICTs on poverty reduction (in general or on sectors where the poor are active)? How are ICTs influencing organization of production processes? How is the rate of adoption of ICTs impacting on investment and Total Factor of Productivity in the economy?
- Carry out the analysis of the mechanics of policy making including policy processes and its political economy (governance and power relationships, incentives and motivation of different actors).
- What has been the experience of policies for the regulation and coordination of selected sectors that have made use of ICT in their design, implementation and monitoring?
- Which are the existing co-ordination and regulatory structures in the selected sector that can or should be involved in ICT? More specifically what have been

found to be the most appropriate institutional structures for the promotion and regulation of ICT usage?

- Which are the existing co-ordination and regulatory structures in ICT that might impact upon production, processing or consumption?
- What role can the national and international private sector play in the promotion of ICT for coordination and regulation that improve production and value added activities at different points along the supply chain?
- How can the economic and social impact of ICT on development and economic transformation be assessed for production and distribution in Africa?
- What stages of the supply chains are most likely to be affected by ICT in terms of productivity and profitability and what are the possible consequences in terms of job creation or loss; capital/labour ratios; gain or loss of control over production and distribution process?
- What is the impact of using ICT on various actors and the respective stages in the supply chain taking account of prices, profitability, choice and quality of life? The analysis should capture both intended and unintended consequences resulting from ICT usage at the selected levels of analysis.
- What are the costs of non-adoption of ICT at different levels (government departments, local authorities, enterprises of different sizes, households and individuals within households) and how is the burden of such costs distributed in society?
- What is the social impact of ICT on geographic location, isolation, market integration, education, income, wealth, gender, ethnicity, and social exclusion?
- What is the role of social networks in the use and diffusion of ICT usage?
- What factors determine the adoption of ICTs by firms at different levels of economic and technological development?
- What is the impact of ICTs on employment generation and transformation of the economy or specific sectors through new skills and new technologies?
- What policies influence the size and shape (demand characteristics) of the domestic market (e.g. taxation, wages), input costs or outputs for entrepreneurs

(e.g. land prices and use), nature of competition, foreign investment, and those that promote local upgrading and linkages between foreign and local agents.

3.0 REVIEW OF METHODOLOGICAL APPROACHES

Assessment of the impact of ICT on development and economic transformation should take into consideration the continuous interaction between technical and social processes. Transformations in the ICT environment are both technically and socially determined whereby the processes of technical change interact with the institutions in which people are differentially empowered to act. Socioeconomic and technical factors interact to shape the innovative processes that influence ICT developments in a dynamic way. Advanced ICTs are being constructed and constituted by a complex matrix of cultural, social, political, economic and technical relationships that are mediated by changing institutional relationships (Freeman, 1994)². Some of these institutions arise spontaneously from social and market circumstances and others are deliberately created by government. The methodological approaches that have been used are categorized into those focusing on gap analysis and impact analysis. These analyses can be further categorized into those adopting quantitative analysis and those adopting a qualitative analysis in respect of either engaging in the production of ICT or in its use ICTs or both.

3.1 Gap Analysis

Gap analysis addresses the impact of ICT on inequalities in society across countries or within countries. Studies on the digital divide have addressed the status of the digital divide and have conceptualized various forms of exclusion or inclusion in the world of ICT. These studies have addressed the challenges of exclusion and how the technology could be made more accessible and affordable.

3.1.1 Gap Between Countries

A major concern in the literature has been expressed around the problem of the *development gaps* and more specifically the digital divide between the developed and developing countries. The digital divide is far from closed and in most parts of the world it is still widening (van Dijk, 2005)³. The gap between the developed and developing countries is extremely wide and it is growing. The digital divide is deepening where it has stopped widening. The significance of the digital divide is

² Freeman, C. The Economics of Technical Change: A Critical Survey Article. Cambridge Journal of Economics, 1994.

³ Van Dijk, Jan. The Deepening Divide: Inequality in the Information Society. SAGE Publications, 2005.

manifested in ICT products and outputs such as Internet access and cellphones and in ICT inputs such as engineers and scientists.

The main aspects of the African economies, which have important implications for attenuating digital inequalities are: the low level of development, low level of knowledge and physical infrastructure and limited benefits associated with ICTs (such as employment creation, productivity growth).

The divide between nations can be explained in terms of gaps in objects like capital, raw materials and human capital or in terms of gaps in ideas represented by instructions that are needed to combine physical resources to produce economically valuable commodities. In recent years, the gaps in ideas as represented by knowledge generation and technological change have gained in importance as determinants of levels of development and levels of competitiveness. Invention, innovation, discovery and technological change are activities which increase the stock of intangible knowledge or ideas (Pohjola, 2001).

ICTs have created a world that is more interconnected than ever before. Growing interconnectedness has permeated economic relations (e.g. trade, finance, investment and global organization of production) as well as social and political interactions. Problems of marginalization and exclusion that have been associated with globalization are due to deficiencies in the governance of globalization which in turn largely derive from the behaviour of nation states (ILO, 2004)⁴.

Employment effects of ICT have influence on marginalization or social and economic inclusion. Marginalisation is real in the global economy threatening to make redundant whole countries especially the least developed countries and a whole section of people excluded from the informational networks. There are more jobs and a higher proportion of working age people employed including greater incorporation of women in paid work. However, employment effects are influenced by social institutions to a greater extent than the influence of new production systems.

It is expected that the spread of ICTs in Africa will enhance Africa's participation in the knowledge economy. The evidence that is coming out of recent research is demonstrating this trend (e.g. the output from Research ICT Africa).

⁴ ILO: A fair Globalization: Creating Opportunities for All. Report of World Commission on Social Dimension of Adjustment, Geneva, 2004.

3.1.2 Gap Analysis Within Countries

The more ICT is immersed in society and pervades everyday life, the more it becomes attached to all existing social divisions. Within specific economies, the ICT networks may to a greater or lesser degree be **inclusive or exclusive**. Even in the advanced countries, there is evidence of production being increasingly concentrated on the educated sections of the population aged between 25 and 40 with the threat of creating highly segmented social structures driven by extreme flexibilisation of work and individualization of labour (Castells, 1996)⁵. The risk of this threat is likely to be higher in developing countries of Africa. The studies that have been done in Africa have found two types of access gaps: the urban-rural gap and the rich-poor gap (Pigato, 2001). Four types of access have been identified in the literature: physical or material access; motivational access; skills access; and usage access. A distinction has been made between these four successive kinds of access that indicate the full appropriation of the new technology. Analysis of the causes of access (e.g. distribution of resources), analysis of consequences of the digital divide and analysis of the context of digital divide could be carried out along the lines of the four types of access.

There is increasing evidence that access to ICTs has a direct impact on raising the standard and quality of life of the poor and has indirect impact on poverty through growth and productivity. Information and knowledge enable the poor to understand better their own circumstances and to voice their own opinions and needs more effectively. ICTs are being introduced to empower rural communities.

3.1.3 Extent and Determinants of Access

Policy implications of these studies are essentially in terms of alternative regulatory incentives or selective financing with a view to promoting access to ICT by the otherwise marginalized sections of society. The research findings also throw some light on the status of distribution of ICT infrastructure and how the infrastructure could be made to facilitate and encourage further inclusivity of the ICTs. For instance, the study on Pro-poor Opportunities and Challenges in Liberalizing Markets (WDR, 2005) is formulated with a view to addressing this challenge.

ICT infrastructure is made up of three components: telecommunications, computing and connectivity infrastructure. Connectivity infrastructure has four components: the aggregate bandwidth of the domestic backbone(s); the aggregate bandwidth of the

⁵ Castells, M. The Information Age: Economy, Society and Culture. Vol. I. The Rise of the Network Society. Published by Blackwell, Massachusetts, Oxford, 1996.

international IP links; the number and type of interconnection exchanges; and the type and sophistication of local access methods in use. Local, National and regional telecommunications infrastructure include server connectors, local loop telecommunication lines, inter-nodal connections, and switching systems among others, and determine the cost and quality of access. Users in high-bandwidth telecommunications environment are likely to have access to lower cost connections. Most developing countries face capacity constraints, largely a result of thin-bandwidth and frequent power outages.

Another WDR study addresses the role of telecom regulation in influencing network investments opportunities (Terrab, 2006). The insights from this study would be useful in understanding issues of access and spread and expansion of telecom networks. This information would be complementary to information that would be generated by the proposed study on the impact of ICTs on the economy.

The study on Information Provision and Participation in Regulatory and Policy Processes (Mahan of Comunica, 2005) has been designed to address information provision practices and communication with a view to enhancing the participation of a wider range of stakeholders in the regulatory and policy making processes. The study provides useful information on the role of stakeholders or beneficiaries of ICTs in encouraging better access and therefore expanding the benefits of ICT in society. The study on indicators of the network use and development is designed to capture more effectively the developments in terms of access to and use of ICTs in developing countries. The findings are expected to facilitate monitoring and evaluation of progress and efforts being made in ICT deployment and adoption. Research ICT Africa (RIA) has produced a document "Towards an African e-Index" indicating ICT access and usage by households and individuals across 10 African countries⁶. RIA is a network of 14 African institutions with the vision of developing a sustainable information society and network knowledge economy by providing data and analysis that may be required for designing ICT policies and regulatory processes and monitor and review those policy and regulatory developments. This is a useful source of information for understanding the status of ICT access in Africa.

However, it should be noted that it is difficult to measure the total number of Internet users given the large number of shared accounts, along with the relatively high and rapidly growing use of public access services such as Telecentres, and cybercafés. Although the number of dialup subscriber accounts is readily available, these figures are only a partial gauge of the size of the Internet sector and should be looked at

⁶ Gillwald, Alison (Ed) Towards an African e-Index: household and individual ICT access and usage across 10 African countries. The LINK Centre, Wits University School of Public and Development Management, Johannesburg, 2005.

along with other factors such as the quantity of international traffic each country generates.

However, an enhanced understanding of the status of ICT, recent trends and challenges of improved social inclusion are useful considerations as inputs into the analysis of impacts on the economy and can be used to improve understanding of how positive impacts on the economy could be enhanced through attainment of better access to ICTs.

One of the research projects under WDR has been designed to explore innovative models of financing ownership and management. The study addresses how alternative models of ownership, management and financing can influence access and adoption of ICTs (Bruce Girard, 2005).

Research on e-Access and Usage at household level has revealed the demand side of ICT by individuals and households and how ICTs are used across 10 African countries. These findings have filled an important knowledge gap and will contribute to policy making. There is need for information on the impact of ICTs on the economy in order to better appreciate the kinds of demands that need to be satisfied first if the positive impacts of ICT are to be optimized. The two sets of studies are complementary in that sense.

Previous work on ICT in Africa is rather scanty. For instance, a recent study done by UNU-INTECH (Oyeyinka and Lal, 2004)⁷ employed firm level data from three countries (two of them Nigeria and Uganda being in Africa) to **analyse factors determining the adoption of internal e-business technologies** in developing countries. The study found that adoption of ICTs was influenced by size of operations, export performance, profitability, value addition, skill intensity, academic qualification of CEOs, learning processes and technological collaboration with foreign firms. The study found bi-directional relationships among several factors although all causal relationships could not be identified due to lack of sufficient time series data. In another study (Oyeyinka and Lal, 2004a)⁸ it was found that sector-specific factors influenced the degree of adoption of e-business technologies. It was also found that there are significant variations in the conduct and performance of

⁷ Oyelaran-Oyeyinka and Kaushalesh Lal. Determinants of EBusiness Adoption: Evidence from firms in India, Nigeria and Uganda. UNU-INTECH Discussion Paper 2004-14.

⁸ Oyeyinka, Banji and K.Lal. Sectoral Pattern of E-Business Adoption in Developing Countries. UNU-INTECH Discussion Paper 2004-7.

firms that use lower levels of e-business tools from those categorized as the most advanced users.

The IDRC studies and others which have been cited here have provided useful insights into the status of access and adoption of ICTs. The proposed study on the impact of ICT on the economy is complementary to these studies. These studies have been designed to enhance the understanding of the status of access and adoption of ICT and have explored ways in which access could be enhanced. Knowledge of the benefits and other impacts of ICT will complement the information on adoption and use of ICT. Policy formulation requires adequate knowledge of both (impacts and access). The approach to be adopted in this study will therefore be to establish the status and patterns of access and adoption with a view to throwing light on the possible impacts in terms of economic development and transformation.

3.2 Impact Analysis

The ICTs will be disaggregated into ICT producing activities and ICT using activities. In assessing the impact of ICT it is important to distinguish which aspect of ICT is being assessed. Productivity increase has occurred in ICT producing sectors and in ICT using sectors⁹. The breakdown of factor productivity aggregates into sectoral contributions has helped to show attributions to ICT producing sectors, ICT using sectors and other sectors (Pilat, Lee and van Ark, 2002).

The impacts in this category can be direct or indirect.

3.2.1 Assessing Impact of ICT Production

ICT producing industries are categorized into ICT producing manufacturing activities and ICT producing service activities.

ICT Producing Activities include: Design and Research; Equipment Manufacturing; Assembling and CKDs and Software Developers. Investing in the production of ICT goods can be done with the specific aim of entering the ICT producing market, in particular, in areas such as software development and assembly and manufacturing

⁹ According to ISIC Rev 3 ICT producing manufacturing are those which manufacture products intended for fulfil the function of information processing and communication or must use electronic processing to detect, measure or record physical phenomena or control of physical process. ICT producing services are those which produce services that are meant to enable the function of information processing and communication by electronic means.

of computing equipment and components. Though initially they may be limited to meeting the internal demand, such efforts may offer, in the longer term, opportunities for export and outsourced technological processes.

Although this path may not be associated with significant benefits to economic development in African countries the importance of efforts directed at the production of ICT goods has been demonstrated by those developing countries that currently enjoy generally significantly higher growth rates in ICT exports, compared to other export-oriented economic sectors. This suggests that such efforts could offer, at least for some African countries, long-term strategic advantage in turning their economies into modern knowledge-based economies.

Production of ICT goods can contribute to economic growth because the global demand for ICT products is growing faster than average of most sectors. In addition, the production of ICT products involves the use of highly advanced manufacturing processes the mastery of which is likely to generate higher productivity growth than the average of other sectors. ICT producing sectors showed important contribution to factor productivity in Finland (both ICT-producing manufacturing and ICT-producing services). This reflects rapid technological progress in the ICT producing sectors. In the case of Finland, the contribution of Nokia is clearly dominant.

ICT sector is one of the leading sectors in R&D effort and the returns from research in ICT should be widespread given their pervasive use. In addition, ICT plays a leading role in knowledge creation, codification and transmission. International R&D spillovers have been shown to be significant whether in terms of social rates of return, elasticities of TFP growth or growth contributions (Mohnen, 2001)¹⁰. The main determinants of spillover appropriation are the acquisition of expertise through own R&D and education, the openness to international contacts and close collaboration with foreign researchers.

(a) ICT Manufactures of hardware

According to SNA Rev 3, ICT producing manufacturing are those which manufacture products intended to fulfill the function of information processing and communication or must use electronic processing to detect, measure or record physical phenomena or control of physical process. In the context of Africa, ICT hardware may be disaggregated into telecommunications equipment and computer hardware manufacture and assembly. The latter should cover manufacture and assembly of

¹⁰ Mohnen, P. International R&D Spillovers and Economic Growth. In Pohjola (Ed.), 2001.

computers (branded or unbranded/clones) and include clusters that are emerging in activities associated with repair of computers. In telecommunications hardware should cover the manufacture and assembly and repair of telecommunications related equipment such as cell phones and others.

(b) ICT Production of Services

ICT producing services are those which produce services that are meant to enable the function of information processing and communication by electronic means. The main categories of products are software and services. The detailed classifications can be sought more precisely from the System of National Accounts.

3.2.2 Assessing Impact of Using ICT

ICT Using Activities include Service providers; Application Developers/ Content providers; Intermediaries and Sector Specific users, government, private firms etc. Reliance on ICT applications for efficiency gains may occur in industry, commerce, agriculture and public administration to result in significant efficiencies, improved quality of service in areas such as health and education, better quality of life for citizens, enhanced and new market opportunities for entrepreneurs and so on. These may take numerous forms, benefiting, amongst others, rural communities through marketing and financial services and producers of developing countries through new global markets for their business and generate new businesses and new and better employment prospects for all.

Users of ICT may be categorized by type of user. Applications of ICT range from personal use, to use in business and use in government. The types of uses can be categorized into individuals or personal use and households level use, use in small and medium businesses/enterprises, use in large businesses/enterprises and use in government.

An alternative categorization may be made by sectors. This kind of categorization can be made based on the most likely users in a particular country. These may be the financial sector, the trade sector and other services sectors to be selected after preliminary investigation has been carried out at country level.

Uses of ICT are diverse ranging from e-commerce, enterprise management, e-services etc. It is recommended that priority be given to the use of ICT in enterprise management and in production systems in the form of automation. Factors driving investments in the use of ICT could be identified for policy consideration. These factors could include national wealth, infrastructure, human resource development, wage rates and prices.

ICTs have the feature of being able to be customized to personal needs or local conditions. It is therefore imperative to define the needs at various levels and explore what ICT can do to meet those needs. At the national level for instance, it is important to define the national development objective and strategy as a basis for posing the question of use of ICT for realizing the national objectives. In the context of Africa, concern over growth and poverty reduction would have to be addressed along with concerns over the transformation of the African economy towards a more dynamic economy which can better cope with the global competitive environment.

The World Dialogue on Regulation (WDR), under a Learning Initiative on Reforms for Network Economies (LIRNE), has produced several research reports addressing the status of various aspects of ICT in selected countries and diversification of networks. These studies have taken a snapshot of selected aspects of ICT like telecommunications, microtelcos and community based networks. These studies have also addressed specific issues relating to institutional design of regulators, mobilizing ICT for effective disaster warning and how access to ICT could be enhanced. The thrust has been placed on the status and prospects of better access or enhanced inclusion. For instance, the research project on replicability of microfinance approach to extending access to telecommunications is addressing the issue of access. These studies are essentially designed to deepen the understanding of the status of aspects of ICT, how the status could be better measured and how access could be enhanced or their application improved. These studies produce outputs which throw light on the ingredients needed to analyse the impact of ICT on the economy but they fall short of addressing that challenge directly.

Returns from investments which can make ICT adoption more widespread in the economy can be very high to the extent ICT reduces transaction cost in business operations. ICTs can create positive economic and social multipliers. Economic multipliers are associated with increasing productivity in the economy through more efficient information gathering and reduction of transaction costs, improving the functioning of markets and accessing new markets (e.g. e-commerce), lowering cost of communicating and improving the management of supply chains. Social multipliers can be manifested in enhanced social cohesion and improved safety and survival. ICT can enhance the functioning of government in general and in public service delivery such as health and education. The functioning of government can be improved through enhancing efficiency in performing administrative and planning functions, facilitating government decision making processes, provision of government services to its people, promoting accessibility to government and

making it easier for peoples' voices to be heard by government and government messages to be heard by the people.

ICT is both a significant sector in the economy and a vital service to business and industry and other users in the economy. In the information economy, the role of ICTs become even more critical for economic development through its role in the system of national innovation, development of entrepreneurship and public service delivery.

The dynamism of ICT is expected to come from several sources including the decline in the prices of information processing, convergence in communication and computing technologies and the rapid growth in network computing. The communication networks and interactive multimedia applications are providing the foundation for transformation of existing social and economic relations into an information society (Pohjola, 2001)¹¹.

The role of ICT in economic development is expected to be manifested in productivity increase, enhancing the quality of life, reducing prices, creating new economic activities and new employment activities as well as generating wealth (Pohjola, 2001). An important revolutionary aspect of ICT is the possibility it offers to unbundle information from its physical carrier characterized by the global movement of weightless bits at the speed of light. This is manifested in increasing share of all services in the GDP and the growing importance of ICT in particular.

Some researchers have found it more manageable to examine specific components of ICT in order to allow more indepth analysis of the impacts. One example of this approach has been the analysis of the impacts of ICT by assessing the importance of the computer as a factor of production in the economy. The decline in computer prices and improvements in quality and performance has led to a substantial increase in the nominal share of computer and information processing equipment in fixed capital formation. However, the capital share of computer hardware has remained rather small because computers become obsolete quite rapidly.

OECD countries that improved performance in the 1990s were generally able to draw more people into employment, increase investment and improve factor

¹¹ Pohjola, Matti (Ed.). Information Technology, Productivity and Economic Growth. International Evidence and Implications for Economic Development. WIDER Studies in Development Economics, Oxford University Press, 2001.

productivity (Pilat, Lee and van Ark, 2002)¹². ICTs contributed to this growth in two ways. First, ICTs contributed to increasing investment and therefore to capital deepening encouraged by the steep decline in ICT prices and the growing scope of their application. Reviews of models of technology adoption show that decreases in prices of new capital goods tend to increase economic growth. Second, ICTs contributed to factor productivity growth. The evidence from OECD countries has shown that ICTs facilitate economic growth by increasing productivity though this is a long-term outcome of ICT investment. Some studies have found that ICT capital has larger impacts on labour productivity than other types of capital suggesting that there might be spillovers from ICT investment (OECD-DAC, 2004a).

ICTs have made it easier to disperse value chains both geographically and organizationally. ICTs have influenced management of supply chains and in the design of products and components by facilitating enterprise resource planning, business-to-business ecommerce markets and electronic data exchange. When combined with CAD and CAM systems, firms can communicate complex product specifications to outside suppliers permitting the creation of fully integrated computer-integrated manufacturing procedures that track product quality and inventory and design and production cycles. The suppliers or subcontracted firms are likely to benefit from membership in the production networks through transfer of technology gains, access to specialized technical and marketing expertise and the impetus that demanding purchasers provide to enhance productivity and innovation (Porter, 2000)¹³.

However, recent research on the use of ICT suggests that the benefits from the use of ICT are likely to outweigh the benefits from production, which are limited to just one sector of the economy. Moreover, globalization of production of ICT is likely to deter most developing countries from reaping the benefits of producing ICT (Kraemer and Dedrick, 2001)¹⁴. The ICT using service sectors showed considerable contribution to factor productivity growth in Germany, Denmark and Finland. The impact of ICT use on factor productivity may be manifested in more productive firms gaining market share, product diversification may be facilitated, customized services may be offered, it may be possible to respond more effectively to customer demand

¹² Pilat, Dirk., Frank Lee and Bart van Ark: Production and Use of ICT: A Sectoral Perspective on Productivity Growth in the OECD Area. OECD Economic Studies No. 35, 2002.

¹³ Porter, M.E. Location, Competition and Economic Development: Local Cluster in a Global Economy. Economic Development Quarterly, 14, 2000.

¹⁴ Kraemer, K.L. and Dedrick, J. Information Technology and Economic Development. Results and Policy Implications of Cross-country Studies. In Pohjola (Ed.), 2001.

or it may help reduce inefficiency in the use of factors of production. Strong productivity growth was found in ICT-using sectors especially retail trade in the US where firms like Walmart used innovative practices to gain market shares and in turn forced competitors to improve their performance.

Relevant evidence relating to the impact of ICTs on economic growth and productivity have not yet been produced for developing countries (OECD-DAC, 2004a)¹⁵. ICTs and related systems have shown the potential to *contribute to economic growth and improvement in social conditions* in the developing world. However, ICT growth is expected to influence growth through gains in labour productivity as well as total factor productivity. Developing countries and LDCs in particular are less well-equipped to tap the potential of ICTs to stimulate growth for several reasons such as economic structure (e.g. dominance of agriculture and low incomes) and policy issues (e.g. restrictive regulatory environments, low levels of human resource development). This phenomenon has been termed the productivity paradox.

The productivity paradox suggested that computers are everywhere except in the productivity data (Solow, 1987)¹⁶. This paradox has been explained in terms of failure to pick it up in statistics to the extent most improvements occur as improvements in the quality of services which are not captured in productivity data. It has also been argued that impacts of new technologies take time to emerge and it takes time to adjust to new organizational arrangements and to upgrading of human resources to cope with the challenges of the new technologies (OECD, 2003)¹⁷. To the extent it takes time and resources to operate a new technology then even a major technological revolution such as ICT may be associated with decline in productivity as has been shown by David (1990)¹⁸ and Greenwood (1997)¹⁹. This learning period is also characterized by increasing wage inequality as skilled labour has an advantage at learning.

¹⁵ OECD-DAC: ICTs and Economic Growth in Developing Countries. DAC Network on Poverty Reduction. DCD/DAC/POVNET (2004)6/REV1, December 2004.

¹⁶ Solow, R. We'd Better Watch Out, Book Review No. 36, The New York Times, 12 July 1987.

¹⁷ OECD. ICT and Economic Growth. Evidence from OECD Countries, Industries and Firms. OECD, Paris, 2003.

¹⁸ David, P.A. The Dynamo and the Computer: an historical perspective on the modern productivity paradox. American Economic Review. Papers and Proceedings 80. 1990.

¹⁹ Greenwood, J. The Third Industrial Revolution. Washington DC. AEI Press, 1997.

ICTs may improve the quality of education to the extent they make it easier to access vast amounts of information, facilitate presentation of materials using multimedia and collaboration with others to improve classroom experience and ultimately lead to improved cognitive skills. However, to make effective use of ICT requires additional complementary investments such as investment in teacher training and adaptation of the curriculum to accommodate the adoption of ICTs. Experience in other countries has shown that a major challenge here is in addressing the question of how ICT should be integrated and how classroom conduct could be changed to take full advantage of the new technology (Yusuf et al, 2003). ICT can also facilitate expansion of reach of long distance learning allowing people to interact with education and learning and allowing the accommodation of larger numbers of learners from virtually all places that can be reached by ICTs.

ICTs have been shown to impact on poverty reduction by impacting on poverty reducing sectors such as the social sectors. For instance, ICTs can increase the volume and flow of medical information which can impact on the health of the poor. ICTs can be used to influence learning and delivery of education.

ICTs impact on poverty through their impact on productivity and income generation as it gives to sectors where the poor are likely to be most actively engaged. For instance, productivity increase in the SMEs can have poverty reducing effect to the extent SMEs gain access to market information (faster and more cheaply), access to information on input prices and output markets and to the extent they strengthen forward linkages to the market (Pigato, 2001)²⁰ and backward linkages to the domestic suppliers of inputs.

Rural based ICTs have the potential to impact on agriculture through increased revenues and diversification of agricultural production, made possible by delivering SMS-based price and crop information (OECD-DAC, 2004)²¹.

ICT based access to public knowledge is influencing governance structures towards more democratic and participatory processes. It is influencing the way development agendas are negotiated. Telecottages, community networks and one stop shops for basic development information and statistics are facilitating access of communities to information flows that are raising levels of awareness. For instance, telecottages in

²⁰ Pigato, M. Information and Communication Technology, Poverty and Development in Sub-Saharan Africa and South Asia. World Bank, Washington DC, August 2001.

²¹ OECD-DAC: Leveraging Telecommunications Policies for Pro-poor Growth Universal Access Funds with Minimum -Subsidy Auctions. DAC Network on Poverty Reduction. Berlin, 27-29 October, 2004. DCD/DAC/POVNET(2004)13. October 2004.

parts of Asia and Africa are broadening access to information. Community networks are being introduced with public access points in locations like schools, libraries and community centres. One-stop shops with basic development information and statistics are being introduced in terminals that are located within the communities. Integrated systems are being designed to meet basic needs of rural communities.

It is important to acknowledge that impacts of ICTs are not automatic. Some prerequisites may have to be present before the impacts can be realized. In this regard, some studies have also suggested that the US may have been able to benefit from spillover effects as ICT investment started earlier and was stronger. Diffusion of ICT may help establish networks which produce spillover effects the more firms are connected to the network. Increased use of ICT may also lead to greater efficiency in the creation of knowledge. Studies at firm level have been able to show spillovers from ICT capital although this has been difficult to show that impact at the aggregate level. It has also been suggested that the US may have been able to benefit more from ICT since it got its fundamentals right. In particular, it has been reported that the impacts of ICT on the US economy were facilitated by high level of competition strengthened through regulatory reforms combined with sound macroeconomic policies and well-functioning institutions and markets. Studies have also suggested that a range of structural reforms in Australia have been important in driving the strong uptake of ICT by firms and have enabled these investments to be used in ways that generate productivity gains. This was particularly found to be evident in wholesale and retail trade and in financial intermediation.

Experience from developed countries has shown that ICT investment can contribute to economic growth and in that process complementary factors such as human capital, and deregulation play an important role in accelerating the benefits of ICT investment both for firms and for countries. However, this potential impact of ICT on growth is not realized automatically or by simply transferring technology to the developing world. The design and formulation of ICT policies is increasingly having to face the challenge of improving their capacity to address the specific contexts in which ICTs are managed and implemented. The importance of context in terms of organisation, sector-specificity, country-specificity or region-specificity deserves recognition in the process of examining the role of ICT in economic development of Africa (Avgerou and Walsham, 2000)²².

ICT sector is one of the leading sectors in R&D effort and the returns from research in ICT should be widespread given their pervasive use. In addition, ICT plays a

²² Avgerou, C. and G. Walsham (Eds.) Information Technology in Context: Studies from the Perspective of Developing Countries. Ashgate Publishing Ltd. Aldershot, 2000.

leading role in knowledge creation, codification and transmission. International R&D spillovers have been shown to be significant whether in terms of social rates of return, elasticities of TFP growth or growth contributions (Mohnen, 2001). The main determinants of spillover appropriation are the acquisition of expertise through own R&D and education, the openness to international contacts and close collaboration with foreign researchers.

Value chain analysis

The framework paper by McCormick and Onjala in this volume gives pointers to how each of the components of ICT can be associated with a value chain that can offer benefits to society.

A value chain is the sequence of production, or value adding activities that bring a product from its conception to its final consumption. The term 'global commodity chains' was extensively used in economic literature in the early 1990s, while the business community often refers to 'supply chains'. Recognition of this chain of value addition encourages the investigation of the distribution of that value among the various actors and promotes a search for upgrading or value addition strategies. Various components of the chain may be associated with high or low linkages to other activities which supply inputs and support services to facilitate activities in the respective components of the chain.

Value chain analysis also highlights the issues of chain coordination or governance (control of the chain by various actors).

Value chains may be buyer-driven (often labour intensive and low technology) or producer-driven (often capital intensive and high technology).

In addressing these impacts, value chain analysis could be used as a tool for mapping and making assessments processes and dimensions involved. Thinking in terms of value chains helps them to identify the appropriate "niche" in the chain as a central part of the strategic plan. For example, in the garment or footwear industry, the relevant criteria are to map out:

- Product quality
- Price
- Time from order to delivery
- Punctual delivery
- Flexibility
- Innovative design.

The value chain approach provides a framework for sector-specific action addressing domestic as well as global linkages and helps to identify leverage points and ways to intervene. The Indian software industry provides a good example of how developing country enterprises can take advantage of the global trend to outsourcing of services and providing software services tailored to the demands of global businesses.

Value chain analysis helps the researcher to find out where the bottlenecks are. Which part of the chain holds up progress in the others? Who (government, private sector, PPP, donors) is most appropriate at doing what?

Demand-side factors

ICTs associated with knowledge products reduce the distance between consumers and producers of knowledge products. It has been shown that demand side factors such as consumer attitudes on sophisticated goods, training, education and skills for consumption (rather than production) importantly influence patterns of technological development and therefore economic growth and development. This explains the failure of the industrial revolution to occur in technologically advanced China of the 14th Century (Quah, 2001)²³. The policy implication of this finding is that training and education can be important, not only in providing skills for work and production, but also in providing a sufficiently strong demand base. Government policies which make consumer attitudes more favourable to knowledge products can cultivate demand which appreciates and exploits sophisticated technology thus enhancing peoples' participation in the information economy.

3.2.3 Quantitative and Qualitative Analysis of Impacts

Methodological approach needs to be specific and focused on the application of ICT on specific activities. Qualitative and quantitative methodologies should be combined as deemed appropriate in specific conditions. Research questions will determine what methodologies can be employed within specific country constraints.

Quantitative approaches often involve the use of sample surveys with emphasis on quantitative indicators such as income, consumption levels and access to technologies such as tele-density. The analysis of the impact of ICTs on economic

²³ Quah, D. The Weightless Economy in Economic Development. In Pohjola (Ed.) 2001.

growth and competitiveness largely rely on quantitative data as exemplified by the World Economic Forum's Global Information Technology Reports.

Weaknesses of quantitative indicators necessitate the use of qualitative methods to complement quantitative data to capture non-quantifiable characteristics such as decision making powers, authority, and the underlying motivation of individuals in using one technology or the other. Experience to date suggests that a decision should be made as to the level of the analysis (micro, meso or macro levels) and combine quantitative and qualitative analysis in most appropriate ways. Insights from relevant fields (e.g. economics, political science, sociology) should be integrated into the analysis and different levels of analysis may be invoked as deemed appropriate.

Considering the paucity of recent data on the ICTs, it is advisable to carry out systematic collection of data on the ICT sector and its growth, explore possibilities of improving on ICT indicators and indices and draw experiences and studies in other countries.

Where appropriate indicators such as those developed by the World Economic Forum and the International Telecommunications Union should be used.

Analysis of policies, policy process and performance requires first hand data on institutional contexts, political configuration and power relationships and incentives as well as access and usage data to review which policy lead to what level of ICT diffusion. This strand of research needs to draw from quantitative and qualitative information including national and cross-country data on democracy and governance (political freedom, participation of civil society, political volatility), access to communication services and the quality of policy and regulation. Subjective data are also important particularly on perception of stakeholders on policy and regulation and how this can be improved.

Where qualitative methods are adopted researchers are expected to carry qualitative surveys and mapping of qualitative aspects such as policy making, regulation, power relationships, governance and social exclusion and inclusion using insights from other fields such as political science. Surveys can be used to collect quantitative data while case studies can be used to collect more in-depth qualitative insights into specific sectors or enterprises.

Micro-level studies are required at the level of the household or enterprise level and these should to the extent possible adopt impact assessment methodologies that

would allow for the identification of the contribution made by a specific intervention and take account of the importance of identifying the direction of causality. Such methodologies may adopt quantitative or qualitative approaches, and often may include some form of randomised intervention that affects the usage or access to a pre-identified intervention. By collecting information on the control, or counterfactual group, and often by collecting information on initial versus post-intervention conditions, impact assessments can improve understanding of positive and negative impacts that can be directly attributed to an intervention. Even when an experimental approach is not followed, the structured research design adopted by impact assessments can be used to guide a less rigorous assessment of the costs and benefits of a development intervention. Developing appropriate policy for both the private and public sectors, and understanding the impact of policy and how intervention actually takes place are thus important research questions for ICT usages in the economy.

When addressing the impact of ICTs two considerations should be made. First, there may be a substantial time lag between ICT investments and their payoffs. Second, ICT is only one of the several factors that contribute to improved firm performance.

Local, regional, and global policies influence the conduct and performance of firms. A framework linking these factors and the performance of firms would be preferred. In addition to internal factors influencing firm performance, account should be taken of determining external factors such as entrepreneurship, infrastructure, competitive environment, human resources, market preferences and cost of communication. These factors are also influenced by the global and regional infrastructure as well as the e-business technological profile., trends in FDI in telecommunications, privatization, convergence in communication technologies and R&D incentives and capital markets.

The impact of ICTs on specific sectors can be addressed. Taking into account the level of investment in ICT that can optimize impact in the specific sector, the role of public investments to ensure optimum application of ICT in the sector for purposes of transformation and how various key actors in the sector may be affected and the distributional implications of the use of ICT.

Within a specific sector indepth studies should be undertaken that examine the use, costs and benefits of ICT at the micro level (level of households, communities and enterprises). These studies need to be able to distinguish the direction of causality (do ICT improve economic well-being, or does economic well-being result in increased ICT usage) as well as the distribution of usage patterns, costs and benefits within the unit being examined.

In undertaking sector level studies, both the quantitative analysis and the case studies could be approached by specifying common building blocks of the sectoral system of innovation. A sectoral Innovation System (SIS) has its own knowledge base and learning processes, it has specific technologies, systems boundaries, institutions and interactive activities.

The basic elements of the SIS are:

- **Actors or agents:** include individuals and organizations. Individuals include enterprise owners, and engineers/ scientists; while organizations include enterprises universities and firms, R&D departments, financial institutions such as development banks.
- **Knowledge and Learning Processes:** Organizations and individual capabilities differ in their scientific and technological skills and experiences. The research should therefore carefully examine the different knowledge bases and the processes of learning.

The sector level studies are expected to cover sector timeline and evolution, sector mapping and sector innovation policies.

- Sector timeline and evolution would address questions like what is the nature and dynamics of the sector? Who are the main players? What has been the performance of the sector to date? What challenges does the sector face? How effective have policies and support structures been in triggering innovation and developing a dynamic innovation capacity?
- Sector mapping would cover issues such as Who are the main actors and organisations in the sector, what role do they play and what are their skills and competencies? Which actors and competencies are missing and how can they be promoted? What is the role of policy in influencing the position and effectiveness of various actors? What is the extent of linkage between actors and organisations, what is the nature of these links and does it support interaction and learning? Which links are missing and what types of linkage need to be encouraged?
- Innovation policies would address the role of policies in strengthening learning, investment and linkages that constitutes the bases for

dynamic innovative change on a continuous basis. Research would map policies that directly or indirectly affect technological capacity building, learning, linkages and investment within the computer system of innovation. These might include:

It is important to define the needs at various levels and explore what ICT can do to meet those needs. At the national level for instance, it is important to define the national development objective and strategy as a basis for posing the question of use of ICT for realizing the national objectives. In the context of Africa, concern over growth and poverty reduction would have to be addressed along with concerns over the transformation of the African economy towards a more dynamic economy which can better cope with the global competitive environment.

Applying quantitative and qualitative analysis is possible in specific areas of ICT itself or in any of the requisite infrastructures. The framework papers have gone into further details regarding specific aspects of ICT. For instance, in the area of human resource development for the ICT development Nissanke has pointed out that relevant information will need to be gathered, synthesised and evaluated. The information will be gathered from government, the academia and the industry with emphasis on collection of human capital information on tertiary education and other forms of specialised education and to a limited extent on secondary education. It is recommended that information be collected on the quantitative indicators as well as qualitative indicators. The collected information is to be synthesised and evaluated based on clusters that can signify key attributes such as quantity and quality of desired categories of human resources, quality of the environment for professional development and related infrastructure. This approach can be adopted with appropriate modifications to different sectors and country contexts.

4.0 CONCLUDING REMARKS

The review of methodology has shown that both quantitative and qualitative approaches to the impact of ICTs on economic development and transformation may be adopted in the analysis. The challenge is in adopting the methodologies to specific contexts with appropriate adaptations. In any case, the assessment of the impact of ICT on economic development and transformation should take into consideration the continuous interaction between technical and socioeconomic processes. The respective roles of various stakeholders should be considered allowing for some of these institutions to arise spontaneously from social and market circumstances and others to be deliberately created by government.

The impact of ICTs on development and economic transformation can be mediated through several channels including its impact on the ways and the speed of acquiring information and knowledge (impact on education and learning) across societies and sectors; its impact on production and the way the production process is organized whereby the technology impacts on the organization of the work place resulting in productivity impact and the consequent impact on wealth creation by transforming traditional production systems as well as creating new production regimes; and its impact on networking with its consequences on the way business and research is carried out.

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