

INFORMATION AND COMMUNICATION TECHNOLOGY, CLIMATE CHANGE AND POVERTY THE INTERTWINED FACTORS IN THE CHANGING DEVELOPMENT PLATFORM: A BANGLADESH PERSPECTIVE

Abureza Mohammad Muzareba¹
Dr. Masudur Rahman²

***Abstract:** The pervasive nature of Information and communication Technology (ICT) is now not only well-known to every individual but also well accepted by most people around the world- inseparable from business, economy, society, politics, lifestyle, and of course climate change and its impacts. Interdisciplinary researches have also found profound relationship between development effectiveness and the existence of ICT tools among common people. Though aggressive usage of technology is one strong reason for climate change and its resulting impacts, ICT is now being treated as a convenient solution to enable even every individual to fight against and to assist coping with the climatic changes. However the impact of climatic changes on poverty situation is not at all a new area of research but researchers still have to go a long way to properly grasp the interplay among the ICT, climate change and poverty situation. It is thus evident that the today's development platform is intimately related to the ICT interventions and climatic changes. In this paper authors tried to explore how this interplay is addressed by both the researchers and the implementers. While exploring this in the global settings, special attention is given toward Bangladesh.*

***Keywords:** ICT, Climate Change, Poverty, Bangladesh, Development.*

INTRODUCTION

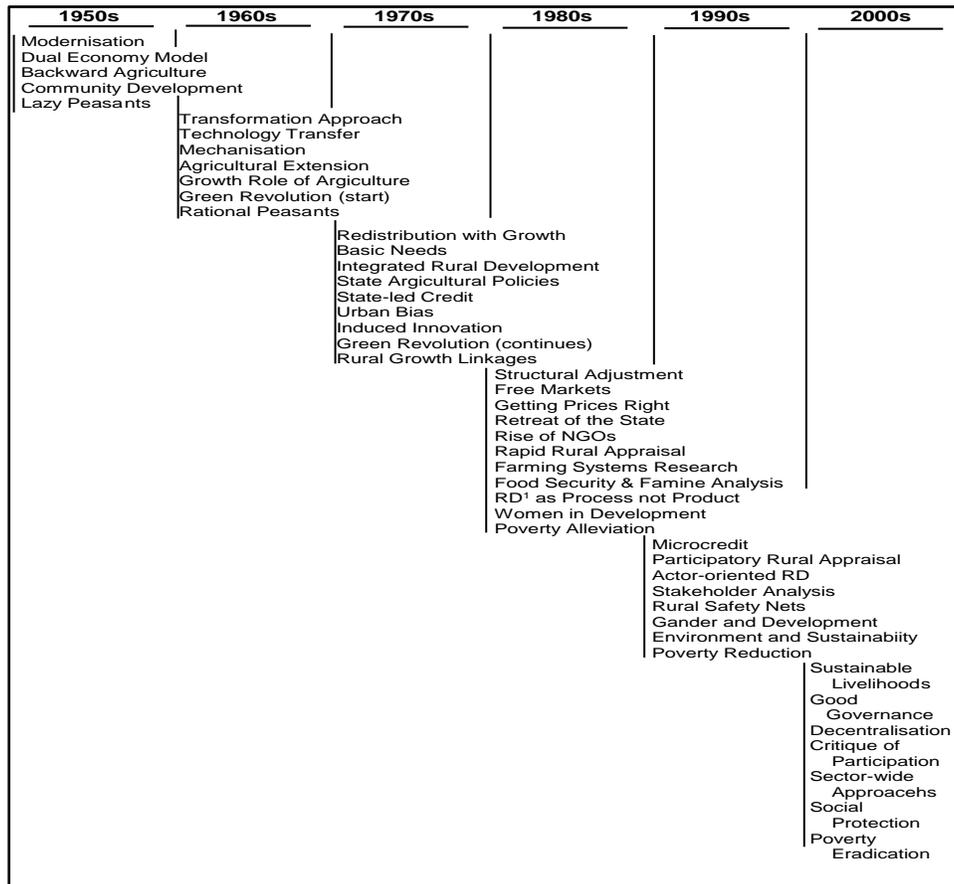
Since 1950s, there have been several changes in the development themes and the changes are continuing with the aim of sustainability and adaptation. Although development is a wide concept, in this paper, we will narrow it down to rural development. In 1950s, this type of development promoted modernization and community development. During 1960s, technology transfer and mechanization became prominent changes. The theme of innovation and integrated approach evolved during the 1970s. However, poverty alleviation, women in development and emergence of the NGOs came into light during 1980s. The said to be popular microcredit and gender issues in development emerged during 1990s. During this period, the complex theme of poverty alleviation got settled into poverty reduction. Nevertheless, during the following decade the concept got refixed into

¹ Lecturer, Department of Marketing, University of Dhaka, Bangladesh.

² Professor, Department of Marketing, University of Dhaka, Bangladesh.

poverty eradication. Sustainable livelihood became another popular theme to promote. Figure 1 specifically presents all these shifts in the rural development themes. Although technology and technology transfer have been considered but giving devoted attention to ICT (Information and Communication Technology), a subset of technology, might result more effective outcomes in development initiatives in the current development platform submerged in innovative diversified ICT interventions with significant socio-economic implications. Although environment and sustainability have been development concerns since 1990s, but now is the time to consider ICT, climate change, and poverty reduction in an integrated manner to find out innovative solutions to address development related issues for the people most of whom are intimately connected or familiar with different ICT tools.

Figure 1: Shifts in Development Focuses during 1950s-2000s



Source: Ellis and Biggs (2001:439)

¹ RD = Rural Development

ICT and climate change are two recent burning topics as globally people of all ages are either the beneficiaries or the victims of their impacts. ICT is defined as electronic networks comprising complex hardware and software that are linked by different technical protocols (Mansell and Silverstone, 1996). According to United Nations Economic Commission for Africa ICTs cover internet service provision, telecommunications equipment and services, information technology equipment and services, media and broadcasting, libraries and documentation centers, commercial information providers, network-based information services, and other related information and communication activities (Adeya, 2002). The famous researcher in this field, Heeks (1999), stated that ICTs are electronic means of capturing, processing, storing, and communicating information. Climate entails the statistics of temperature, humidity, atmospheric pressure and particle count, wind, rainfall, and other meteorological elemental measurements in a given region over long time periods. The five components of climate system - atmosphere, hydrosphere, cryosphere, land surface, and biosphere define the climate of a region (IPCC, 2007). However, climate change can be defined as a significant and enduring change in the statistical properties of the climate system over time periods ranging from decades to millions of years (Houghton et al., 2001). Sometimes the term climate change is used to imply the changes caused by human activities though changes in climate is a part of the natural processes of the earth (UN, 1994). Scientific point of view does not constrain climate change only within global warming, rather it links the term with other greenhouse gas increasing issues as well (NASA, 2011). Nevertheless, climate change today is synonymous with anthropogenic global warming.

Poverty is another highly discussed issue in any developing country but poverty and ICT are rarely discussed together. There exists different concepts of poverty as well as diverse approaches to its measurement. Conceptually poverty can be viewed in absolute and relative terms; while it can be approached from either objective or subjective perspective (Lok-Dessallien, 1999). Absolute poverty refers to survival below the minimum and socially acceptable living conditions whereas relative poverty compares the lowest bracket with the upper bracket of a population (Adeya, 2002). Most development practitioners emphasize on reducing absolute poverty due to the urgency associated with starvation, malnutrition and other adversities. However, United Nations Development Program (UNDP) stated that poverty is not merely in the impoverished state in which a person actually lives, but also in lack of real opportunity– due to social constraints as well as personal circumstances to lead valuable lives (UNDP, 1997).

LITERATURE REVIEW

Climate change involves several dynamic and interconnected disciplines but most of the time the consequence is vulnerability. Generally developing countries face challenges in livelihoods and finance, socio-political conditions, health,

habitat and migrations, food security and water. These challenges are intensified by the adverse impacts of climate change and related issues (Hardy, 2003; IPCC, 2007; Parry et al., 2007) that constrain resilience power i.e. the ability to withstand, recover, and adapt in the ever changing climate situations. Though climate changes are uncertain and unpredictable but current situation implies that vulnerabilities will increase in both magnitude and frequency that may threaten the development challenges (IPCC, 2007; UNDP, 2007).

Generally climatic hazards take place in a geographically limited area and these include rainstorms or cyclones causing landslides, flood, disruption of transportation systems, and erosion of agricultural land. Climatic changes are evident in rising sea level, melting glaciers, and changing oceanic acidity (Cannon, 2010). These changes have the largest and the most significant impacts mainly in low-income, resource constrained countries. However, although some of these countries have started using innovative ICT systems (UNCTAD, 2009; ITU, 2010) to fight against the negative impacts of climate changes most of the existing literature on ICTs, climate change and development reveal that the potential of ICTs has not yet been integrated appropriately with adaptation and resilience. Ospina and Heeks (2010) opined that even in contexts that are vulnerable to climate changes, ICTs have the potentials to strengthen resilience to contribute to adaptation. They advocated availing e-resilience and e-adaptation while explaining how ICTs can be of unparalleled assistance to all livelihood system components at different levels. They also asserted that integrating ICTs may create some problems like (a) further empowerment of privileged groups resulted by the reinforcement of social, economic and power divisions that are created by digital divide, (b) spread of unreliable or irrelevant or non-contextual information, (c) threat of deskilling, (d) increased severity as vulnerabilities are not properly addressed, (e) reinforcement or even increase of existing inequalities as gender inequality and other imbalances and power relationships in a community are not considered properly, and (f) mismatch in appropriate ICT choices, as ICTs that are appropriate for individual adaptation might not be suitable for community or national or international level.

Wresch (1996) analyzed poverty in the context of ICT and found significant differences between absolute and relative poverty. He argued that for the poor as opposed to the rich, information and communication costs more in absolute terms, and 'astronomically' more in relative terms, as a percentage of a day's wages (Adeya, 2002). According to Chowdhury (2000) some ICT related causes of poverty are lack of 'info-telecommunication' infrastructure and appropriate skills. d'Orville (2000) claimed that information poverty is a new type of poverty and developing countries are struggling to manage the infrastructure, skills and other requisites to mitigate this new poverty. According to World Development Report 2000/01 there are three priority areas that need to be attacked for poverty reduction: increasing opportunity, enhancing empowerment, and improving security (Cecchinia and Scottb, 2003). ICT can be of great help to all these three

areas. Therefore, ICT is now considered as an important factor to minimize poverty. In the spirit of formulating effective poverty reduction measures information and knowledge are treated as critical components of poverty reduction strategies (Harris, 2002). As ICT offers easy access to information useful for the poor (Harris, 2002), it can be treated as one of the elements that influences poverty and poverty reduction endeavors either directly or indirectly.

Much debate is going on whether developed countries have been playing proper roles or not but the victim countries should now adopt some medium or small scale local adaptation and mitigation measures to facilitate a synergistic positive impact to reduce the vulnerability due to climate change. Wasting time by waiting for compensation might in the long run bring the aid but this for sure will magnify the distress particularly for the poor people in the victim countries. Therefore, appropriate adaptation and/or mitigation strategies should be made for the poor people of Bangladesh so that they may develop the capacity to fight against the climatic impacts and help build a low carbon economy. One important issue should be noted here that lack of climate change-specificity in ICT initiatives is the nature not a flaw of the approach and hence generic ICT for development initiatives, though might not be climate change-specific, can address climate change issues successfully and can also develop adaptive capacity among stakeholders (Pant and Heeks, 2011).

Sustainable development for any country requires addressing the three aspects - economic, environment, and social, in an integrated manner (MacLean, 2008). A critical element of environment, the climate change, is a cross-cutting issue that might be treated as a driver of economic and social change. ICT can help us improve the environmental performance and address climate change across the economy. Three main areas – power generation and distribution, buildings, and transportation; that contribute most of the greenhouse gases (GHG) gained significant improvement from the innovative ICT solutions (OECD, 2011). ICT solutions are also used in other areas like water management, biodiversity protection and pollution reduction. Unfortunately ICT solutions of those three main areas are difficult to implement in most of the developing countries. However, ICT may intervene with its potential through the benefits of dematerialization and enhancement of efficiency that can benefit the poor countries. Emerging technologies like radio frequency identification (OECD, 2008) and mobile technology (Beurer-Zuellig and Meckel, 2008) have been playing significant roles in increasing the global Gross Domestic Product (GDP) (The Climate Group, 2008) but the increasing environmental impacts of the production, use and disposal of IT have also been cruxes even for the developed countries (Elliot and Binney, 2008). Obsolescence of electronic goods at an increased rate has been contaminating the environment (Herat, 2007)). Use of fossil fuel to meet the increasing demand of power in the ICT sector has been another reason for the increased GHG in the atmosphere (Katzer et al., 2007 and The Climate Group, 2008). However, ICT has also been driving innovation and

thus been working as a potential source of solutions to improving environmental performance (Ghose et al., 2008) although according to International Institute for Sustainable Development (IISD), policy makers have underestimated the impact of ICT on sustainable development (MacLean, 2008).

The greatest positive impact that ICT might incur by 2020 is to increase energy efficiency in some industrial processes that are high GHG emitter. Reduction in GHG emission through dematerialization is small but contribution of ICT in increasing efficiency in industrial processes altogether could reduce total GHG emissions by as much as five times the emissions of the ICT sector itself (OECD, 2009). However, shorter product life accompanied by the inception of newer technologies has become a serious concern due to evidence like – production of a personal computer generates 130 kilograms of GHGs (Berkhout and Hertin, 2001). These simple mathematics might not be of strong relevance with the poor people in developing countries as they have been struggling with inadequate penetration of broadband internet along with lack of infrastructure; dearth of digital content in local language; and required education and skills (Kalas and Finlay, 2009).

The increasing pace of adoption of ICT is fighting incessantly against digital divide. Global trends in business and society are cooperating with this ICT diffusion and adoption but at the same time the chronic issue of poverty has consistently been restraining a significant chunk of people in poor and developing countries from benefiting themselves from the ICT utilization. However, the consistent downward trend in the technology product prices, as per Moore's Law, has been enabling many people avail the blessings of ICT. This trend may cease the uneven situation where most of the industrialized developed countries are producing the majority of the GHGs causing the climatic changes but are enjoying the privilege of adopting expensive ICT solutions to minimize the environmental impacts. This might lead to rebound effect leaving the poor countries with distress of ever increasing adverse climatic shocks. ICT innovations are effective even in the current economic crisis but these should be utilized in a globally synergistic manner. Developing or poor countries should be a part of the process but in an adaptive manner that suits the socio-economic aspects of the country and the countrymen as well. Karanasios (2011) identified three major areas where ICT applications might assist developing countries face the challenges imposed by climate change. The areas are monitoring of climate change and environment, disaster management, and climate change adaptation.

The impacts of ICT interventions may benefit the poor countries in the long run in areas like promoting a knowledge-based society, improving the education situation, reducing the birth rate and others that are significant for promoting sustainable development (Kalas and Finlay, 2009). Although it might be difficult for the poor people to avail mitigation through adopting production and use of energy and carbon dioxide efficient technologies but they may avail other options. Innovative application of emerging technologies like video conferencing

and VoIP along with efficient waste management and recycling might be the immediate affordable options for the people of the developing countries. However, some may argue that adaptation rather than mitigation might be a better option for the poor people in a developing country to reduce risk and vulnerability, and to increase strategic adjustments at local settings (Kalas and Finlay, 2009). MacLean (2008) explained how adaptation issues at international, national, and local levels are linked with ICTs. It was demonstrated that national level adaptation issues like economic diversification, infrastructural development, and security and inclusion of people might be linked with ICTs through the development of broadband networks, intelligent infrastructure, and e-government and e-services. However, at local level the adaptation issues were found to be social adaptation, and preservation and application of traditional knowledge that are linked with ICTs through affordable access to ICT networks and knowledge resources, and local contents. Both international and national policy and coordination are prerequisite to establish the ‘networked governance’ to effectively link the ICTs to the adaptation issues. In addition to these, Finlay (2011) advised for the involvements of civil society organizations at several levels of climate change responses like advocacy, information dissemination, assistance towards the local communities to adapt, and providing voice for the affected people. These multifold involvements might be facilitated by the community-based approach in a country setting where non-government organizations (NGO) have familiarized this approach decades ago. Sala (2010) also opined that to foster resilience at community level for climate change, participation of professionals from different sectors and institutions are a challenging requirement.

OBJECTIVES

This paper aims at exploring the relationships and interplay among ICT, climate change and poverty. In the spirit of reaching this aim authors set the following specific objectives.

1. To explore how ICT, climate change and poverty are related and how this interplay is addressed.
2. To identify the necessary initiatives in Bangladesh.
3. To recommend some success factors in gaining development opportunities for Bangladesh from this emerging interdisciplinary coherence.

METHODOLOGY

This paper is developed following qualitative research approach. This is a very new area of research in Bangladesh. Dearth of quality data on Bangladesh and complexity of the correlation among data and meta data regarding ICT, climate change and poverty issues motivated authors to undertake a qualitative approach instead of a quantitative one. If qualitative research is conducted prior to

conducting quantitative research then appropriate results can be achieved. This is because quantitative reasoning and explanations stand on the epistemology that becomes understandable after qualitative analysis. Hence considering all these factors choosing qualitative approach is justified for this paper.

Authors used desk based research methodology to develop this paper. Data were collected from existing literature on the relevant issues, authentic web sources, books, journals, conference proceedings, seminar papers, globally recognized newspapers and news sources, and authors' observations. After synthesizing secondary data, information were derived to identify the linkages among ICT, climate change, poverty and development issues. An analysis was also performed to figure out the changes in focuses in development initiatives during several decades. These shifts in focuses in development themes reinforced the concept of integrated focus where ICT, climate change and poverty interplay can create significant development impacts. After exploring relevant theories and analyzing the linkages, the scenario of Bangladesh is presented. This is followed by brief mentioning of some exemplary initiatives in Bangladesh undertaken by Government of Bangladesh (GoB), donor agencies and other non-government institutions. Comparison between these exemplary initiatives and the theoretical analysis built the ground of critical success factors that Bangladesh needs to address to harvest development benefits from the interplay among ICT, climate change and poverty.

BANGLADESH SCENARIO

The impact of climate change on Bangladesh is readily apparent as all the major reasons for climate change have directly and indirectly been causing multifold negative impacts. More than 174 natural disasters affected Bangladesh from 1974 to 2003 (Sapir et al., 2004). Natural disasters like floods, droughts, and cyclones directly and indirectly affect life and livelihood of people of this country almost every year. Along with those extreme events, sea level rise, salinity, temperature and rainfall variations are other severe climatic issues that have been considered as serious concerns for this country because of their adverse impacts over implementation of development initiatives and development as a whole.

The poor people of Bangladesh are unfortunately the worst victims though they are taking part in the least extent in leaving carbon footprint. Though the donors and the developed countries are moving forward to assist these poor people but given the reality of our global economic recession and lack of commitment, the stated assistances are yet to be there in reality. Therefore, it is time that the affected developing countries themselves should take measures to a possible extent to minimize the impacts of climate change and to adapt with the situation. Increasing urbanization and adoption of technologies requiring fuel are the scopes where these poor people can compromise and make changes. However, to materialize this, assistances from the donors and the developed countries are

often a prerequisite though the local governments should also come forward with policy inputs and reinforcement initiatives.

A collaborative interdisciplinary assessment by the Ford Foundation and British Overseas Development Administration identified multidimensional climatic issues affecting the poor people of Bangladesh. The assessment declared that - GHG effects; sea-level changes in the Bay of Bengal; effects of climate and sea-level changes on the natural resources; critical socio-economic implications; and legal implications of global climate change are serious concern for the people of Bangladesh. The evident negative impacts are recurring flood; erosion of river bank; cyclones; salination of soil; and others. Socio-economic impacts are revealed through climate-society interactions; population and settlement; migration and employment; vulnerability; health care and education; water and vector-borne diseases; and knowledge gaps (Ericksen et al., 1997). The resultant economic distress in the rural areas has been causing large-scale urban migration and complex urban poverty that is inadequately addressed by government or even NGOs. Existing institutional approaches are even in the initial phase where the initiatives are limited only in non-enforceable guidelines (Molla, 2009). Hence, a well-defined institutional framework along with appropriate supporting organizational processes is required to supplement governmental and donor agency initiatives to integrate efforts to fight against this critical global crisis in a local context (Cundale, 2008).

INSTITUTIONAL INITIATIVES IN BANGLADESH

Most of the policies in Bangladesh are developed from a sectoral perspective that appear difficult to be considered when a cross-sectoral issue is to be considered. The Environment Policy of Bangladesh was formulated in 1992 covering almost 15 sectors, including agriculture, industry, energy, health, and land but lacking appropriate involvement of ICT. GoB has formulated two important policies so far regarding climate change and these are the National Adaptation Program of Action (NAPA) and the Bangladesh Climate Change Strategy and Action Plan (BCCSAP) in 2009 and 2010 respectively. BCCSAP addressed climate change issues and their impacts on society, the economy, and ecosystems. It considered diversified areas such as food security, agriculture, disaster management, and most importantly ICTs. However, such existence of policy frameworks do not necessarily imply real time initiatives in effect. As an instance, GoB has created climate change fund but it has received almost no significant project proposal related to ICTs and environment sustainability (AIT-UNEP, 2010). The only significant initiative is the Comprehensive Disaster Management Program (CDMP) that uses mobile phone-based early warning and forecasting services targeting the people living in natural disaster prone areas.

GoB has taken several initiatives through different projects to offer different types of services aiming higher efficiency, and improved transparency and accountability. Another implied motivation behind this digitalization in services

offering is reduction in corruption. The underserved and hard to reach population will be benefitted if this digital conversion of providing services can be maintained in a sustainable manner. Go Bendeavors to ensure availability of information to common people and to different agencies of it. The following eight strategic priorities aiming reduced environmental vulnerability were determined by GoB (A2I, 2010):

Remote Sensing and Forecasting: A geostationary satellite will be installed to ensure constant monitoring of weather patterns to forecast climatic events. Establishment of an automated weather station is also included in the plan.

Early Warning and Disaster Recovery: Mobile communication will be utilized to promote location based services with the help of ICT tools like mobile phone, VHV/UHF radio, and broadcast radio.

Satellite Based Network: Global Positioning System (GPS) technology will be incorporated into radio frequency receiving sets to disseminate hazard warnings to the people of affected areas.

GIS Based Modeling: Geographical Information System (GIS) is being utilized to develop a system that can predict medium term river erosion with a month length lead time so that target population can be removed safely before the hazard takes place.

Green ICT: GoB is planning to arrange green ICT related education, training and skill development to develop environmental skills at all levels in all industries. It aims to reduce commuting and travelling through tele-working and videoconferencing. It is also planning to take initiatives to minimize ICT-related disposal through reduce, reuse and recycle policies.

Leverage Community Radio: GoB has already granted license to 15 organizations to operate community radio to broadcast disaster warning that can benefit not only the people of affected areas but also the fishermen at work in sea or rivers.

Preparedness and Awareness: Community radios, national television channels, and radio channels will be used to create awareness among the communities.

Monitoring and Post Disaster Recovery: Aerial photography will be used for making prompt post disaster assessments of the impact of disasters to facilitate timely planning of recovery efforts.

Apart from the GoB and its agencies, several non-government and private initiatives from institutions like Centre for Policy Dialogue (CPD), Bangladesh Institute of ICT in Development (BIID) in association with several research firms and corporate houses have been maneuvering strategic involvement of ICTs in climate change adaptation and mitigation and in development at large with implications for poverty reduction. Among the development partners UNDP, United Nations Environment Program (UNEP), World Bank (WB), Asian Development Bank (ADB) and others also have been shouldering the

development initiatives in this interdisciplinary emerging area. One such initiative that could have been quite effective is the Poverty Environment Initiative (PEI) managed by both UNDP and UNEP. PEI supports country-led efforts specially in areas like poverty-environment linkages into national development planning. It provides financial and technical assistance in setting up institutional and capacity building programs in poverty-environment context. As poverty, climate change and ICT issues are critical for Bangladesh, to achieve Millennium Development Goals (MDG), PEI and similar initiatives are vital for effective changes from development endeavors that can benefit the poor in a gender balanced way. These donor initiatives influenced appropriate consideration for similar interdisciplinary approaches and this was materialized through relevant planning initiatives in the Poverty Reduction Strategy Paper (PRSP). Although the GoB has got back to its Five Year Plan (FYP) approach but it should weigh those priorities in the same manner if it wants to achieve sustainable development.

RECOMMENDATIONS

The following critical success factors need to be addressed carefully to harvest from the multifold impacts ICT have been creating that entangle outcomes of development initiatives.

1. Bangladesh abounds cheaper technically skilled human resources who are not properly utilized. These skilled human resources should be the best choice to develop adaptive ICT systems. As learning fatigue is a serious concern in technology adoption specially in case of people who are technologically challenged, the ICT systems should be designed accordingly. It should be remembered that sustainable ICT solution is more important than cutting edge ICT solutions.
2. Local people should be properly incorporated while designing such ICT systems to gain twofold benefits – the system will interact the way the users of the system are capable of interacting with it, and precious indigenous knowledge can be converted into ICT system.
3. Three issues should be considered properly – regional knowledge sharing system, generation of new knowledge, and application of existing and new knowledge.
4. ICT itself is a contributor in carbon footprint and hence quality and number of devices are critical to the positive impacts of the ICT tools. A community based approach can be a good option to reduce the number of device to be used by the ICT system users.
5. Mobile phone has stronger market penetration potential but radio has even better prospect in terms of both information richness and information reach. Besides these, radio as a medium is culturally more acceptable among the common people living in the rural areas of Bangladesh. Mobile phone driven

approaches like broadcast short messaging service (SMS) have higher reach but most of the times have limited impacts.

6. ICT systems should be designed in a way that the users can operate and maintain with least technical support from experts. This is a major success factor for developing a sustainable ICT system to combat climate change and its impacts along with adaptation measures. Poverty reduction can become a consequence of an effective ICT system.

CONCLUSION

Bangladesh needs to go a long way to successfully integrate its initiatives in ICT, climate change and poverty, if it wants to achieve sustainable development in this ever-changing development platform. Although some people claim that significant development in infrastructure and human resource can only ensure effective gain from ICT, climate change and poverty interplay but it is also true that the existing infrastructure and human skills are under-utilized. Therefore, if an adaptive and sustainable technology framework can be developed from the existing infrastructure by efficiently utilizing the existing human resources then we can leapfrog the investment intensive infrastructural development requirement in this sour economy.

REFERENCES

- A2I (2010). "Strategic Priorities of Digital Bangladesh", Access to Information (A2I) Program, Prime Minister's Office, Government of Bangladesh.
- Adeya, C. N. (2002), "ICTs and Poverty a Literature Review", Acacia Initiative of IDRC.
- AIT-UNEP, (2010). "Scoping Assessment on Climate Change Adaptation in Bangladesh", AIT-UNEP Regional Resource Centre for Asia and the Pacific, Thailand.
- Angelica, V. O. and Heeks, R. (2010). "A Conceptual Framework for e-Resilience and e-Adaptation", Centre for Development Informatics, IDPM, SED, University of Manchester, UK.
- Berkhout, F. and Hertin, J. (2001). "Impacts of Information and Communication Technologies on Environmental Sustainability: Speculations and Evidence".
- Beurer-Zuellig, B. and Meckel, M. (2008). "Smartphones Enabling Mobile Collaboration", 41st Annual Hawaii International Conference on System Sciences.
- Cannon, T. (2010). "Adapting to Climate Change: Applying Concepts in Practice", Climate Change, Disasters and Urban Poverty, SED, University of Manchester, UK.
- Cecchinia, S. and Scottb, C. (2003). "Can Information and Communications Technology Applications Contribute to Poverty Reduction? Lessons from Rural India", *Information Technology for Development*, Vol. 10, pp.73-84, IOS Press.
- Chowdhury, N. (2000). "Poverty Alleviation and Information/Communications Technologies". Towards a Motif for the United Nations ICT Task Force Web link: <http://www.eb2000.org/short_note_19.htm>.

- Cundale, K. D. (2008). "Climate Change in Bangladesh, Technical Appraisal of the Institutional Implications and Considerations", OPAL Consulting Pte Ltd.
- d'Orville, H. (2000). "Information and Communications Technologies- a Rapidly Emerging Dimension of Development Co-operation", UNDP. Web link: <http://www.oneworld.org/media/net/undp_ICT.htm> and <<http://www.undp.org/info21/program/index.html>>
- Elliot, S. and Binney, D. (2008). "Environmentally Sustainable ICT: Developing Corporate Capabilities and an Industry-relevant IS Research Agenda", Pacific Asia Conference on Information Systems, Suzhou, China.
- Ellis, F. and Biggs, S. (2001). "Evolving Themes in Rural Development 1950s -2000s", *Development Policy Review*, Blackwell Publishers, UK, Vol. 19, No. 4, pp.437-448.
- Ericksen, N. J., Ahmad, Q. K. and Chowdhury, A. R. (1997). "*Socio-Economic Implications of Climate Change for Bangladesh*", Bangladesh Unnayan Parishad, Dhaka, Bangladesh.
- FAO (2009). "Advancing Adaptation through Communication for Development", Third International Workshop on Community-Based Adaptation to Climate Change, Communication for Sustainable Development Initiative (CSDI).
- Finlay, A. (2011). "*Climate Change as a Strategic Priority for ICT4D Organizations: Current Attitudes, Responses and Needs*", South Africa.
- Ghose, A., Hasan, H. and Spedding, T. (2008). "Carbon-centric Computing: IT Solutions for Climate Change", University of Wollongong Working Group on the Carbon-Centric Computing Initiative, Visit: <www.uow.edu.au> [Accessed on 15 October 2014].
- Hardy, J. T. (2003). *Climate Change: Causes, Effects and Solutions*, Chichester.
- Harris, R. (2002). "A Framework for Poverty Alleviation with ICTs", Roger Harris Associates, Hong Kong, p.1.
- Heeks, R. (1999). "Information and Communication Technologies, Poverty and Development", IDPM Development Informatics, Working Paper # 5, University of Manchester, Visit: <<http://www.sed.manchester.ac.uk>> [Accessed on 23 August 2013].
- Herat, S. (2007). "Sustainable Management of Electronic Waste (e-Waste)", *CLEAN-Soil, Air, Water*, Vol. 35, No. 4, Wiley Online Library, Visit: <http://onlinelibrary.wiley.com/> [Accessed on 13 December 2013].
- Houghton, J. T., Ding, Y., Griggs, D. J., Noguer, M., Linden, P. J., Dai, X., Maskell, K. and Johnson, C. A. (2001). "*Climate Change 2001: The Scientific Basis*", Cambridge University Press, UK.
- IPCC (2007). "Forth Assessment Report (AR4): Intergovernmental Panel on Climate Change (IPCC)", Visit: <<http://www.ipcc.ch>> [Accessed on 3 November 2014].
- ITU (2010). "ITU Sees 5 Billion Mobile Subscriptions Globally in 2010: Strong Global Mobile Cellular Growth Predicted across all Regions and all Major Markets", ITU Press Release.
- Kalas, P. P. and Finlay, A. (2009). *Planting the Knowledge Seed Adapting to Climate Change using ICTs*.
- Karanasios, S. (2011). "New and Emergent ICTs and Climate Change in Developing Countries", AIM Tech Research Group, University of Leeds, UK.
- Katzer, et al. (2007). *The Future of Coal*, Massachusetts, USA.

- Lok-Dessallien, R. (1999). "Review of Poverty Concepts and Indicators", UNDP. Web link: <http://www.undp.org/poverty/publications/pov_red/Review_of_Poverty_Concepts.pdf>
- MacLean, D. (2008). *"ICTs, Adaptation to Climate Change, and Sustainable Development at the Edges"*, IISD, Canada.
- Mansell, R. and Silverstone, R. (1996), *"Communication by Design: The Politics of Information and Communication Technologies"*, Oxford.
- Molla, A. (2009). "The Reach and Richness of Green IT: A Principle Component Analysis", 20th Australasian Conference on Information Systems, Melbourne, Australia.
- NASA (2011). "What's in a Name? Global Warming vs. Climate Change". [Accessed on 23 July 2014].
- OECD (2008). "RFID Radio Frequency Identification, Committee for Information, Computer and Communications Policy, Directorate for Science, Technology and Industry", Visit: www.oecd.org, [Accessed on 7 October 2013].
- OECD (2009). "Measuring the Relationship between ICT and the Environment", OECD, Denmark.
- OECD (2011). "ICTs, The Environment and Climate Change", weblink: <<http://www.oecd.org>>. [Accessed on 2 November 2014].
- Ospina, A. V. and Heeks, R. (2010). *"Linking ICTs and Climate Change Adaptation: A Conceptual Framework for e-Resilience and e-Adaptation"*, Centre for Development Informatics, IDPM, SED, University of Manchester, UK.
- Pant, L. P. and Heeks, R. (2011). *"ICT-Enabled Development of Capacity for Climate Change Adaptation"*, Centre for Development Informatics, IDPM, SED, University of Manchester, UK.
- Parry, et al. (2007). *"Climate Change 2007: Impacts, Adaptation and Vulnerability"*, Cambridge, UK.
- Sala, S. (2010). *"The Role of Information and Communication Technologies for Community-Based Adaptation to Climate Change, Communication for Sustainable Development Initiatives (CSDI)"*, FAO, Rome, Italy.
- Sapir, D. G., Hargitt, D. and Hoyois, P. (2004). *"Thirty Years of Natural Disaster 1974-2003: The Numbers"*, Centre for Research on the Epidemiology of Disasters, University of Lovain Press, Belgium.
- The Climate Group (2008). *"SMART 2020: Enabling the low carbon economy in the information age"*, GeSI.
- UN (1994). The United Nations Framework Convention on Climate Change.
- UNCTAD (2009). "Information Economy Report 2009: Trends and Outlook in Turbulent Times", UNCTAD, New York and Geneva Visit: <<http://www.unctad.org>> [Accessed on 18 December 2014].
- UNDP (1997). "Human Development Report", Oxford University Press, New York, USA, p. 15.
- UNDP (2007). *"Human Development Report 2007/2008: Fighting Climate Change"*, Human Solidarity in a Divided World, UNDP, New York, Visit: <http://www.preventionweb.net> [Accessed on 23 January 2014].
- Wresch, W. (1996). *"Disconnected: Haves and Have-nots in the Information Age"*, New Brunswick: Rutgers University Press.