ISSN 2307 - 0099

Volume 2
Number 2
December 2012

ICT for DEVELOPMENT

Working Paper Series

Information Communication Technology

ICT for Development Working Paper Series

Spearheading ICT4D Knowledge

Volume 2 ***Number 2*** ***December 2012***

Publishers

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Volume 2 *Number 2* *December 2012*

TABLE OF CONTENTS

Addressing the Problem of Digital Exclusion

Welcome to the third issue of the Working Paper Series on ICTs for Development!

Last issue, the articles focused on groups at risk of digital exclusion. Marginalized sectors of society such as women, youth, aged, persons with disabilities, persons living in far flung areas, low income groups, low education groups, etc. have a difficult time accessing, understanding and utilizing ICTs to better their lives. In cognizance of the concerns raised in the previous, the articles in the present issue concentrated on exploring, finding and/or proposing solutions to address the problem of digital exclusion.

In the first paper "ICT, Economic Growth and Regional Inequality: A Case of Indian Federation," the author (Dukhabandhu Sahoo) found out that reforms in the telecommunication sector brought about a reduction in regional inequality across 15 Indian States. States with higher tele-density and proactive ICT policies grew faster than others. Due to this, he recommended the improvement of accessibility to telecommunication services through increasing spending on IT education and spreading IT infrastructure in remote areas. In discussing how to address geographical IT inequality, the next two articles illustrated how ICTs can be established, affect the lives and help persons living in far flung areas access and utilize ICTs.

In his contribution, "Union Information and Service Centre: ICT-enabled One-stop e-Service Outlet for the Rural Citizens of Bangladesh," Zaman studied the operations of e-Service Delivery Centers in Bangladesh's parishads (the lowest tier of local governments). He explained that the government engages two local entrepreneurs (one male and one female) to maintain these centers; thus enabling rural citizens to access cheaply public and private goods and services. The result is a win-win situation with the entrepreneurs earning monthly revenue of BDT 50 million (USD 625,000) while about 4.5 million citizens enjoying the service. In her contribution, "Mobile Phone and Social Communication Network Expansion," Widiastuti showed the link between social communication networks, use of mobile phones and seeking advice of opinion leaders among poor fisherman of the village of Indramayu in West Java. She discovered that fishermen possessed small, simple, limited and overlapping social communication networks. They likewise sought advice frequently from opinion leaders (who are generally polymorphic). Fishermen utilized mobile phones to contact network members and opinion leaders they have strong ties with. Mobile phone usage was hence classified as consumptive and not productive. The author concluded that mobile phones (given their present usage) did not carry out its potential as an equalizer in community development.

The next two papers rooted out the problem and searched for solutions to address the digital exclusion of marginalized groups such as women and children. In the essay, "Exploring the Social Exclusion of Women in the ICT Profession," Genilo presented global data relating to the under-representation of women in the ICT profession – whether at the entry level or managerial level. He then surveyed various literatures in an effort to explore the reasons ehind such under-representation. Using a life cycle perspective and guided by the social exclusion concept, he reported on the impediments women have in accessing/using ICT devices and services; selecting their fields of study at the secondary, vocational and tertiary levels; and working in ICT companies with cultures often described as macho and anti-women. In the exploratory study, "Applications of 3G Technology: A Study on Colleges and Universities in Dhaka City," Osmani asked the perceptions of college/university teachers and students regarding the potentials of using Third Generation (3G) services for educational development. Describing it as a giant leap for Bangladesh, the author explained that 3G may open new windows for mobile phone users with uninterrupted video streaming, enabling video calls and optimizing usage of data intensive applications.

In the last paper, "Potentials and Prospects of Innovative Electro-medical Technology Development in Bangladesh," the author (K Siddique-e Rabbani) dealt with the potential of Majority World citizens manufacturing their own equipment with the help of ICTs. Under the author's leadership, several healthcare technological products and methods have been developed and most are being used in hospitals, clinics and homes. These innovations ranged from simple muscle and nerve stimulators to sophisticated EMG and evoked EMG equipment. He assessed that there is a great potential for innovative electro-medical technology development in Bangladesh.

From these articles, we can get an idea of the range and complexity of development problems, particularly those affecting marginalized sectors of society. However, we also see the potential ICTs can play in providing solutions to the problems faced. In this regard, we understand the importance of doing more research and work to address the problem of digital exclusion.

On behalf of the entire editorial board,

Jude William Genilo

Editorial Advisor

Article

ICT, Economic Growth and Regional Inequality: A case of Indian Federation

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Abstract

The objective of this paper is to test the unconditional convergence (β and σ convergence, Barro and Sala-i-Martin, 1995) across 15 major Indian States from 1980-81 to 2010-11, and to explore the proximate reasons for the growing regional inequality. The present piece of work also carries out the convergence test (both β and σ convergence) in Information and Communication Technology or ICT. The result shows that tele-density has gone up significantly in India, especially in the underdeveloped regions. However, even after five and half decades of planning, regional inequality still is a major issue. In fact, the reform regime has seen more of this evil. But, the reforms in the telecommunication sector have had a positive contribution towards reducing regional inequalities, even though reforms in other sectors had negative impact on reducing regional inequalities. Given the structural differences across the states, some degree of inequality among the States is indispensable. This inequality depends on the factors like; availability of productive resources to the respective States, its optimal utilisation, transfer of resources from the rich States to the poorer ones, either through market forces or through policies of transfers and grants by the centre, and the policies of respective States to enrich their resources. On the other hand reforms in the telecommunication sector have raised the tele-density of the relatively poorer states than their richer counterparts. By using the Panel Co-integration technique, the present study concludes that, States, primarily endowed with qualitatively better human resources (human capital) and that have adopted an appropriate policy towards improving the quality of these recourses, have a better growth rate over their counterparts. Similarly, States having higher tele-density and a proactive ICT Policy grow faster than the others. However, the impact of a favourable ICT policy has a comparatively better impact on the growth (the long-run elasticity of human capital to growth is 0.65, whereas the same for tele- density is 0.78). Thus, State policies, particularly poorer ones suggest, improving the accessibility of the services of the telecommunication sector to all. This could be done by enhancing the quality of their telecommunication sector through the provision of better telecommunication infrastructure in remote areas. Additionally, the States need to improve the human resources by effectively raising their spending on education, especially on IT education and health so that the telecommunication infrastructure can be effectively and efficiently used towards the growth of an aspiring economy.

Keywords
ICT, Economic Growth, Convergence; Human Capital; Tele-density, Panel Co integration

1. Introduction

The classical doctrine lost its credibility with the Great Depression, and that thrust into the self- regulating forces of the market gave way to increasing scepticism. As a result, the role of market paved way to the role of government (and sometimes the combination of the two) to understand, explain and formulate the economic policies (Garvy, 1975). Given that modern government acts as an agent of welfare states, egalitarianism is never far from their agenda. Therefore, reducing inequality and poverty has become the major policy objective of many governments. Thus, an important issue the modern government has to address with the spirit of developing economics is identifying whether economies that initially were poor, subsequently grow faster in per capita income terms and converge with those that started out ahead. It is also observed that, income differentials are not only extremely large across countries, income differentials across regions of a given country can also be significant (Heshmati, 2006) and India being a union of different regions (28 States and seven Union Territories) can hardly be an exception. Inequality in any dimension gives rise to unequivocal negative effects on subsequent growth and development, and worsens economic, social, and political tension among regions leading to misallocation of resources (Chowdhury, 2003). Therefore, it is important to identify the sources of changes in productivity and growth in order to recommend appropriate policies for accelerating growth and achieving equity by raising the standards of living of people in different States (regions) in a federal set up like India.

India accounts for a meagre 2.4 per cent of the world's surface area, yet it sustains a whopping 16.7 per cent of the world's population, amounting to a little over one billion people residing in 28 States and seven UTs. The variation in physical geography, culture, and economic conditions across these states and territories is enormous. Some states have achieved rapid economic growth in recent years, whereas others have languished. However, in spite of five and half decades of development planning in India, aimed at reducing the income disparities among regions, inequality in income and growth across the regions has been rising over time. Further, in spite of considerable research undertaken on the subject, much more remains to be understood to explore the nature and causes of differences in growth rates in order to calibrate appropriate policies and institutions to achieve balanced regional growth by spreading the benefits of growth processes across different regions of India. Therefore, this paper seeks to explore the proximate policy variables of the States and centre that could explain the growth differentials across the Indian States.

Recent advancement in growth theoretic literature has effected an augmentation of Solow's growth model by providing an endogenous explanation of the sources of technological change. This new development, in turn, has transpired a stream

of research identifying endogenous sources of technological change attributable to faster growth across countries. The findings of these studies can be divided into three groups. The first group including Lucas (1988) and Romer (1990) has emphasised the stock of human capital as the most critical source of technological change. The second group, noteworthy among which are Aschauer (1989), Mowery and Rosenberg (1989),

Canning, Fay and Perotti (1994), Lichtenberg (1995), Sanchez-Robles (1998), and Canning and Bannathan (2002), has paid close attention to public infrastructure and argued in favour of its potential to impact economic growth by producing technological change1. Deviating slightly from the second group, the third group including Norton (1992), Roller and Waverman (1996, 2001), Cornin et al (1993) and Nadiri and Nandi (2003) has focused primarily on one component of infrastructure investment, namely investment in telecommunications infrastructure and its ability to generate significant gain in productivity growth. While complementing the results derived by the second group of studies referred above, summary conclusions of these studies add to the convergence hypothesis by suggesting that investment in telecommunications infrastructure, with its ability to create spillover effects through network externalities, can impact growth far more significantly than that in any other alternative infrastructure. Though limited to developed country perspective, the empirical findings offered in this last group of studies have raised hope that increased investment in telecommunications infrastructure, with its associated network externalities and spillover effects, may work wonder for developing countries in driving their efforts forward towards closing the developmental gap. No serious efforts, however, has been made in the literature to examine the importance of telecommunications infrastructure investment in the context of developing countries. It seems important to fill this gap.

A growing literature recognises the positive link between mainline tele-density and economic growth, mainly in the long run. Starting from Hardy (1980), numerous studies including Leff (1984), Norton (1992), Litchenberg (1995), Roller and Waverman (1996) and Datta and Agarwal (2004) contribute to this end by quantifying positive impact of telecommunications infrastructure on economic growth. It is implicit in all these studies that the positive link between the two referred variables is explained mainly by the phenomenon of network externalities associated with telecommunications infrastructure. While analysing online service competition, Kim et al (1997) provides explicit demonstration of this phenomenon by documenting relatively higher impact of telecommunications infrastructure on economic growth compared to that of other traditional infrastructure. Nadiri and Nandi (2001) extend the work of Kim et al further by analysing the impact of telecommunications infrastructure for all industry sectors in the US at their disaggregated levels. Roller and Waverman (2001) provide similar extension with cross country data from OECD countries. By utilising sophisticated econometric techniques, both these studies suggest that telecommunications infrastructure, through its network externalities, transforms economic productivity by shifting economic growth onto an altogether higher level. Noting that the benefit of the

network effect is dependent on the presence of a critical mass of 40 per cent penetration rate, Roller and Waverman concludes that convergence in telecommunications infrastructure capabilities between countries can serve as an effective means for convergence of their economic growth. Chakraborty and Nandi (2003) and Sridhar and Sridhar (2004) are the only studies that analyse growth impact of telecommunications infrastructure from developing countries' perspective. Utilising panel data on mainline tele-density and economic growth for 12 Asian developing countries, the former study shows that the two variables share a steady state equilibrium relationship in the long run, with two way feedback effect visible only for the countries that allow a high degree of private participation in their telecommunications Sector. Allowing for endogeneity of telecommunications adoption and economic growth and for fixed effects,

the latter study reports that though significant, growth effects of both mainline and cell phone penetration for developing countries are smaller compared to that observed for high-income OECD countries. Both these studies provide important insight on use of telecommunications infrastructure as a tool for spreading economic growth in developing countries. Yet, they fail to address the wide disparity in the attained level of development within the developing countries and its impact on their ability to benefit from development and adoption of telecommunications technology.

The paper focuses on the 15 most populous States of India, which excludes the Himalayan States, the northeastern States except Assam, and the seven UTs. Thus, the current paper includes the 15 major States of India namely; Andhra Pradesh (AP), Assam (AS), Bihar (BI), Madhya Pradesh (MP), Rajasthan (RJ), Orissa (OR), Uttar Pradesh (UP), Maharashtra (MA), West Bengal (WB), Punjab (PU), Gujarat (GU), Tamil Nadu (TN), Haryana (HY), Karnataka (KT) and Kerala (KR). The States mentioned have a combined population of 997 million (approximately 94 per cent of India's population) and cover 2.9 million km2 (87 per cent of India's total land area). Economic performance varies greatly among these 15 States. The Gross State Domestic Product (GSDP) per capita, among the 15 sample States, ranges from Rs. 3,775 per year in 2010-11 in the poorest State, Bihar (population 82 million), to Rs. 20, 000 per year in the richest State, Gujurat (population 96 million). The period of study for the current paper is from 1980-81 to 2010-11. The time period is limited to 2010-11 because of the fact that data on some variables was a constraint for sates like Assam.

This paper applies mainstream economic theory and draws on existing empirical studies in order to achieve its objectives. The paper is organised as follows. Section two gives the theoretical framework of convergence. It presents the theoretical background for testable hypotheses. It also reviews the results of previous studies of convergence across Indian States, then validates the functional form of the model and presents results of estimations, discusses measures of convergence, and summarises the conclusions on inter-state convergence. In the next section, the paper accounts for the lack of convergence, discussing the policy and institutional factors that affect the economic performance of the 15 States under study, while section four provides an empirical inquiry of the

policy variables on the growth differentials across the states, with the concluding remarks.

2. Convergence across Indian States (1980–81 to 2010-11)

2.1 Measures of Convergence

There are two standard ways of examining the presence or absence of unconditional convergence (Barro and Sala-i-Martin, 1995). The first measure is absolute or commonly known as, β-convergence and it implies that poor economies (in this case the poor Indian States) tend to grow faster than their richer counterpart (due to the diminishing marginal productivity of capital as explained by the Inada condition of Neoclassical growth models, Solow, 1956) upon reasonably homogeneous preferences and technology and no barriers to the inter-regional movement of factors of production. The second measure is σ-convergence which states that the inequality across States tends to decline over time. However, the former does not necessarily warranty the later as explained below:

Let Yit be the per capita income of the i State at time period,'t'. In this case, 'i' is 15 and 't' ranges from 1980-81 to 2010-11 and Yit is assumed to follow the following scheme, i.e.

$$LnYit = \alpha + (1 - \beta)LnYit - 1 + \varepsilon it \quad (2.1)$$

where, 'Ln' is the natural logarithm of the series, α and β are the parameters and ε it ~ IID(0,σ). With some arrangements, equation 2.1 can be expressed as:

$$Ln(Yit / Yit - 1) = \alpha - \beta LnYit - 1 + \varepsilon it \quad (2.2)$$

By taking the derivative of equation 2.2 with respect to LnYit-1, one would get:

$$dLn(Yit / Yit - 1) / dLnYit - 1 = - \beta \quad (2.3)$$

The left hand side of equation 2.3 is the definition of absolute or β-convergence. Under the assumption, β>0 (β, in fact lies between 0 to 1 as shown later) , the equation establishes the fact that States with low per capita income tend to grow faster than States with high per capita income (the measure of β convergence). Now, in order to relate both β and σ convergence at steady-state equilibrium, lets define the measure of inequality at time period't', 'Dt', which is:

$$Dt = var(LnYit) = (1 / 15)(LnYit - \mu)$$

where, 'μ' is the arithmetic mean of LnYit. Putting the value of LnYit from equation 2.1, we get:

$$var(LnYit) = (1 - \beta)\, var(LnYit - 1) + var(\varepsilon it) \quad (2.4)$$

$$Dt = (1 - \beta)\, Dt - 1 + \sigma\, \varepsilon 2 \quad (2.5)$$

If, β convergence would lead to σ convergence, then at steady state equilibrium, one must have,

$$Dt = Dt - 1 \ldots\ldots = D^* \quad (2.6)$$

where $D^* = \sigma 2$, the steady state level of inequality. From equations 2.5 and 2.6, we get,

$$(D^* = \sigma\, \varepsilon 2 / 1 - (1 - \beta) \quad (2.7)$$

Some important observations could be made from equation 2.7. First, if β=0, i.e. if poor states do not grow faster than the rich states, then at steady state, the inequality is not defined, an impossible case and if β>1 or < 0, then, D* becomes negative, also theoretically impossible. On the other hand, if β=1, then, which implies β convergence and falling inequality are not synonymous or β convergence is a necessary but not the sufficient condition for σ convergence. However, before analyzing the empirical issues relating to convergence in India, it is pertinent to highlight some of the issues studied on the theme in Indian context.

2.2 Studies of Convergence across Indian States: Some issues

Several studies covering different time periods examine whether per capita income levels have been converging or diverging in India. Most of the studies have shown that there is a tendency toward divergence rather than convergence. Nair (1971) finds no noticeable reduction in inter-state income differentials between 1950 and 1960, and Chaudhury (1974) concludes that the degree of state income inequality did not change between 1950 and 1970. Majumdar and Kapoor (1980) revealed that inter-state inequality of income in India steadily increased during 1962–76.

There are some recent literature on the issue of regional growth and convergence in per capita real income across the States in India. These studies also have tried to unearth the determining forces of the tendency of convergence or divergence. While some of these studies reveal that the growth pattern of per capita income has followed a divergent tendency in absolute term (Marjit and Mitra, 1996; Rao, et al., 1999; Dasgupta, et al., 2000); after controlling for internal migration, centre-state grants, and different indices of physical, social and economic infrastructure, there is also evidence in favour of unconditional and conditional convergence in per capita real income across the States (Cashin and Sahay, 1996; Nagaraj, et al., 1997; Aiyer, 2001).

Several other studies (for instance, Rao, 2007; Ahluwalia, 2000, and 2002; Shand and Bhide, 2000; Nagaraj, et al. 1998; Rao, et al. 1999) have observed that the

regional inequality in India has widened, especially during the 1990s. However, these studies have used pre-revised State Domestic Product (SDP) data. Further, some analyses do not adequately cover the post-reform period, especially the new millennium when the growth rate has accelerated at the aggregate as well as at the State level.

To sum up: the studies addressing the issue of growth and convergence in India have used different samples of states over different time periods and at times arrived at conflicting conclusions. But, the most important policy issue that is grossly overlooked in these studies is how the fiscal policies of the governments both of the centre and States have contributed toward the growth and (in)equality in the Indian Federation. This needs immediate and urgent attention so that the federal fabric of the country is not endangered. Another issue that needs due methodological attention is the estimation of State Domestic Product (SDP) used by the existing studies. SDP in India are based on the United Nations System of National Accounts (SNA) 1993. The new SDP series not only changed the base year in terms of price, but also revised the production boundary in a number of sectors, notably, agriculture, real estate and finance (Bhattacharya and Sakthivel, 2003). It has also shifted the occupation force database from the Census to the National Sample Survey (NSS). Finally, it has incorporated some new dynamic economic activities, such as, software, which were not included in the earlier series. The SDP growth rates from the earlier series therefore, cannot be compared with the same from the revised series. A proper analysis of regional growth and inequity should therefore be done through a common database. This paper tries to overcome this methodological problem by extending the 1993-94 SDP series backward to compare growth and regional variation across states on a common database.

2.3 Growth and Inequality across Indian States: The issue of 'β' and 'σ' Convergence

As mentioned earlier the present study is an endeavour towards addressing the issue of growth and inequality across 15 major Indian States from 1980-81 to 2010-11, and the policy concerns it endangers. The relevant data for the present study are sourced from Central Statistical Organisation (CSO) and Reserve Bank of India (RBI). However, before getting into the analysis, some conceptual issues regarding the data on the SDP need to be addressed. The SDP are estimated by the individual states, thus they are not comparable due to the qualitative differences in data collection and computation system. The CSO has revised the SDP series with base 1993-94 and the revised series of SDP is available only from 1993-94. The revised series based on new concepts of sectors and data; alter relative growth across States, sectors and periods. For a proper analysis of regional growth and inequality over time, the revised series of SDP should be extended backward. For this purpose, the Price Correction Factor (i.e. PCF, defined as the ratio of implicit deflator for 1993-94 series to the

1980-81 series for the year 1993-94) and the Quantum Correction Factor (QCF) are used to have the consistent series of SDP with the 1993-94 series data[1]. Additionally, the SDP of the States like Bihar, Madhya Pradesh and Uttar Pradesh are combined with the SDP of the bifurcated States to make the measures of growth and inequality comparable over time.

Interstate Growth Comparison

Both the Gross State Domestic Product (GSDP) and Net State Domestic Product (NSDP) could be used as a measure of SDP. However, from an accounting perspective, GSDP would be more appropriate measure of SDP. Thus, the analysis in the present paper is centred around GSDP as a measure of SDP. The growth rates of GSDP and the per capita GSDP, across the sample 15 major states have shown a fair degree of variation. While some states have witnessed rapid and phenomenal growth, the rest lagged behind. The annual moving average growth rates of GSDP for 15 major States at 1993-94 prices for the two sub periods of 1980s (1980-81 to1989-90) and 1990s through the new millennium (1990-91 to 2010-11), and for the whole sample period, i.e. (1980-81 to 2010-11) are given in Table 1. It may be seen that except few States – Rajasthan, Orissa and Kerala, all other States have progressed rapidly during the 1980s. Rajasthan recorded the highest GSDP growth rate (nine per cent), while the GSDP growth rate of Orissa was hovering around 3.3 per cent per annum. However, in general, there was a comparatively balanced regional growth during the 1980s. But, the post-reform era belonged to the relatively industrialised States and States that have resorted to service sector. The GSDP both in absolute and per capita term of relatively better industrialised States like, Gujarat and West Bengal, grew at over 7.4 and nearly seven per cent per annum respectively. Among other major States, Karnataka and Maharashtra have performed very well with over six per cent growth. It is surprising to note that West Bengal, which is considered to be a more socialist State has grown faster than some of the pro-reform States, such as, Andhra Pradesh (5.7 per cent) and Punjab (4.5 per cent), during the reform era. Such a startling scenario in West Bengal, contrary to the common perception needs an in-depth, careful and robust inquiry. The two slow growing States Andhra Pradesh and Punjab have comparatively better infrastructure and are known to have pro-market attitude. While Punjab's slow growth may be attributed to stagnation in agriculture and fiscal mismanagement, Andhra Pradesh needs an in-depth and careful scrutiny. A detailed study on Andhra Pradesh (Rao and Mahendra Dev, 2003) also confirms the slow growth rate of GSDP in the post reform era. Among other States, Rajasthan, Kerala, Haryana, and Tamil Nadu have recorded above average growth rate during the reform era. The GSDP of Kerala accelerated in the post-reform period, due to the remittances from the golf by the people of Kerala working there. One striking finding of the paper is that, Orissa, which had the lowest, growth rate among the sample States during the

[1] for the detailed discussion of the methodology see Bhattacharya and Sakthivel, 2003

pre-reform era (3.3 per cent), has achieved a considerable jump in the growth rate in the reform era (5.1 per cent). This staggering achievement of Orissa can be attributed to her greater adoptability to the reform, particularly, reforms in the loss making Public Sector Units (PSUs) like the State Electricity Board, Iron and Steel industries and reform to bring transparency and accountability in General Administration.

The other issue that needs to be addressed is whether initially poor States have grown faster than initially rich States between 1981 and 2011. Prima facie, the present study supports this proposition (Table 2.1). As explained by the neoclassical models, the relatively poorer States of India like Orissa, Rajasthan and Andhra Pradesh had below-average real per capita GSDP in 1981, and relatively high rates of growth 30 years later. While Punjab clearly had the highest real per capita GSDP in 1981, its 1981-2011, growth rate (2.7 per cent) was close to that which would be predicted given its initial level of per capita income. But, Bihar, the poorest State in 1981, could not achieve the higher growth rate after 30 years, as postulated in the neoclassical growth models. This aberration can be attributed to a host of factors like the deterioration of the law and order in the State owing to gross negligence to improve the general administration by the successive State governments and due to the inefficiency of the State government to utilise the central transfer[2].

Nonetheless, there has been some evidence of convergence across the 15 major Indian States over the study period. However, the movement of the rank of the State (according to the growth rate), is mainly among poorer States and richer States, only exception being West Bengal, Andhra Pradesh, Haryana, Madhya Pradesh, Tamil Nadu and Punjab. West Bengal and Andhra Pradesh, the two poor States in 1981, have moved to the richer group in terms of growth rate in 2011, whereas Madhya Pradesh, Tamil Nadu and Punjab, the three richer States in 1981 have come into the group of poor States in terms of growth rate.

Since the result is mixed, it is not conclusive to establish the fact that poor States have had a better growth rate than their richer counterparts in the past 30 years. Therefore, this needs to be further tested with some robust technique.

[2] in the neoclassical parable, on striking force to raise the growth rates of the poorer states is the transfer of resources from the richer states to the poorer states through central transfer (Cashin and Sahay, 1996)

Table 1 Growth Rates (Gr.) of SDP (GSDP) and per capita GSDP of 15 major States at 1993-94 Prices (percent per annum)

Per Capita GSDP at 1981 (Rs.)			GSDP 1981-2011		Per Capita GSDP 1981-2011		GSDP 1981-91		Per GSDP 1981-91		GSDP 1991-11		Per GSDP 1991-11	
States		Per GSDP	States	Gr.	States	Gr.	States	Gr.	States	Gr.	States	Gr.	States	Gr.
BI	P	2912.0	AS	3.8	BI	1.5	OR	3.3	OR	1.5	BI	3.0	BI	0.6
RJ	o	4284.3	BI	3.9	AS	1.8	KR	3.7	AS	2.0	AS	3.4	UP	1.3
OR	o	4538.5	UP	4.2	UP	1.9	AS	4.2	WB	2.1	UP	3.5	AS	1.6
UP	r	4551.6	OR	4.3	MP	2.5	WB	4.4	KR	2.3	MP	4.5	MP	2.3
AS		5057.7	MP	4.8	OR	2.6	BI	4.9	UP	2.7	PU	4.5	PU	2.7
AP		5175.1	PU	4.8	PU	3.0	UP	5.1	BI	2.7	TN	5.1	HY	2.9
WB		5335.5	KR	4.9	HY	3.4	KT	5.2	MP	2.7	OR	5.1	RJ	3.3
MP	R	5422.3	TN	5.4	KR	3.7	MP	5.2	KT	3.2	HY	5.3	OR	3.5
KT	i	5575.1	WB	5.8	WB	3.9	PU	5.3	PU	3.3	AP	5.7	TN	4.0
TN	c	6003.9	HY	5.9	MH	4.0	TN	5.7	MH	3.7	RJ	5.8	MH	4.3
KR	h	6275.5	KT	6.0	TN	4.1	GU	5.9	GU	3.9	KR	5.8	AP	4.3
GU		7404.7	AP	6.0	KT	4.2	MH	6.1	HY	4.1	MH	6.3	KR	4.8
MH		7833.4	MH	6.2	AP	4.2	AP	6.4	AP	4.1	KT	6.6	KT	5.0
HY		8591.9	GU	6.8	GU	4.7	HY	6.6	TN	4.2	WB	6.9	WB	5.2
PU		9360.6	RJ	7.4	RJ	4.8	RJ	9.6	RJ	6.8	GU	7.4	GU	5.4

Source: Handbook of Statistics on Indian Economy (HSIE), Reserve Bank of India (RBI), 2012

In order to test for β convergence[3], the present study estimated equation 2.2 with three different models, namely, Fixed Effect (FE), Random Effect (RE) and simple Pooled Ordinary Least Square (OLS) model[4]. Additionally, the study also divides the States into two groups based on their initial (1981) GSDP per capita and examines convergence within these two sub- groups. Group one includes the initial high-income (rich) States like Maharashtra, Punjab, Haryana, Gujarat, Tamil Nadu, Karnataka, Kerala and Madhya Pradesh. Group two includes the initial poor States like West Bengal, Rajasthan, Andhra Pradesh, Uttar Pradesh, Orissa, Bihar and Assam. After a check on different test statistics for all the competing models for panel data estimation, the study settled for the Two Way Random Effect model for all the groups (all 15 States, eight initial rich States, seven initial poor States) and the results are reported in Table 2. The results confirm the presence of β convergence across the 15 major Indian States as well as across the sub groups of eight rich States and seven poor States. The results show that the values of βs' for all the samples is negative which imply that States with low level of initial per capita income grow faster than the States having

[3] defined earlier

[4] for a detailed review on these Econometric models see Dielman (1989) and Hsiao (2003)

higher initial per capita income: the connotation of β convergence[5]. Furthermore, the higher absolute

value of β for the group of rich States than for the group of poor States implies that the speed of convergence is higher for the former group than the later group. This finding corroborates with the findings of previous study by Cashin and Sahay (1996).

Table 2 Panel Regression results of the estimated equation 2.2

Group	Model	Estimated A		Estimated **B**		R^2	*F- Stat.*
All 15 States	Two Way Random Effect	0.73*		**-0.08***		0.36	*4.11**
		SE[$]	0.21	SE	0.02		
		T value	3.38	T value	-3.3		
		SL[#]	0.00	SL	0.00		*0.00*
Initial eight rich States	Two Way Random Effect	1.14*		**-0.12***		0.33	*3.34**
		SE	0.36	SE	0.04		
		T value	3.15	T value	-3.1		
		SL	0.00	SL	0.00		*0.00*
Initial seven poor States	Two Way Random Effect	0.74*		**-0.08***		0.28	*1.95**
		SE	0.32	SE	0.04		
		T value	2.27	T value	-2.2		
		SL	0.02	SL	0.2		*0.01*

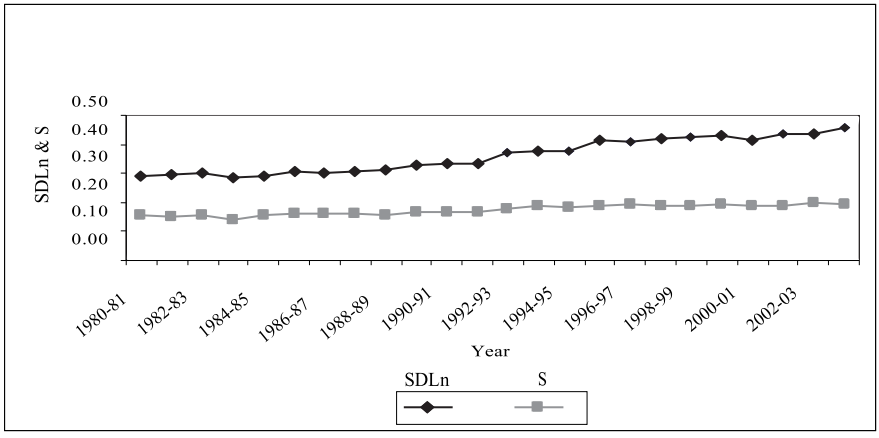
** implies the coefficients are significant at 0 per cent level*
$ SE stands for standard error, # SL stands for significance level

Then again, as explained in section 2.1, β convergence does not necessarily lead to σ convergence, i.e., even if the initial poor Sates grow faster than their richer counterparts, the inequality may not decline across the sample Sates. Therefore, it is pertinent to have a look at the trend of inequality across the Sates. However, some issues relating to the measurement of inequality needs to be addressed as there is hardly any concept other than inequality that draws more attention in economics. But the measurement of inequality of a distribution is simple as well as complex. It is simple because a simple measure of Range[6] can, to some extent, capture the inequality in a distribution, and it is complex because of the addition of new dimension (social, political and ethnic) to the concept. In order to incorporate the new dimensions to the concept of inequality, one needs to work a lot on the subjective (qualitative) aspect. Therefore, the measures of inequality fall into two classes' viz. positive measures, that make no explicit use of any concept of social welfare, and normative measures, which are based on an explicit formulation of social welfare and the loss incurred from unequal distribution (Sen, 2002). While the line between these two types of measures is not a firm one, it is clear that there is a distinction, and it may be useful to discuss the two types of measures in detail (which is beyond the scope of this

[5] logic is explained in section 2.1
[6] the ratio of excess of maximum value over the minimum value of a distribution to the mean value of the distribution

paper) [7]. Then again, a pure normative measure lacks motivation whereas in a positive measure, one may miss many a properties of inequality. But some delimitation, however tentative, is indispensable to have a quantitative measure of inequality. Though, there are extensive literature on the positive measures of inequality, the present study has used the most convincing measure of inequality Sen's index (S)[8]. The inequality across the Indian States during the study period is presented in Graph 1. Here, Sen's index is preferred over the widely used Gini coefficient (Lorenz ratio) because the former is sensitive to any transfer from the rich State to the poor State in the distribution [9].

Over the period 1980-81 through 2010-11, the inequality of real per capita GSDP across the Indian States has widened. The inequality has accentuated after the liberalisation of 1990-91. This may be due to the fact that the liberalisation era has enabled the already rich industrialised States to adopt a pro-market policy that has given a boost to their growth. The economy as a whole witnessed a more regional balanced growth in the pre reform period and there were robust growth rate in initially poor States like, Andhra Pradesh and slow growth rate in initially rich states like Kerala and Madhya Pradesh. Therefore, the dispersion of real per capita GSDP across the states was not that prominent during this period.



Graph 1 Inequality across 15 major Indian States as measured by SDLn and S

[7] interested readers can go through Sen, 2002, Chapter 2

[8] for a detailed understanding of the advantages, disadvantages and derivations of these measures, see Sen, 2002, Chapter 2

[9] in fact the Sen's index can be formulated with a little manipulation of Gini coefficient as follows:

$$S = (1/2n^2\mu)\sum_{i=1}^{n}\sum_{j=1}^{n}\left|y_i - y_j\right| = 1-(1/n^2\,\mu)\sum_{i=1}^{n}\sum_{j=1}^{n}\mathrm{Min}(y, y)$$

$$S = 1+(1/n)-(2/n^2\mu)[y_1+2y_2+ \ldots\ldots +ny_n], \quad \text{for } y_1 \langle y_2 \langle \ldots\ldots\ldots \langle y_n,$$

where, yi is the income of ith state and the average level of income is 'μ

To sum up, it can be said that some initially poor States (e.g. Rajasthan, West Bengal and Andhra Pradesh) have achieved commendable growth rates in their real per capita GSDP. However, this growth rate is not accompanied by reduced inequality across these States, and therefore, cannot be considered egalitarian, something any federal government would cherish. As seen from the pages of economic history, the market forces cannot reduce inequality. This is more so in India, since the market here is far from perfect due to a host of factors lying outside the purview of economics. Notwithstanding, some explanation needs to be unearthed from the system within i.e. from the economic structure and the policy decisions of the centre and States so that policies can be calibrated to reduce an evil like inequality. Therefore, the following section tries to explore some of the policy variables those determine the growth differentials across the Indian States.

3. Telecom Infrastructure and Growth:

An Empirical Analysis of 15 major Indian States

The varying performance in growth across States may be due to their initial endowment (Lal 2002; Olson, 2001) of resources and the policy towards improving the quantity as well as quality of these initial endowments. There is good number of literature that add to the convergence hypothesis by suggesting that investment in telecommunications infrastructure, with its ability to create spillover effects through network externalities, can impact growth far more significantly than that in any other alternative infrastructure (Norton, 1992; Roller and Waverman, 1996, 2001; Cornin et. al., 1993 and Nadiri and Nandi, 2003). These studies have focused primarily on one component of infrastructure investment, namely the telecommunications infrastructure investment and its ability to generate significant gain in productivity growth. Additionally, public expenditure on human capital also boosts the economic growth. Most studies found that type of spending to be significantly and positively correlated with economic growth. Generally, the approach used in empirical papers to estimate the impact of public expenditure in infrastructure is criticised from the following perspectives. Firstly, it is not clear whether the causation goes from government expenditures to economic growth and not the opposite or in both directions, the problem of simultaneity. In the empirical analysis that follows, the paper first tries to address the issue of simultaneity among the variables like GSDP, tele-density, developmental (sum of social and economic) revenue and capital expenditures (DRE and DCE respectively) and the states' own tax revenue (OTR). The theoretical rationale for including states own tax revenue as a determinant of growth of SDP is that with higher own tax revenue the states are more equipped to carryout projects beneficial to the overall health of the economy. However, there can be counter arguments for a distortionary tax policy of the state. Therefore, whether tax revenue really helps raising the GSDP of the state is an empirical question and in the empirical analysis that follows, this paper tries to address this issue for the states of India. All variables are transferred into their natural logarithm to scale down the values. Such a monotonic transformation will not alter properties of the

variables. After converting the variables to their natural logarithm, an estimable linear relationship among the dependent and independent variables can be presented with help of following basic regression equation.

$$GSDP_{it} = \alpha_1 + \beta_1 DRE_{it} + \beta_2 DCE_{it} + \beta_3 OTR_{it} + \beta_4 TEL + \varepsilon_{it}^{G} \quad (3.1)$$

where, GSDP, DRE, DCE and OTR are the Gross State Domestic Product, Developmental Revenue Expenditure, Developmental Capital Expenditure and States' Own Tax Revenue respectively (DRE, DCE and OTR are the control variables). TEL[10] expresses the tele-density of the states indicating the importance of Information and Telecommunication (ITC) sector of the state. One can estimate equation 3.1 with the usual panel data models, but such an exercise may give very inconsistent and inefficient coefficients as there can be very high degree of relationship among the explanatory variables. A look into the correlation matrix confirms the high and significant correlation among the explanatory variables (Table 3).

Table 3. Correlation matrix of variables GSDP, DRE, DVE, OTR and TEL

Variables		OTR	DRE	DCE	TEL	GSDP
OTR	Pearson Correlation	1	0.918**	0.754**	0.864*	0.913**
	Sig. (2-tailed)		0.000	0.000	0.000	0.000
DRE	Pearson Correlation		1	0.796**	0.872**	0.868**
	Sig. (2-tailed)			0.000	0.000	0.000
DCE	Pearson Correlation			1	0.711**	0.623**
	Sig. (2-tailed)				0.000	0.000
TEL	Pearson Correlation				1	0.754**
	Sig. (2-tailed)					0.000
GSDP	Pearson Correlation					1
	Sig. (2-tailed)					
	** Correlation is significant at the 0.01 level (2-tailed).					

One solution to overcome such a statistical problem is to devise an index (by Principal Component Method, PCM) of the explanatory variables and estimate the coefficient of the index. But, such an exercise may turn to be futile as the individual effect of the explanatory variables cannot be estimated and thus policy suggestion for each variable becomes difficult. Additionally, the positive and significant correlation of the dependent variable GSDP with OTR, DRE, DCE and TEL confirms the feedback relation between dependent variable and explanatory variables. But, the detection of endogenous and exogenous variables can be quite a tricky task. Neither, the economic theory nor the data (as revealed by the coefficient of correlation) assign exogeneity to any of the variables and thus, the

[10] The estimation of equation 3.1 is limited to the time period 1999-2000 to 2010-11, since the data on tele- density for all the states was not available for the rest of the study period.

feedback relation among the variables exists, confirming the endogeniety of all the variables. In such case, the empirical literature advocates for a Panel co-integration (PCONT)[11] technique. A PCONT model is best suited here, because of the following reasons:

- The pooling of the data for 15 States over 11 years will increase the degrees of freedom and also enable exploring the co-movement of the variables.
- It would get rid of the simultaneity problem of the model as all the variables become endogenous in the model.
- It will also enable to allow the short-run dynamics to be potentially heterogeneous.

On the other hand, there is a need for the verification of the stationary properties of all the variables in the analysis of a PCONT model and for the present study it has been carried out for all the variables by the unit root tests as prescribed by Pedroni (1999)[12]. The usual tests for the unit root for a panel set of data are Levin-Lin, Phillips-Perron (PP) and Augmented Dickey-Fuller (ADF) test. The test covers the most general specification for all the variables, which include a constant and trend. It is also necessary to determine the lag length of the variables in the PCONT model. The Akaike Information Criterion (AIC) and Schwarz Criterion (SC) are the common test-criterion to fix the lag length in such models. However, in the current PCONT model, though the test statistics confirmed for a lag length of one, the present study settled for lag length three, assuming that DCE and TEL will affect GSDP only in the long run. The results of the panel unit root test are given in Table 4. The unit root tests show that all the four variables, i.e. GSDP, DRE, DCE, OTR and TEL are non-stationary at their log level (though the test statistics Levin-Lin and PP show that two variables, i.e. DRE and OTR are stationary at their level, ADF test does not confirm such a result). However, all the variables are stationary at their first difference (Δ) and are integrated of order one i.e. I (1). Thus, in order to carry out the analysis, all the variables are made stationary by differentiating once. Such transformation will also reduce the co-linearity of the variables. Furthermore, if the variables are not stationary, there can be upward bias of the estimated coefficients giving rise to spurious results.

The lag lengths of the variables, as mentioned earlier, are decided by taking into the economic logic that DCE and TEL has a long run effect and thus the lags are fixed at three. Confirming the variables

are stationary at their first difference, the PCONT model is estimated with the first difference (Δ) of all variables. The analysis included computation of Panel Co integration, Panel Group Fully Modified OLS (FMOLS) and Dynamic OLS (DOLS) (Table 3). As evidenced from the group rho-statistics and PP- statistics, for panel co integration, the explanatory variables like TEL, DRE, DCE and PTR have a co integrating relation with the GSDP of the States.

[11] for a detailed discussion see, Pedroni, 2001
[12] for details, see, Pedroni 1999

Table 4 Unit-root Test Results for GSDP, DRE, DCE, OTR and TEL

Test.	Levin-Lin		PP		ADF	
Variables	Level	First Difference	Level	First Difference	Level	First Difference
GSDP	1.16	-2.67*	8.70	180.03*	9.44	70.54*
DRE	-3.03*	-4.39*	57.98*	151.76*	16.35	63.75*
DCE	0.67	-7.19*	17.52	172.86*	15.82	72.44*
OTR	-2.42*	-4.13*	70.49*	131.03*	16.78	59.21*
TEL	0.98	-3.86*	7.62	149.53*	6.21	52.93*
The unit root test regressions include the intercept and trend * implies that the test statistic is significant at one per cent level						

The positive and significant coefficient of tele-density in the short run (in the panel group DOLS the corresponding elasticity is 0.26) implies that ICT has helped the States to enhance the growth of their income. ICT is not only expected to raise the productivity by improving the communication, but it has a long-term effect on growth through increase in efficiency of all the inter-related sectors of the economy. The positive and significant coefficient of revenue expenditure in the short run (in the panel group DOLS the corresponding elasticity is 0.16) implies that the developmental expenditure on this head has helped the States to enhance the growth of their income. But, the short run elasticity of GSDP with respect to developmental capital expenditure is negative (elasticity is -0.03) and significant, which is once again supported by the literature (Devarajan, et al., 1996). This is because, the gestation period of such expenditures is little high and its impact on the economy can only be realised in the long run. Several components of the current expenditures, such as operations and maintenance, may have higher rates of return than capital expenditures. Therefore, States are required to complement the capital expenditure with the revenue expenditure to have the desired effect on their SDP. This supports short-term management of the capital budget and time bound completion of ongoing projects. If the States can manage their capital budget efficiently on a short period in the 'time bound' basis, they can perform well.

Table 5 Panel Co integration, Panel Group FMOLS and DOLS results

Panel Co integration Result				
	Group rho-Statistic	Group PP-Statistic	Group ADF-Statistic	
	3.58	-3.35	-1.35	
SL#	0.00	0.00	0.16	
Panel Group FMOLS				
Variable	Coefficients	SE$	T value	*SL#*
DRE	0.002	0.002	0.99	*0.59*
DCE	0.00051	0.00053	0.96	*0.33*
OTR	-2.52*	0.03	2.97	*0.00*
TEL	1.89*	0.14	3.61	*0.00*
Panel Group DOLS				
DRE	0.16*	0.03	4.90	*0.00*
DCE	-0.03*	0.01	-3.12	*0.00*
OTR	0.69*	0.04	18.04	*0.00*
TEL	0.26*	0.05	3.87	*0.00*
** implies the coefficients are significant* *$ SE stands for standard error, # SL stands for significance level*				

But, the study is unable trace the long run impact of DRE and DCE on the GSDP. This may be because the time period in this paper is too small i.e. 11 years (from 1999-2000 to 2010-11) to sketch the long run relationship of these variable on the SDP.

However, the effect of tele-density has a positive and significant impact on the GSDP of the states in the long run (elasticity is 1.89). This establishes the fact that ICT has been the main driving

force for long run growth in the Indian economy since 1999. But, states own tax revenue has a deterrent effect on their GSDP in the long run (elasticity is -2.52). This may be because of the fact that with the increase in tax, private consumption expenditure is not reduced in the short run (due to Ratchet Effect) but in the long run people adjust to the policy changes in the tax system of the States. As a result, the aggregate demand is not compressed in the short run but it has a deterrent effect in the long run.

4. Concluding Remarks

It is now widely believed that information technology in general and telecommunications technology in particular will play a growing role in pushing the growth and development process forward in the increasingly integrated global economy. Beginning from early 1990s, India has introduced reforms in telecommunications sector to enhance investment in telecommunications infrastructure and remove policy related obstacles that may keep help in fully capturing the benefits of network externalities and spillover effects. But, did the initially poor Indian States experience higher growth rates than their richer counterparts during this reform? Yes. The economy liberated itself from the restrictive regime, growth accelerated, but the elimination of regional inequality that has been repeatedly declared by policy makers to be a primary aim has failed. Many of the detailed policies of the centre are justified as having the aim of protecting the weak and poor States. More often than not, they had an opposite effect, (aptly visible, but in an invisible way) as they protected mainly the already privileged States. As a result, inequality was aggravated across States. Given the structural differences across States, some degree of inequality among the states is indispensable, as perfect equality/equity was, is and will be a myth in any economic structure. Thus, there will be some degree of natural inequality in any federal structure. This natural inequality depends on the factors like; availability of productive resources to the respective States (regions), its optimal utilisation, transfer of resources from the rich States (regions) to the poorer ones, either through the market forces or through the policies of transfers and grants by the centre, and the policies of the respective States to enrich their resources. States, primarily endowed with qualitatively better resources and that have adopted an appropriate ICT policy towards improving the quality of these recourses (may be through its positive spillover effect), have a better growth rate over their counterparts. Thus, the palpable suggestion for the States, particularly poorer ones, is to improve the quality of these resources by effectively raising their spending on ICT sector.

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Article

Union Information and Service Centre: ICT enabled one-stop e-service outlet for the rural citizens of Bangladesh

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Abstract

The Bangladesh government has committed to foster development programmes using ICTs, and declared a vision of 'Digital Bangladesh' by 2021 to ensure services at citizens' doorsteps. The Union Information & Services Centres (UISCs) were commissioned on November 11, 2010 at all Union Parishads (the lowest tier of the local government). It created a new era in the field of e-Service delivery in Bangladesh. The UISC is an ICT enabled one-stop e-service outlet that brings government and private services within reach of every citizen in terms of proximity and cost. The government engages two local entrepreneurs consisting of a male and a female to maintain the information & service centre at every union. While the entrepreneurs make monthly revenue of BDT 50 million, about 4.5 million citizens are currently enjoying the service every month. These hubs of information and services at doorsteps of rural citizens save their time, energy and money.

Keywords

UISC, Telecentre, ICT4D, Bangladesh

CASE STUDY 1

UISC provides healthcare information to poor people for free

"Even though I was suffering from back pain for years I couldn't seek medical help due to lack of finance. UISC's free healthcare services helped me greatly. My back ache is improving gradually. I am deeply grateful to the UISC"- a 65 year old penurious beggar of Fulkocha Union in Melandoho upazila, Jamalpur district shared his experience.

The Doctor provides health services from UISC. Photo: a2i, PMO

The UISC of Fulkocha Union of Melandoho upazila has been organising 'Free health camps' on the first Friday of every month since August 2011. Specialist doctors from the upazila health complex provide the necessary healthcare information. More than 50 destitute people come to the camp every month to communicate their health related problems and get prescriptions. This once-a-month health camp is a beacon of hope for the poor people of Melandoho upazila who are deprived of free healthcare services.

UISC entrepreneur Md. Shoaib Ali says, "People in my locality are deprived greatly on healthcare services. I had a dream for long to make healthcare services free for the poor people of my area. My effort at UISC helped me realize my dream."

It is very difficult to find specialised healthcare in the rural spaces of Bangladesh. 400 UISCs out of 4,516 UISCs, operating across Bangladesh, have undertaken similar initiatives to provide healthcare to their impoverished constituents.

CASE STUDY 2

UISC shed the stigma of unemployment

Mr. Anwar Hossain is an entrepreneur of Rohita UISC at Monirampur in Jessore. After completing BSc in 2009, he applied for job at different places. After some time he got tired of looking for work. He was torn between his jobless state and the need to take care of his family.

Mr. Hossain wanted to leave the country but to apply for a passport he required a national identity card. He went to the local Union Parishad (UP) and explained his situation to the incumbent Secretary of the UP. Mr. Hossain required a work that would earn him around BDT 12000-15000 per month. The secretary then advised him that he could make even more working here in his own community.

The secretary offered him the opportunity to become a UISC entrepreneur. It was July 27, 2010 when he met with the secretary and he asked Mr. Hossain to start working from August 1. That is how he became an entrepreneur.

Gradually, Mr. Hossain developed one of the best information & service centres in unions of the country. He has successfully shed the stigma of unemployment. He bought a few equipments for the centre, and now earns BDT 15,000 - 20,000 a month. Along with his increase in income, he also developed a reputation in the community.

Introduction

Majority of the population in Bangladesh live in the rural areas and they largely depend on the government institutions for basic information and services. For the smallest service in the public offices, because of enormous public demand, it fails to deliver swiftly. Citizens meanwhile travel long distances and toil for days to obtain a simple government form or pay a bill. This daunting task of managing a large population's needs with limited resources was made more complicated with inherent inefficiencies of manual service delivery mechanisms, hence feeding into an ever-lasting vicious cycle of rent seeking and corruption.

Decentralising the services is largely believed to make the quality and speed of service delivery easy and speedy. Incorporating simple ICTs in the service delivery process can compound these benefits by manifold. Hence, bringing government and private e-services at the union level through a one-stop e-service outlet was a timely measure by the Bangladesh government.

Hon'ble Prime Minister Sheikh Hasina and UNDP's administrator Ms. Helen Clark inaugurates UISC simultaneously through a video conference.

Photo: a2i, PMO

Background

Previously, different private organisations initiated similar endeavours such as the UISC. Commonly known as 'Telecentres', these are basically ICT enabled outlets extending the coverage of parent organisations' services. The common problems with the initiatives however, have been long term financial and social sustainability.

UISC emerged from its earlier version known as CeC (Community e- Centre) in the public service platform at union level. In 2007, two CeCs were established as pilot (Quick Win) under Democratic Government Thematic Trust Fund (DGTTF) of UNDP. In 2008, CeC became a flagship project of the UNDP supported Access to Information (a2i) Programme at Prime Minister's Office. Thirty CeCs were commissioned in Union Parishad (UP) in 2009 through partnership between Local Government Division and a2i programme. The Quick Win initiative expanded rapidly culminating in a launch in all 4,501 UPs of the country.

Objectives

Overall objective

The overall objective behind establishing UISCs is to bring government information and services at the 'doorstep of rural citizen'.

Specific Objective

The specific objectives include:

- To ensure fast, cheap and close-to-home access of all citizens to government information and services
- To decentralise government services by taking information and services at the lowest level of the Local Government i.e. Union Parishad
- To ensure free flow of information across the society especially in rural and remote communities
- To provide a supportive environment for creation of local entrepreneurs.
- To create a vibrant, knowledge-based UP.

Model of UISC

Similar to the 'telecentre' concept of different private organisations, the UISC model, however, is unique in the sense that it builds Public Private Partnership (PPP) instead of donation dependant models. Each UISC is operated by two young local entrepreneurs – a male and a female – under supervision of a local advisory headed by UP Chairman. The UP provides space and utility for the centre. The UP and/or LGD bear some initial costs including basic equipments such as computer, printer, internet modem and a webcam; the entrepreneurs are free to install additional facilities keeping pace with business growth. The social sustainability of these centres is achieved by delivering government information and services. Entrepreneurs are self-employed, and they manage their living with the income. These employment opportunities created by the UISCs have stimulated more employment in the country.

Necessity of UISC

UISCs have eased the lives of people by providing necessary information and services to citizens in cost manner. Today, a farmer in a remote location can learn about appropriate fertiliser and pesticide use for his crops; a victim of domestic abuse can access information on legal resources; a villager can apply for land records, a migrant labourer can learn English using digital resources; and unbanked people can access banking services from UISC. All these are now possible from a UISC located typically within walking distance or a few kilometres from the citizen's home.

Barodi UISC of Narayanganj provides mobile banking services to the citizens.
Photo: a2i, PMO

Further implications of such services also include:

- Long-standing demand for the right information at the right time at the right place
- The coverage of useful government and private services has expanded beyond urban areas
- Financial transactions have become easier and cheaper through branchless banking. A large number of rural people are enjoying banking facilities.

CASE STUDY

Positive changes emerging in the lifestyle of people of Mahajanpur

Mr. Minarul Islam
Entrepreneur, Mohajanpur UISC
Mujibnagar, Meherpur
Photo: a2i, PMO

Mr. Minarul Islam is the entrepreneur of Mahajanpur UISC, Mujibnagar upazila, Meherpur District. He joined the UISC in 2010. He has elevated his community on a higher plane by providing services to the people through the UISC. The people

of this union are receiving various public and private services from the UISC.

Everyday students are coming to fill out application forms for admittance into universities. Local youths are coming to receive computer training. Women are coming to get information on poultry diseases. Farmers are coming to resolve crop issues and general people are coming to access internet or video chat with friends and family living abroad or to use computers to compose, scan or print documents. The people of the community are happy to have access to information and services at their doorsteps as it is saving both their time and effort. In this way the lifestyle of the people of the Mahajanpur union is undergoing a positive change.

"UISC has changed my life. Besides earning quite a good living I am also helping the poor and neglected people of my community. The people are satisfied with my efforts and their delight fills my heart. No other occupation would have given me joy and satisfaction," said Mr. Islam.

Md. Islam is now self-sufficient. He is earning on average BDT 18,000-20,000 a month and helping out his family. His family is also very happy with his success. The people of the union can always count on Minarul to come to their aid in times of crisis.

He is very popular within his community. Minarul received award from Prime Minister Sheikh Hasina and Secretary General of UN Ban ki-moon as the best UISC entrepreneur in 2011.

Partnership with GO-NGOs

MoU signing ceremony among a2i, BBS and LGD. Photo: a2i, PMO

In order for UISCs to survive successfully in the long run, support from various government and private organisations is being mobilised through partnerships. These entities not only offer citizen oriented e-services through the centres, some of them also provide hardware maintenance and other technical support to keep these centres operational. In the forefront of such partnerships are public and

private banks (e.g. Dutch Bangla) – powered by the upcoming mobile banking facilities, Life Insurance agency (e.g. Jibon Bima), telecommunications (e.g. Banglalink), development organisations (e.g. Dhaka Ahsania Mission) and government institutions/agencies (e.g. Bangladesh Bureau of Statistics).

As of January 2013, partnership status is as follows:

Sector	Organization/Institution	Services for UISCs
Bank	Dutch Bangla Bank Limited Mercantile Bank Limited Trust Bank Limited One Bank Limited BKash Limited	Mobile banking services
Telecommuunication	Banglalink Robi Grammenphone	VAS, Sim selling, top up, internet speed
Insurance	Jibon Bima Corporation	Life insurance
Govt. institution/ agency	Bangladesh Bureau of Statistics (BBS)	Economic census, population census
	Bangladesh Computer Council	Training and troubleshooting supports
	Cabinet Division	Monitoring and Training
	Soil Resource Development Institute (SRDI)	Soil test and fertilizer recommendation
Hardware Samity/ Association	Bangladesh Computer Samity (BCS)	Troubleshooting supports
Development	Dhaka Ahsania Mission	Training and troubleshooting supports
	Swanirvor Bangladesh	Training and troubleshooting supports
	Practical Action Bangladesh	Agriculture, Fisheries and Livestock services.
Education	UNESCO	Non-formal education
	British Council	English learning
	Bangladesh Technical Education Board (BTEB)	ICT training
	Directorate of Technical Education (DTE)	Troubleshooting supports
	Ankur ICT Development Foundation.	Bangla computing
Health	Directorate General of Health Services (DGHS) Ayesha Memorial Hospital	Telemedicine
	Development Research Network (D.Net)	`SMS alert for pregnant women
Renewal energy	Infrastructure Development Company Limited (IDCOL) Bangladesh Computer Council (BCC) Palli Daridro Bimochon Foundation (PDBF)	Solar system
Others	Shurjobarta	Free SMS

Service Provisions

Early experience shows that affordably priced government services often do not generate enough revenue to ensure self sufficiency of UISCs, commercial services are helpful to fill this gap. Below is the list of services currently provided at UISCs:

Rural students log in into www.forms.gov.bd from Patharia UISC, South Sunamganj, Sunamganj

Public services	
Public exam results	Citizenship certificate
Online university admission	Logistic supports for various govt. campaigns
Govt. forms downloads	All sorts of citizens' petition
Birth registration	Online application for passport
Death registration	Visa verification and tracking
Citizenship certificate	Online application for driving license and license renew
Application for land copy (porcha)	Online application for teachers-officers pension
All sorts of citizens' petition	Online application for teachers-officers welfare trust fund
Online application for passport	Life insurance
Visa verification and tracking	Telemedicine-skype
Govt. forms downloads	Health consultancy by upazila health complex
Birth registration	Agriculture consultancy through mobile phone
Death registration	Stamp selling (vendor license by DC office)
Law services	Govt. notices and circulars
Electricity bill payment	Water test
E-Purjee	Arsenic test
Report writing based on the demands of UP chairmen	

Students take ICT training from Purbo Charbata UISC, Subarnachar, Noakhali

Private services	
Email	Knowledge services (Fisheries-Practical Action)
Internet browsing	Knowledge services (Livestock-Practical Action)
ICT Training	Solar system management by IDCOL
Mobile banking	Compose and print
English learning of British Council	Scan
Photography	Photocopy
Online job application	Lemination
Agriculture consultancy by service camp	Phone/ mobile call
Health consultancy by service camp	Mobile money load
Law consultancy by service camp	Mobile servicing
Phone call (land phone)	Mobile SIM selling
Video conference (skype)	Nebulizer rent
Video recording and editing	Video show by multimedia projector
Height and weight measurement	
Knowledge services (Agriculture-Practical Action)	

Benefits and Impacts

Progress

Crucial livelihood information i.e. agriculture, health, law, etc. is available quickly and near doorsteps of all citizens

Many new potential public and private services are added. The services available at district and upazila level have also become accessible from UISCs

Women – who are traditionally less mobile – are benefitting from the service and livelihood information close to their homes

Online communication and problem solving platform, UISC blog (uiscbd.ning.com), and UISC Activity Management System (UAMS)/Online Monitoring Tool (uams.e-service.gov.bd) developed

As of December 2012, 4.5 million citizens receive services per month on average countrywide (Source: UAMS, uams.e-service.gov.bd)

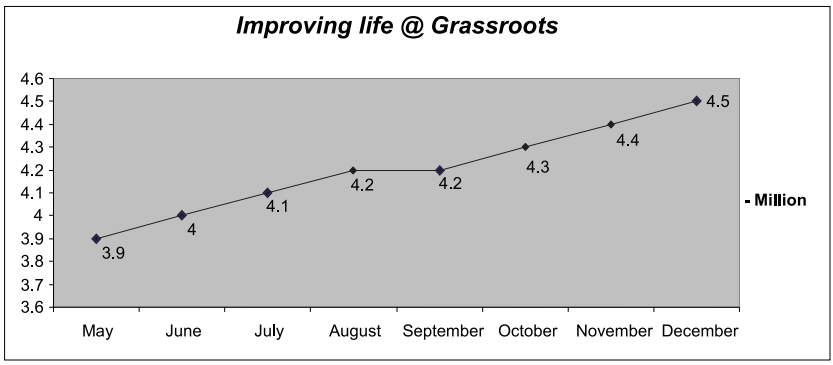

Figure 1: 4.5 Million Service Recipient / Month

More than 9000 local entrepreneurs, half of who are women, empowered through training and support

The entrepreneurs as of December 2012 earn BDT 50 million per month on average (Source: UAMS, uams.e-service.gov.bd).

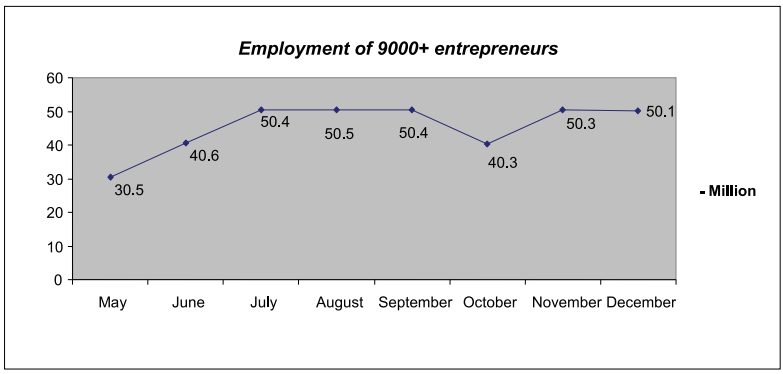

Figure 1: 4.5 Million Service Recipient / Month

Capacity of Union Parishad in prompt service delivery enhanced and closer ties established among the LG employees, people's representatives and citizens

Closer ties established between the local administrations and the citizens through creation of service oriented UPs

Longer Term Impact

UISCs are now gradually being established as quintessential service delivery point for rural citizens closest to their home – 3 kilometres being the longest distance one has to cover to reach a centre

Public service delivery are gradually becoming more decentralised and accessible at Union, Upazila and District levels with more and more government e-services being delivered through UISCs

Using the content and equipments available at UISCs, skills training are being planned. As a result a large pool human resource is expected to be developed with skills in ICT, English and other areas

Each UISC will strive to be financially and socially sustainable.

In general, greater participation of citizens will be ensured in local and national development as local government institutions and local administration become more service oriented

Free flow of information will eventually contribute in building a knowledge based society

Conclusion

UISC is a local knowledge centre. These hubs of information and services at doorsteps of local people save time, energy and money. Operating more like a social-business UISCs put more emphasis on citizen's needs and earn revenue by offering an ever widening range of services for revenue. Simply put UISCs enjoy the best of both world – support from government and agility of private entrepreneurship. In addition, a greater community involvement helps sustain business and maintain social relevance. As a result, UISC will be a centre of service excellence which will meet hassle free citizen demand by reducing digital divide between core and periphery.

Article

Mobile Phone and Social Communication Networks Expansion

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Abstract

This article is written based on research of Social Communication Networks and Structural Poverty, Social Studies Communication Network on Poor Fisherman Village in Indramayu, West Java, Indonesia. It is describing patterns of social communication networks, the existence of opinion leaders, and the use of mobile phone technology among the poor. The theoretical framework is using the network exchange theory, based on the approach to communication network analysis. The important findings are as follows: social communication networks among the poor have their own patterns of communication networks, small, simple, limited, and overlapping. Social communication network differs from the formal structure of communication channels. Sources of information related to daily life, primarily build up on strong ties, while new and innovative information is obtained from weak ties. Opinion leaders are polymorphic. Mobile phone is more widely used among strong ties in homophile relationship, but is not as widely used in establishing relationships with weak ties in heterophile ones. The fact is mobile phones are widely used for consumptive purposes and not productive. This means that mobile phone still does not play its role as equaliser for the welfare of the community.

Keywords

Social communication networks, structural poverty, the network exchange theory.

Introduction

In the poverty alleviation programme, “socialisation” through various channels of information is a process of development communication. The problem of poverty however, still remains unresolved and the information development programmes do not reach the target. Many efforts are made to resolve the problems of poverty, but in the end the provision of resources and social services to increase the welfare of the poor do not arrive to the absolute poor or those identified in the structure of poverty. The fact makes me focus more on the structural dimension of

poverty because of the difficulty in the accessibility of some resources, also having relation with lack of social communication networks in society.

Information is an essential element that is implicitly inherent in the concept of a planned development. Any development activities can only take place and achieve the desired goal, when each stage — planning, implementation and monitoring — is based on adequate information (Dahlan, 1997:2). Information is obtained through a variety of communication process, but finding the useful is most challenging.

Content or information is vital for every human. For example, price, weather, trade transactions, cost estimates, implementation of budget, education, health, insurance, etc. greatly depend on the completeness, correctness and accuracy of the information. A good development is possible only when it emerges with the distribution of information and communication technology (Dahlan, 1997:5). Any effort without equitable distribution of information and communication will find gaps. This gap in turn has an impact on poverty as experience shows that development interventions often do not reach the target because the information is withheld and used by non-target groups.

Information mostly channelled through formal networks cannot reach the audience at the lowest tier of the society, because persons in formal networks have their own social networks. For example, information about the aid that should be addressed to the villagers is held among the village elite. When the village chief has to know about credit, the information is not distributed to the poor in his area, but only to his relatives (Setiawan, 1980). If there are projects related to physical development in the village, the village elitesknow first. Afterwards, the village elites use the information for their self and group interests (Setiawan, 1989: 3).

The examples above indicate that people with strong economic solvency usually make up a powerful information group. They know how to search and utilise information fast to strengthen their economic position. Compared to the notion, “information is money”, which can be used to add to the wealth of information – in order to gather more real wealth (Dahlan, 1997: 5), “Information is commodity”, said Daniel Bell (1973; in Dahlan, 1997) in his book The Coming of Post-Industrial Society: A Venture in Social Forecasting. The most valuable commodity in the post-industrial society is knowledge; this is why the super elites in society are producers of knowledge information.

Information allows people to develop ideas, gain new opportunities, and a variety of learning from others. In other words, poverty occurs reciprocally among poor because of lack of information and the difficulty of obtaining them (Dahlan, 1997). This occurs because of structural barriers to the flow of information among the poor.

Equal distribution of information and communication is required in areas such as economics, politics, people’s welfare and for poverty reduction. Information gaps in the economic field can reduce the chances of industrial expansion, securing

good business and revenue. In the political field, information gap hinders the implementation of democracy, develops inter-group suspicions, distrust and even shuts down the channel opinions and aspirations of the community. In the field of social welfare, information gaps harm the effectiveness of various community services that form the basis for improving the quality of community life.

Structures that restrain information flow must be identified and resolved to allow distribution of information across social communication networks. Social communication is defined as a process of social interaction that involves two or more participants in the context of social events, taking into account the social factors that influence individual behaviour in interacting (Kashima, Kleinand Clark; in Fiedler, ed., 2007:28-30). Social communication network is a circuit that connects people in a society. The network shows users who communicate regularly, its vastness or proximity of users with other members, flow of communication through the network and accordingly positions each user in it (Dahlan, 1976/1977: 13-14).

As a set of people, society is a collection of relations in the form of relationship by blood or descent, friends, neighbours, work, and many other relationships. These relationships are only going to happen if there is meaningful communication process. Therefore, a method to understand human behaviour is to observe or understand the social relationships created by the communication process.

In society there are many communication networks, but each has a different model and speed. The more important the type of information for a particular community, the more rapid development and increasingly broad range of information streams in the network. Communication network with information about the primary needs of a society will have the fastest and widest range. For example, for the farmer, information on agriculture should be the most important information. As with the fishing community, information about weather conditions and fishing location will be the most important for them.

Literature Review

Social Communication Networks and Structural Poverty in the Context of Network Exchange Theory

Social communication networks and structural poverty in the context of network exchange theory is seen as a form of social exchange being understood at the micro and macro level. Micro-level analyses how a dyadic relationship can be created between two people who exchange information and link them across a level of social structures that influence the pattern of dyadic communication. 'Networks exchange' theory assumes that people communicate with each other because of the resources needed and to be met by certain people.

Sources meeting the needs of everyone in society can be very diverse. Some are likely to be members of various networks, privileged with resources that others may not have access. Disadvantaged groups, experiencing barriers in accessing and understanding the resources available to them, should be utilised for the

welfare of their lives.

Opportunities for people to enter in a network are determined by the role they can play in such networks. The greater return that a person gives to another member, the greater are the chances of getting accepted in the network (Emerson, 1981). However, resources owned by one person in a network can be different; one can be more resourceful than the other. Imbalance in the ownership of resources between the parties determines their rule.

In conditions of scarcity, a person will feel a lot of pressure in his life. Resources can help reduce those tensions. Both strong ties and weak ties can hep maintain peace in the society. Granovetter (1973) defines a strong bond consists of people who have close contact, such as family, relatives and close friends. While a weak bond consists of people who are known but not regularly in contact.

In societies of the developed countries, the network bonds provide emotional support or material assistance, but not both (Wellman &Wortley, 1989, 1990; in Monge &Contractor, 2003: 237). Two other factors help nurture the network:information and assistance (Monge &Contractor, 2003: 237). Poverty is a multidimensional problem that includes political, social, economic, assets and access. Their poor economic condition,implying resource gap, excludes them from decisions and policies concerning them. Their exclusion is legitimised by all the work/effort they did not have access, including insufficient information about various key resources,which can improve their lives.

Poverty reduction programmes guided by democratic spirit and by providing opportunities and mechanisms to involve communities in the decision process can solve these problems. The decisions will primarily affect their destiny in the future. Opportunities and participation mechanisms inherent in the design of the programme assume that involvement of communities especially the poor would give them the opportunity to influence significant decisions in accordance with the issues, needs and interests.

In implementation, the government used the assumption that the nation structure is a structure that is consistent, understood and accepted by society. The government implements the programmes using formal channels followed in the formal structure of the country, beginning from the department, province, county, district, village, etcetera. Poverty alleviation programmes undertaken are channelled through this formal channel.

The poverty reduction programmes are perceived as socialisation and dissemination of programme development for poverty reduction. In other words the process of communication and dissemination of information from government to the people, follow formal or official channels by a mechanism that government finds appropriate. However, in field, the government's assumption does not always find the fruition as expected. Theoretically, both sociologically and based on science communication, the community has its own structure and its communication network. This does not related to the formal definition as the government describes. Each community has a structure and social network, and

every people have their own structure and communication networks.

This in turn hampers the smooth flow of communication, in which each person or group have different rules for who communicates with whom. The existence of values, norms, and customs that govern the patterns of communication in society, leads to concentration of ownership of the information about certain parties in the stratification of society. Communications blockages resulting in information do not reach appropriate audience. In other words, there are some people or groups who do not have access to the information because of the obstructive structure.

Research Method

Research method is using social network analysis as an effort to gain an understanding of social communication networks in rural communities today. Analysis of communication networks is a research method to identify the structure of communication within a system, where the relational data about communication flows are analysed by using several types of interpersonal relationships as the unit of analysis (Rogers & Kincaid, 1981: 75).

Level of analysis is individual about the role of actors in the network. The data collection technique is sociometry. Sociometry method is generally used to find, write and evaluate the social status and progress or process of the symptoms, by measuring the amount of rejection and acceptance among individuals within a group. Respondents who get social communication questionnaire are a population, required for a study using the method of analysis of communication networks.

By studying the daily lives in the communities, knowledge is gained about symptoms that manifest in the society. Information sought in the form of an overview of the symptoms, such as actions, objects, events, and so on, as well as a link between the symptoms with others that are meaningful to the community of Wanasari, Indramayu, West Java, Indonesia.

The present study also involved library research and documentation to support the primary data. The information collected in the form of data is associated with a general location of the study. The study conducted by collecting documents provides detail on the social context of the study site, written or preserved in the oral tradition. Patterns of social relations embodied in the respondents was analysed by a computer programme that is Ucinet version 6, which show the communication network sociometry in which actors are interconnected in a network.

Research Findings and Discussion

Profile of Wanasari Hamlet

Research location is in Wanasari hamlet, Karangsong village, Indramayu, West Java, Indonesia. Data in Table1 shows that population in Wanasari has educational background at elementary school (52.47%), junior high school

(18.13%), uneducated (13.32%), senior high school (11.54%), diploma (2.88%), and undergraduate (1.23%).

Table 1.Educational Background

Education	Frequency	Persentage
Uneducated	97	13,32
Elementary School	386	52,47
Junior High School	132	18,13
Senior High School	84	11,54
Diploma (D1/D2/D3)	21	2,88
Undergraduate	9	1,23
Total	728	100

Based on first identification survey result at whole,110 people were selected as respondents to represent people in Wanasari hamlet. However, field visitors chose 87 respondents related to structural poverty criteria because rest of them (23 respondents) were working out of hamlet as fishers, housemaid in Jakarta and Batam. Respondents' profile maintain working persons maintaining social communication below the age of 20 years 1.1%, 20-30 years 10.1%, 31-40 years 19.2%, 41-50 years 22.7%, more than 51 years 46.9%. Marital status is married with 1 partner 85.1%, widower 9.2%, unmarried 3.4%, and married with 2 partners 2.3% in polygamy format in which a man is married to more than one woman.

Respondent working types are fishpond labours (21.8%), small fishermen (17.2%), fish market labourers (11.5%), pedicab men (9.2%), small traders (8%), fishpond farmers (6.9%), fishing labourers (2.3%), scavengers (5.7%), housemaids (3.4%), parkingmen (2.3%) and stone breakers(1.1%). Based on these working activities they have monthly income from Rp600.000 to 500.000 (equal to $ 62 - $ 52). Respondents' involvement in social organisation includes8% followed as mosque members, each of 1.1% as village welfare body, and rest of them (89.7%) not involved in any social organisation.

Patterns of Social Communication Networks

Five existing communication networks maintain different flow charts. This difference is observed, as the respondents are not members of all the networks.

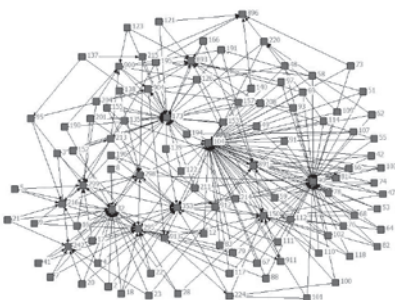

Figure 1.

Sociogram of Social Problem Communication Network

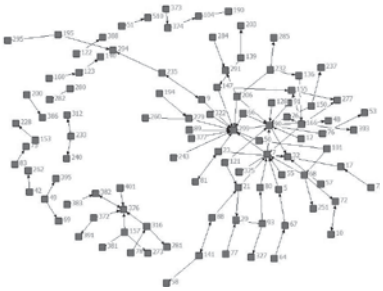

Figure 2.
Sociogram of Water
Problem Communication Network

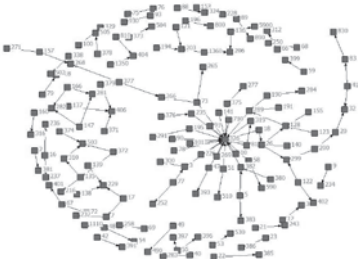

Figure 3.
Sociogram of Financial Problem
Communication Network

Figure 4.
Sociogram of Job Seeking
Communication Network

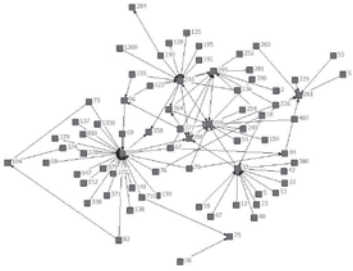

Figure 5.
Sociogram of Group Aid
Communication Network

The background of the respondent's involvement in various issues can be seen from a personal motivation. It is a desire to meet needs in a variety of things such as psychological, material and social. In view of the theory of exchange in general, when one is in a relationship with another, the economic motivation is the most visible (Homans, Thibaut & Kelley, & Blau; in Emerson, 1976:336). Field evidence showed that people who relate to different socio-economic layers, such as between fish farmers and fishermen with baskets (called 'bakul' or basket). The bakul is considered to have the resources needed by fish farmers and fishermen.

The relationship includes the economic motivation for fish farmers and fishermen who require a number of sources that they could not provide on their own.

In general, a network is commonly conceptualised as a type of relationship between actors that is characterised by the symmetrical reciprocal interactions. Any relationship that exists between actors in society is a pattern of network, because the basis of different social relations gives birth to different networks. In addition, according to Rogers and Kincaid (1981) in social relationships, each actor brings his own personality traits, so that the configuration of the entry or exit of an actor in the social relationship affects the structure of interaction that is created.

A communication network of economic innovations seeks capabilities of the largest social group of members affected by the economy. The network requires members with high mobility influenced by their age. A communication network of high complexity of innovation is influenced by the intellectual or educational potential of community members.

Trial of communication network of innovation by people is influenced by the presence or absence of public attitude and the courage to try it. In the process of innovation there is always a group of people who are brave and those less willing to take risks. This network is expected to observe the people, influenced by the type of innovation. If innovation is in the pattern of material, it does not require high intellectual ability, but if innovation is more of an idea, then it requires a relatively high level of education.

Because communication network is used as a study object, networks that transmit information in the form of ideas (communication network of social issues, water issues, finances, employment, and aid groups), are observed by the ease of getting and receiving information. The lack of information is valued from presence or absence of structural barriers in terms of getting information. While aspects of receiving depends more on how respondents recognise and understand, the information available can be utilised for the welfare of their lives.

Based on five communication networks in Wanasari, a network structure of wheel has been discovered. The pattern of communication is spread. Wheel networks mean people at the centre of the wheel control the exchange of messages. A wheel-shaped network reflects the pattern of centralised communication among people of the network. Those on the suburb of the wheel are less likely to be leaders.

This village can be categorised as open countryside that is easily touched by a wide range of information originating from outside the village because of the various infrastructure and community activities and facilities for the mass media. The infrastructure supports the communication process such as paved roads, the village office facilities, Marine Fisheries Cooperative (KPL), fish auction place (TPI), and a health facility. Wanasarieris radio and TV are components of mass media. These media besides entertainment function, provide vital information that villagers certainly require.

The study of communication networks in Wanasari did not find wider participation in semi-formal institutions such as fishermen, fish farmers groups and cooperatives, except those directly related to the social life of society such as teaching in mosques. Sources of information that are considered to provide important contact such as fishermen, fish farmers groups and cooperatives are not found. This is expected because in hamlet where there are no studies specifically guiding these groups, existing cooperative members are the owners of the boat containing medium and large sizes. Organisation channel seems to be more potential in reaching out to women, because of the BKB Kemas facility, where once a week meetings are held between the representatives of the mothers whose children attend school in BKB.

The Existing Opinion Leaders

Research findings identified several key positions or source of influence over the flow of information in rural areas, especially villages studied, namely the leaders of informal and formal leaders of the Chairman Hamlet or Rukun Tetangga (RT). RT Chairman has an important position in the village for a variety of assistance programmes to the community channelled through the RT and in addition to the physical distance closer than the village chief and other village officials.

Compared with formal leaders, informal leaders had more influence in society, the merchant and/or bakul. These traders contact with the outside community regularly besides contacting the fishermen and fish farmers for their daily activities. The position of greatest influence is on the bakul and the business owner/owners of capital as they try to maintain their investment by providing a variety of information that people need, such as fishing location, technology, how to catch fish, how to manage the pond, the type of seed, fertiliser, medicine, and etc.

In terms of ownership of mass media like TV and radio, the influence is less visible on the leadership of owners in the community. Because most of the respondents have TV and radio, those not having personal arrangement have public facilities that allow them to enjoy the show on TV and radio, as in the neighbourhood, in the boat, and in other public places.

Network exchange theory sees how people in a network exchange the things they have. But the relationship does not always balance because of differences in the resources that each have. Inequality eventually leads to power and aspect of power pay attention to inequality of relations between the two people who are related (Emerson, 1981). Someone said to rule over others, he must have resources needed by others and make them dependent on him.

Among various characteristics, a leader is someone having traits that supersede their followers (Rogers, 1995). These can be in terms of higher socioeconomic class, higher education levels, greater interaction, and more outward-oriented group (cosmopolitan). Power is generally more easily seen from the magnitude of income and ownership. Someone who has lots of resources such as property, money, and goods, are more likely to get what they want. Conversely, people who

do not have the materials will take pains to get what they want. To make ends meet they even would go looking for people who are well off.

From the aspect of education level, one is powerful when they have the knowledge, information, and specific skills. For example, someone with a good background of religious education than others will tend to be followed for what they say about religious affairs. In rural communities, religious leaders are often perceived to control and distribute other information beyond the religion.

It cannot be said that a certain job is better than others. In general, jobs associated with specialised knowledge are rewarded with higher income from other jobs on average. Examples include doctor, engineer, architect, and work with other special skills. Persons with such skills, usually have influence in the society because of their knowledge.

People who have a lot of information and relationships tend to have a great impact. Patterns of communication networks in Wanasari tend to concentrate on those with high-class economy. This is even more in a distributed network of information with economic value. People with high economic class, in general, have high mobility and social contacts. Opportunities for people of low economic class still exist, but their opportunities to become leaders are slim.

Studies of social communication networks seek to identify the role of individuals as becoming opinion leaders. In the old paradigm, leadership is seen as belonging to individuals who are highly influential. Leadership, including opinion leaders, is generally seen as top-down process (Allen, 1989). Studies of leadership assume that leaders and leadership depend on people who have the authority and tha usually exists at the top of the group, organisation or community.

One thing that must be revised over time is that the leadership should be viewed from all directions. The way leadership moves through the system and the way these networks and relationships among multiple leaders create leadership (Allen, 1989) are factors that require a closer look. With multiple levels of leadership lies the influence of some people who play an important role in the group.

Field observations indicate that young people usually take lead while in a group. For example, in communication networks of social problems, leaders were identified within 39 years of age, being elementary teachers or fish farmers, using mobile phone and Internet. They have worked in NGOs. From here we can see that the experience in question and the personal character determined their decision-making roles.

In view of multiple levels of opinion leadership, people oriented to various groups in society are usually more influential. Referring to the involvement of opinion leaders in the five existing communication networks,, it can be said that opinion leaders comprise of those who are able to reach many levels of society in the village because of their work, education and experience.

The diversity of information owned and controlled by opinion leaders is gained from the interaction with other leaders. It is hard to imagine an opinion leader to

master many things in a short time. For that, opinion leaders communicate with each other about knowledge they have and then build up on those knowledge in not too long time.

Empirical studies indicate the existence of a strong clue that the person who has many relationships in communication networks tend to have lots of information and have a great impact. The patterns of sociometry are the relationship between members of society. It also establishes regular patterns of centralisation and leadership competitions. Thus, many people who have information are usually opinion leaders since they become the persons to consult. The role of opinion leaders in encouraging people to receive an innovation is enormous. Rogers proved it in his research on Li Oryu villages in South Korea, where socio-economic progress in the village was achieved, thanks to the informal leaders or opinion leaders (Rogers, 1976).

In real life, there is a combination of two factors that determine someone's leading in the society. The society picks its leader as needed, according to the description and expectations. In contrast, an elected leader is a person who is active in groups, through his activities.

A leader in the community is, one who fulfils the actualisation of needs, able to influence and urge people to perform what is considered as the wishes of the people.

Hierarchy is closely related to social leaders. Social leaders or opinion leaders are bound by social contacts, which are achieved by extraordinary people. Because of their position and contacts they are seen, heard, read, experienced, and known.

Research findings of social communication networks in Wanasari reveal that any one person does not hold the position of an opinion leader. Opinion leaders made up of people who have a high awareness of the condition of all-strapped in the village. In the background they have some similarities, such as:

- Education background: senior high school, diploma, andundergraduate.
- Working as fish farmers, in addition to other basic work.
- Relatively the same age (37-40 years).
- Active in social organization.
- Having good access to a variety of sources such as members of Local Parliament, Head of Department, NGOs and other institutions.

Besides having some similarities, they also have some differences in personal characteristics. The traits comprise of their boldness at what they speak, courage to take risks and to try new things and strength to accept defeat. They also maintain patience, speak slowly, take careful, thoughtful decisions, and are usually good listeners.

The combinations of these people generate multiple levels of opinion leadership. To defend the interests of the poor, the first characters are the ones to be heard

and those who dare to take risks. Meanwhile, to deal with officials in the formal structure, leadership requires patience and reasonability. So, for the same objective, leadership qualities are integrated between the stakeholders in order to achieve welfare of the community.

Opinion leaders gain trust of their followers based on various considerations. As described above, those with high concern for people around them are opinion leaders. Trust is not gained solely but it arises through the process of interaction in everyday life. For example, a worker's advice may not be taken or accepted while extending a fishpond compared with people who have many years of managing a fishpond, have extensive knowledge about gains and losses.

Trust is a natural process that is obtained as proof of what a person is tasked with at work. If one can prove that his opinion with fact, the confidence level will be higher. In view of Rogers (1983), aspect of the ability to observe (observability) is important for an innovation to be followed by others.

In context of rural communities, manners and culture of shame are still preserved. In communication, socio-cultural aspects are crucial, such as age, socioeconomic status and position/title of the communicators. For example, for people who have same socio-economic status, like a fisherman, messages can be exchanged instantly. However, when these people have differences in socio-economic status, such as, between a boat owner and a fish farm owner commonly called the skipper (juragan), there is a custom to deliver a message through someone who already has proximity to the sources.

Communication patterns based on the structural hierarchy are complementary to the suggestions by Berlo & Rogers. Berlo (1960) argues that people from different social classes will communicate differently. According to Rogers (1983) there is relationship between personal characteristics of members in a social system such as innovative and cosmopolitan and characteristics of the social behaviour such as norms and the properties of systems of innovation with the use of communication channels. Second opinion shows that the social characteristics of individuals are ones that affect the use of communications channels that are selected as the source of information.

The Use of Mobile Phone among the Poor

Advances in technology have increased social mobility and enabled people to interact with each other where interaction takes place in the form of personal contacts, followed by the exchange of ideas and experiences. Human relations between one nation and another nation in an ever growing world are becoming increasingly narrow. McLuhan called the world today as a global village (Straubhaar &Larose, 2002). Television creates, in terms of McLuhan's global village, word of gossip to let people feel close to what they said.

Sources of information more widely used are TV, radio, and mobile phone. Almost all respondents have TV, nearly a third has radio, and almost half of respondents

own a mobile phone. Media are still not optimally used for information of economic value. TV is mostly used to watch soap operas, radio to listen to songs and music, and mobile phones are used to communicate for family and personal affairs.

While radio broadcasting content is determined from the centre, it does not answer the information needs of the community. Media content has become indispensable for survival. A communications network linked through radio, television, film, newspapers and mobile phones covers almost the entire country.

From the five social communication networks in Wanasari, interpersonal communication channels are the main sources of information. Sources of information however, have no connection with the structure. For example, for information regarding social issues, water issues, finances, etcetera, respondents communicate with their family, relatives, and neighbours. The ones finding solutions are those who mastered and understood the information.

It is understood through the sociometry that only a subset of respondents provides response to information received from various channels of communication in a communications network. Response is shown by funnelling information back to others, by seeking additional information, or confirming information to their social networks. It turns out that most do not try to ask again or confirm the information they receive. This shows that interpersonal communication is more familiar.

In societies where interpersonal communication channels exist, other media are less empowered as a channel for valuable information. For example, information about training and job vacancies from various companies is placed on the bulletin boards of Social Services, Manpower and Transmigration, which is located in the city district. People seeking work at home and abroad, use interpersonal communication channels with people who are well known as an agent working with a network of recruitment offices in Jakarta.

Other findings show the structural barriers in terms of distribution of the information needed by the community. Information in the fields of education, workforce employment, training, marketing, sales, and even the location of fishing, in fact is more favourable for information elite. For example, the field of human resource development is aimed for those who first have an adequate level of education. Brokers who have the capital hold information on the marketing, sales, and credit. Similarly bakul skipper and skipper of the boat control the fishing locations.

Opinion leaders can be identified strategically by observing usage of mobile phone. However, not all mobile phone users are opinion leaders. This is because, the key position on the ownership of the phone is different and therefore the users' level of influence on information and society will also vary. Thus not everyone who has a mobile phone can be called an informal opinion leader, but each one can be a source of influence that has the potential to rival the formal opinion leaders. The availability of technology makes it possible to reach the source of information and disseminate information more quickly.

The fifth structure of communication network is a combined network of social

issues, water issues, finances, employment, and aid groups. While this network maintains overlap of the issues, 'communication network structure of social problems' found more clicks. In the daily interaction, respondents only interact with family, neighbours, relatives and friends who physically have a close distance of residence. Those in a social network generally live in the same village and/or make friends with people from neighbouring villages.

Kinship networks are still influential. Communication network that exists among people who are still bound by family ties or kinship, in fact, can be channelled a variety of information. Among the people in a family, one can distribute information on existing networks and interconnect with each other. Uncles, nephews and cousins were found in the 'communication networks of social problems'. Although the age difference among the three relations is far, all three are still able to communicate across the generations.

Those five networks of social communication identified are not extended, not just because of the deployment or ease of obtaining information, but because the trickle-down effect is still big. The orientation of the upper layer is expected to immediately convey the information it holds to the tier below. The framework builds on the philosophy that the success achieved by large employers, in turn, will also be felt by small businesses under it. Even from the communication aspect though, trickle-down effect models can be found in the two-stage model of communication or two-step flow of communication, the information submitted to the community leaders, in turn, will come to his followers (Katz & Lazarsfeld, 1955). The gradual pattern of communication would ideally form a communication network that is able to reach many members, including those from the lower layers.

Previous studies showed that channelling information from the top layer to the needy could not be ensured (Setiawan, 1980, 1989). A tendency to hold or retain the information was observed.

Addressing poverty will never be effective by only touching the poor just because the people have been associated with the structures and networks. Poverty is a structural product of inter-related, namely the economic structure, education, health, and social networking. Social communication networks have limitations and these limitations make the eradication of poverty difficult.

Limited access is the biggest of all the reasons that makes a person likely to experience poverty. Due to that a poor person cannot afford to get education, health services, nutritious food, proper clothing, and adequate housing. Their inability to enter the labour market makes it difficult for them to earn money for the household. In fact, poverty can bar people from entering the social communication network due to their differences with socio-economic status of other members of the network.

Due to scarcity or lack of information, communication networks play a vital in coastal villages. Fisheries owners and fish farmers seek information about weather forecasts ahead of going to the sea, rainfall forecast for the supply of fresh water, pond water quality improvement efforts , efforts to increase soil nutrients,

production of processed fishery, marketing, business management, technology, fisheries, etc.

In addition, limited knowledge about the marketing area and the limited ability to reach markets suggest that fish farmers and fishermen have not undergone significant changes. Middlemen dominate a wide area of marketing by purchasing the commodity from fish farmers and fishermen. Fish farmers and fishermen are not likely to have an incentive to increase production when they do not know the market areas. This as a result directly reduces their motivation to increase production. In absence of the knowledge about marketing area fishermen are reluctant to engage in communication networks of financial aid and credit .

If the fishermen and fish farmers know about the potential market, they can increase production to meet demands. For example, by organising exhibitions can open potential market. The next problem is how these markets can be reached. The problem here is not just related to technical matters such as processing, packing, shipping, but it also includes making contacts with people in network marketing.

Fish farmers and fisher folks in the rural areas are not used to having open communications with anyone new. With limited exposure and understanding of information, it is difficult to develop a rural fishing community. This is a common weakness that can be addressed easily by bringing in large companies to help marketing. The result once again benefits the large employers, while small employers make a meagre profit.

In the traditional business, communication is mostly done through personal interaction or what is said to be interpersonal communication. Although such a relationship is more effective to foster familiarity, the capacity is very limited and cannot be relied upon to reach or even break through structural barriers, such as in the field of marketing. Thus, the commodities produced simply meet basic needs and sometimes even less.

Almost all activities aimed at improving rural people's income cannot be separated from the bureaucratic services. Bureaucratic procedures are often found in government service. For example, for loans and aid procedures for small businesses such as banking services, there are some general procedures. The villagers will not be interested, because of the difficulty in receiving and understanding information in order to meet these requirements.

Cooperative, which is expected to contribute to improve the welfare of fishermen, only brings prosperity to the board and a handful of members (Kompas, July 2, 2009: 21). Ideally the field of cooperative activities can be expanded not only in terms of providing basic services, but it can serve beyond those provisions such as marketing, capital, sales, and business partners. Moreover, it can also provide information to improve knowledge and skills of its members.

For the provision of social support, especially among the poor, it is important to consider the explanation above. In fact people still need social support to reduce

tensions they experienced. For example, to deal with social problems associated with everyday life, people seek information from the bond strength (strong ties), the family, relatives and close friends. They are reliable because they know the difficulties experienced by the poor in their daily lives.

When it comes to finding information about new things that only a few people own and control, people generally look it from persons with whom they are formal, relatively less bonded (weak ties). But of course the process of finding information from weak ties cannot fully ensure that the information required, will reach those who require them most. Previous studies indicate that information that should be given to the less fortunate is instead distributed to an elite group's information network.

Information from the central to regional development and vice versa can be channelled through mass media. Advances in communications technology will clearly have an impact in both positive and negative socio-cultural life of society. Positively, these advances would give the possibility of better communication, faster, and greater audience exposure. Conversely, conflict of values in the cultural background because of a technological shift in a society can have a negative impact.

Technology makes communication between members within communication networks easy. In addition, it speeds up the communication, overcomes barriers of distance and time, and expands existing network. As Monge and Contractor (2003) said, communication technology such as phones, mobile phone, and the Internet has allowed people to communicate more freely. Even the physical proximity can now be replaced with electronic proximity.

But based on the data findings, as much as these assumptions have been reinforced and they have also been denied. Although technology speeds up communication, overcomes barriers of distance and time, technology has not proved itself capable of expanding the network. This is evidenced by the pattern of utilisation of mobile phones. Mobile phones are used to contact people who had previously been known and have become part or a new member of the network. In this case there are obstacles that cannot be solved by communication technology.

Barriers in the use of communications technology in this study are mainly caused by structural factors. For example, in a community there is social stratification based on socio-economic status of people. A ship owner is free to contact helmsman via mobile phone, but it cannot be vice versa. Even those who have higher socio-economic status still need another person as a liaison i.e someone who knows the owner well or is relevant in the protocol.

Patterns of media consumption among the poor in the region show more use of media for entertainment. Telecommunications service is expected to act as an equaliser, on the assumption that all people have the ability to use the same technology so that it can make people communicate freely with anyone and can be used to find information they need. Since the service is still not optimally used, there is a need to learn how to use and utilise the phone to increase welfare.

Conclusion

Firstly, the social communication network among the poor has its own pattern of exchange. Exchange of information in five communication networks which was observed is very diverse. Respondents seek information on matters related to daily life mainly from the strong ties, such as family, relatives and neighbours. Meanwhile, for information related to things that are new (innovative), they usually seek from those with who they have relatively weak ties. People in the village are considered to have the resources or have the experience and knowledge needed.

Secondly, the role of opinion leaders has been observed polymorphic in this study. This means that opinion leaders have control over many areas. Official position of formal leadership does not have an impact on society by itself. In contrast, informal leaders are recognised and heard more. Formal leaders, despite their place in society, tend to have less influence compared with the influence of informal leaders.

Leadership is no longer seen as something that is owned by one person, but owned by more persons than one in a group. Multiple levels of opinion leadership are bestowed on those who play an important role in the group and those who can influence others. Multiple levels of opinion leadership can be relied upon in the framework of prevention and alleviation of poverty. Communication channels used are formal, while the poor has their own communication network structures that are more informal. Formal communication channels are occupied by the owners who have capital. Hence poverty lines of communication need to be routed on two paths, so that information from central reach to the regional level and from the top layer moved to the target audience in the bottom layer.

Thirdly, mobile phone technologies in social communication networks among the poor, is more widely used for matters relating to family affairs while in business it is still less common. The phone is expected to play a bigger role in the networks; it is still a tool that accelerates contacts between network members. Mobile phone is more widely used for matters relating to kinship, such as contacting family and relatives who work and live outside the village, but not fully utilised for the welfare of the poor. In fact, the phone is used for consumptive purposes and has not been used for things that are productive.

Additionally, the phone has not been able to overcome the structural obstacles in communicating within a community. This is because social structures bar people to communicate with people of higher status than them. Mobile phone has not been fully able to overcome the structural barriers as they cannot distinguish the economic status and influence of people. The upper layers of the class are free to contact people on the bottom, but it cannot be vice versa. Ideally the person having a mobile phone should be able to communicate with people outside and look for information such as employment, prices of fish, marketing, venture capital, credit, so on and so forth. But this assumption cannot be applied entirely because even among the poor, there are limitations in the knowledge about its use. Mobile phones still do not play the role of an equalizer for the welfare of community life.

Although there are many social communication networks in the community, any study on these networks in Indonesia has been rare. Given that any kind of information has different potential in terms of social integration, each type of information should be considered potential for creating communication and information distribution.

Opinion leaders are usually considered to have one distinctive characteristic. In future research, there should be emphasis on how characters among opinion leaders of opposing views work together in the study of group dynamics.

Map obtained through the communication network sociometry has been an attempt to find a channel of communication that is considered important and influential in society. Sociometry of the communication network can be used to find people who are influential in the selection of media strategy, for achieving effective and efficient communication channels. However, finding the communication network is not enough. A study should be conducted to determine the factors that affect the development of group dynamics.

The present study reveals that mobile phone has not provided a lot of influence on the expansion of the network outside the family business. It is necessary to study how mobile communications play a role in the network of kinship within the scope of the larger society or in a particular community to determine the factors influencing network expansion.

Also, it is necessary to arrange communication network to channel people's aspirations to stakeholders, both government and non-government firms. These networks are managed by the community, even though the initiative may come from the government. The networks should not be allowed to act only as an arm of government, but they can actually serve as a forum to discuss and find a way out of poverty issues at hand.

In the context of poverty alleviation and poverty reduction programme, communication process allows socialisation. The patterns of social communication networks that exist in society should be seriously studied because every layer of society has different characteristics. One of the causes of the difficulty at reducing poverty in Indonesia was the choice of multi-media strategy. The strategy has a limited target of audience. As a result, most of the information expected to reach the poor, to help them out of poverty, did not happen.

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Exploring the Social Exclusion of Women in the ICT Profession

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Abstract

The paper presents global data relating to the under-representation of women in the ICT profession – whether at the entry level or managerial level. It surveyed various literatures in an effort to explore the reasons behind such under-representation. Using a life cycle perspective and guided by the social exclusion concept, it reports on the impediments women have in accessing/using ICT devices and services; selecting their fields of study at the secondary, vocational and tertiary levels; and working in ICT companies with cultures often described as macho and anti-women. It then cites recommendations for a reversal of the phenomenon, including the inclusion of gender issues in national ICT policies.

Key Words

Women, Social Exclusion, ICT career, Access, Life Cycle Perspective

Introduction

Women are under-represented in the Information and Communication Technology (ICT) sector and this under-representation has been reported across the globe. In the Asia-Pacific region, Wangmo, Violina and Haque (2004: 12) reported that women find the Internet intimidating and believe that ICT jobs are best suitable for males. Women working in the sector hold the least secured positions. During workplace automation and computerisation they become the first to be displaced (p. 10). For this reason among others, the authors asserted, “in the ICT sector, labour is highly sex segregated.” In South Africa, James (2006: 2) stated that in 2002 “only about 20 per cent of current ICT workforce was female.” Women also earned less than men in the ICT industry and comprised of only 18 to 20 per cent of management positions. Apparently, the country has only a small base of highly skilled, predominantly white male, ICT professionals.

In Organisation and Economic Cooperation and Development (OECD) countries, women filled up only 15 to 40 per cent of ICT jobs in 2007. They likewise made up less than 25 per cent of ICT specialists in the United States, 20 per cent in northern Europe and 10 to 15 per cent elsewhere (Castano and Webster 2011: 365). Gras-Velazquez, Joyce and Debry (2009: 1) cited similar statistics. In 2010, fewer than one in five computer scientists in Europe were women. According to them, "We know that European women are significantly under-represented across the board in ICT – from education and training programmes right through to high level careers in the sector, whether in academic or industry." The countries considered to have a high gender gap in ICT professions are the Netherlands and Sweden. In Belgium, the gender gap is wider among young professionals rather than among older professionals.

But, in the OECD countries, the concern does not end with under-representation. The number of women in the ICT sector has also been in decline. Statistics from the OECD indicated that in the European Union, the percentage of women employed in the ICT sector remained stagnant from 2001 to 2006 while that of men increased. In the US, women's share in the science workforce has been decreasing since 2000 – even reaching below 25 percent in 2009. Such indicators raise the alarm that there may be a widening gender disparity in the sector over the long term in OECD countries.

In light of these developments, the World Congress on Information Technology (WCIT) held in Montreal in October 2012 focused on attracting women into the ICT sector and retaining them. WCIT CEO Francois Morin, in an October 23, 2012 interview with The Montreal Gazette, explained that "We are facing all around the world a decrease in IT enrolments and this is not only in Canada, it is in every country. Women represent nearly 50 per cent of the workforce, but make up only 25 per cent of the IT industry." Morin found it ironic that more women graduate from university but less of them take up jobs in the ICT sector. He felt that the sector is losing out on women's ability to manage projects and teams successfully.

With these in mind, this paper explores possible reasons why women are under-represented in the ICT sector using a life cycle perspective. In addition, it questions whether such under-representation merely reflected a broader phenomenon, i.e., the social exclusion of women. The paper explains first the life cycle perspective and later, elaborates on the social exclusion concept. It then interprets data from various secondary sources to shed light on various life trajectories – access to ICT, education and employment (early and later stages).

Life Cycle Perspective

Several researchers (Cohoon 2010, Palmen 2010 and Castano and Webster 2011) have expressed preference towards the life cycle perspective in analysing the plight of women in the ICT profession. For them, the leaky pipeline approach (the traditional way of observing the phenomenon) is based on an erroneous assumption that women follow an orderly linear progression in their careers – from education to career development – and those women disappear as they move

along this set of progression. The pipeline is considered to be a metaphor illustrating that women leak away from the profession at certain junctures in time. This notion explains why there are very few of them occupying managerial positions.

For Castano and Webster (2011: 368), the leaky pipeline approach "makes no provision for alternative educational and career pathways." It also fails to recognise the social, political and cultural factors influencing women in making career decisions. The life cycle perspective, on the other hand, brings forward the sequencing of stages in an individual's life, which moves along differing pathways. A person experiences transitions, trajectories, life events and turning points in their life courses. Castano and Webster (2011: 370) explained that:

> *"transitions' are changes in roles and statuses experienced by individual women or men; 'trajectories' are long-term patterns of stability and change that involve multiple transitions in an individual's life; 'life events' are significant occurrences involving relatively abrupt change that may produce serious long lasting events in an individual's life; and 'turning points' are a substantial change or discontinuity in direction that is not temporary, but lasting."*

These transitions, trajectories, life events and turning points define, to a large extent, career decisions made by women and men. Castano and Webster (2011: 370-71) contended that life events such as "family relationships, educational choices and achievements, family formation, geographical mobility patterns, labour market participation patterns and decisions separately and in combination influence women's ability to engage in this field." In light of this, the life cycle of women and men differ from each other and its various stages impact on their careers in unlike ways.

For example, due to sex role differentiation and stereotyping, there are certain expectations from women when they marry or when they have children, which are different from that of men. In many societies, married women who chose or are allowed to work are also expected to manage the household and take care of their husband. Women with children are expected to prioritise family over career. For this reason, they opt for jobs that require less pressure and they prefer positions that are not critical to the organisation. Men, on the other hand, are considered breadwinners of the family. As such, they are somewhat exempted from household management and child rearing responsibilities in order to focus on their job – thus being able to face the pressure and climb the organisational ladder.

Social Exclusion of Women

Sex role differentiation and stereotyping are major reasons for the exclusion of women in the ICT sector. Social exclusion relates to the deprivation of an individual to certain advancements in society due to the relative position of the group the said individual belongs to. To illustrate, an individual may be excluded from being employed, receiving education or from accessing digital technologies

due to his/her membership to an ethnic/religious minority or gender group. Sometimes, an individual may be excluded due to their membership to many other disadvantaged societal groups – youth, aged, people with disabilities, people living in geographically disadvantaged areas, etc. Mancinelli (2007: 7) identified digital exclusion as a manifestation of social exclusion. For her, "the digital divide is basically about social access to digital technologies" as it "considers social relations around the uses of ICT."

Mancinelli (2007: 7) described the three types of digital divides: (1) access divide (those with and without access to ICT); (2) usage divide (those who use and do not use ICT); and (3) quality of use divide (difference in usage by users). Keniston (2003: 1) earlier discussed the linguistic and cultural divide – those who can speak English or another West European language and those who do not. For Mancinelli (p. 8), the lack of access to digital technologies puts individuals at disadvantage. They are excluded from benefiting from changes in social structure and relationships; new working methods; new ways of education and training; and communities of learners/citizens.

Parsons and Hick (2008: 4) concurred stating, "the lack of Internet services increasingly threatens the chances of many people to find good jobs and participate in the affairs of the broader society." They (p. 6) added that digital exclusion may have severe consequences such as academic failure, social isolation, increased unemployment, lower competitiveness and inability to participate in social and political spheres. In this way, since women are susceptible to digital exclusion, they are less likely to become attracted and/or aspire for careers in ICT sector.

The next sections of the paper explores the status of women and ICTs using a life cycle perspective – from having access to digital technologies, selecting a field for their education, and employment from early to later stages.

Women's Access to ICTs

Digital exclusion is perhaps the biggest barrier for women entering the ICT sector. Women need to be habituated with digital technology first before they become attracted to it and contemplate pursuing careers in it. DiMaggio and Hargittai (2001: 1) spelled out five dimensions of digital inequality – in equipment, autonomy of use, skill, social support and the purposes for which the technology is employed. Various studies indicated digitally the inequality in these five areas between men and women in different parts of the globe.

One very useful measurement of this inequality is the Digital Divide Index (DDIX). Husing and Selhofer (2002: 1277), after measuring social inequalities in European ICT adoption, concluded high risks groups for gender (women), age (50 years and older), education (low education group) and income (low income group). The DDIX indicators considered the percentage of total computer users, percentage of computer users at home, percentage of total Internet users and percentage of

Internet users at home. The European averages have not changed very much between early 1997 and late 2000, finds a study in its DDIX. The gender and the income divides have slightly decreased, while the age divide has increased. The education divide remains nearly unchanged. That means that the digital divide on the European level has not decreased since 1997. (p. 1280)

Chen and Wellman (2004) examined digital divide in terms of access and use of the Internet across eight developed and developing countries: the United States, the United Kingdom, Germany, Italy, Japan, the Republic of Korea, China and Mexico. They found out that, in these countries, men are more likely than women to have access and to use the Internet. Except for the US, the share of female Internet users is lower than 50 per cent. Nevertheless, the gender digital divide showed signs of narrowing in many countries but not in Germany and Italy.

In the Asia Pacific region, Wangmo, Violina and Haque (2004: 10) observed that women's connectivity "to ICT services is not equal to their male counterparts because of different social, economic and know-how related grounds." For example, women cannot buy or use ICT machines and services due to their relatively more inferior socio-economic position – geographic location, literacy level and local customs.

Such a situation was well documented in Pakistan. Khan and Whalley (2012) surveyed the digital connectivity of Pakistanis living in the cities of Karachi, Lahore and Quetta. They discovered that, compared with men, women spend less time on the Internet. Only 28.6 per cent of women considered themselves to be heavy Internet users – compared to 72.0 per cent for the men. In addition, 71.4 per cent of women described themselves as low Internet users – the figure for men is a measly 28.0 per cent. (p. 41) In Indonesia, Wangmo, Violina and Haque (2004: 118) reported that only 24.14 per cent of Internet users are women.

With less access and usage of the ICT devices and services, women may not be aware of the potentials of careers in the sector. Hence, when they select a field of study, they may be directed to take traditional or alternative routes. These will be discussed in the following section.

Women ICT Study and Career Decisions

Between the ages of 13 to 17 years old, people make critical decisions about their careers. From this decision, they select what field to study – whether science, arts, engineering or technology. According to Gras-Velazquez, Joyce and Derby (2009: 1), "education data shows that at age 15, girls and boys have roughly the same preferences and ability in science and technology, but as they progress towards adulthood, girls generally drop out of science, engineering and technology to pursue other subjects."

Researchers (Gras-Velazquez, Joyce and Derby, 2009; Castano and Webster, 2011; and Omamo, Abagi and Sifuna, 2005) generally point to socialisation as the reason for this occurrence. Socialisation may be defined as the learning of male and female roles from infancy. Many countries have clearly defined gender roles,

which impact on career decisions. In Korea, for example, women are stereotypically characterised as sensitive and pliable. They should devote themselves solely to housework and childcare and stay complacent in a male-oriented atmosphere. In Bangladesh, women are expected to be family-oriented as they provide most of the unpaid family labour.

After secondary education, girls drop out of ICT studies due to gender stereotyping even though they enjoy ICT studies and are competent computer users. Omamo, Abagi and Sifuna (2005: 3) mentioned several reasons why this occurs in Kenya. Firstly, parents discourage their daughters to pursue ICT courses because they are expensive. Negative attitudes such as fear of mathematics and sciences are instilled in girls at home and in school. "Girls shy away from subjects such as physics, chemistry, biology and mathematics as these fields belong to the male domain," they stated.

In Europe, Gras-Velazquez, Joyce and Derby (2009: 2) reported that many teachers and parents are "poorly educated about what ICT really entails. They are told that ICT is suited for boys. As a result, we find girls in the Netherlands thinking that ICT is more difficult than other subjects and in the UK lacking confidence in ICT.

Castano and Webster (2011: 369) stated that role models shape the trajectory of women. The absence of female role models in ICT deters girls from taking up ICT studies. Existing role models may not be tech-savvy. Gras-Velazquez, Joyce and Derby (2009: 4) noted that girls are "actively discouraged by families, teachers and career advisors from pursuing further studies or careers in the field of math, science and technology." They are also told that ICT careers do not offer travel opportunities or chances to help other people.

According to Servon (undated), for females in the US, the desire to give back to society is a powerful motivator to pursue a career (See table 1). Hence, when told that ICT careers do not offer a chance to help people, female students select another career.

Table 1: Prime Motivators of SET Talent in the US by Sex

Motivator	Male	Female
Ability to Contribute to Society	40%	51%
Being Highly Compensated	54%	45%
Receiving Recognition from Company	38%	40%
Having a Powerful Position	17%	10%

Around the globe, there are more male than female students in science, engineering and technology. Palmen (2010) presented data showing more male students sitting in ICT-related examinations in the United Kingdom in 2005 and 2010. In 2005, the percentage of female students taking GCSE ICT was 43.22, A Level ICT was 35.46 and A Level Computing was 11.27. Not much changed in 2010 with the percentage of female students sitting for GCSE ICT was 44.4, A

Level ICT was 38.1 and A Level Computing was 8.9.

Kirkup (undated), meanwhile, reported the under-representation of women in vocational training and academic programmes lead to ICT careers. He explained, "women in the UK prefer to complete vocational training in retail, commercial enterprise, health care and public services. Men, as opposed, complete training in ICT, engineering, manufacturing and construction." In Germany, women gravitate towards training in the areas of society and culture, health, management and commerce, natural sciences, food and hospitality, personal services, creative arts and education. Men move towards fields such as IT, agriculture, environment, engineering and architecture. Some similarities can be observed in Japan. Men dominate in information technology and engineering. Women focus on communication.

Table 2: Students Sitting for ICT-related Examinations in the United Kingdom by Sex

ICT-Related Examination	Year 2005		Year 2010	
	Male	Female	Male	Female
GCSE ICT	58,713 (56.78%)	44,687 (43.22%)	33,922 (55.6%)	27,100 (44.4%)
A Level ICT	9,606 (64.54%)	5,277 (35.46%)	7,543 (61.9%)	4,643 (38.1%)
A Level Computing	6,426 (88.73%)	816 (11.27%)	3,704 (91.0%)	361 (8.9%)

In Bhutan, Wangmo, Violina and Haque (2004: 45) showed that only 22 per cent of the graduates of the Royal Institute of Management (RIM) diploma course in Information Technology and Technology System were female. Similar data are reported regarding female students taking ICT tertiary courses. In the US, Cohoon (2010) revealed that only13 per cent of students in 2009 intended for a computing major in college. Alarmingly, the number has been decreasing from a high of 28 per cent in 1995. The share of women in computer science tertiary degrees is less than 20 per cent in 2009.

"Engineering culture is a tough nut to crack, it's very male. When I was an undergraduate, engineering courses were not just male they were overtly sexist and misogynist and anti-women," said Don Tapscott in an interview with The Montreal Gazette in October 2012. Tapscott is the co-author of the bestselling book Wikinomics: How Mass Collaboration Changes Everything. For this reason, low female enrolment was noted in other countries as well, including Bangladesh, Kenya and Indonesia.

Women and ICT Careers

The types of ICT professions have been expanding over the years. These include the traditional core of informatics such as occupations in design and engineering

of IT systems, software and networks. Also, on the list are new and increasingly diversified web and multimedia occupations, which combine technical skills with communication and creative skills. Emerging jobs in the sector are linked to specific application fields such as medical informatics, e-commerce platforms, customer relationship management systems, etc.

In spite of this, the trend of being unable to keep women in the ICT profession continues. Servon (undated) explained that in the US, a significant portion of young Science, Engineering and Technology (SET) talent is female. The female SET talent aged 25 to 29 is 66 per cent in science, 21 per cent in engineering, 43 per cent in technology or 41 per cent overall. However, most of these women leave the profession when they reach the ages of 35 to 40. Over half (52 per cent) of highly credentialed women have left their private sector jobs in SET.

Castano and Webster (2011) made a list of factors that cause women to leave the profession. During early employment, women may find it difficult to adjust to employer practices, gender cultures and working time. During motherhood, women are expected to balance care for family and the job, if not leave the profession entirely. As their careers progress, they meet difficulties in promotions. Older women become more vulnerable to attrition as well.

Servon (undated) characterised the SET work culture as a macho culture where women experience extreme work pressure, feelings of isolation, mysterious career paths and systems of risk and rewards. In the US, 63 percent of women report dealing with sexual harassment. More than a quarter of them feel that they are considered less capable compared to their male counterparts. In Spain, engineering is considered traditionally a masculine profession. The word "masculine" is associated with individualistic, competitive, authoritative, rationality, hard skill, toughness, total commitment and no private life. Macho culture is also characterised by quick feedback and high risk.

As women climb the ranks in this sector, their numbers dwindle. They feel extremely isolated at work. There is a lack of female role models, mentors and sponsors. Then, there is extreme work pressure. The average female global tech worker logs 73 hours a week. The usual work week is 40 hours. In addition, more than half of these workers operate in multiple time zones. They need to be available 24/7.

Wangmo, Violina and Haque (2004: 83) assessed that:

> *Even being academically fit for posts, female applicants in many instances voluntarily give up their interest for application for the job because other non-academic requirements do not fit with them. For example, a professional female engineer who has to spend many hours for household activities (for example, rearing children, caring households, etc.) cannot fulfil non-academic requirements like ability to work under pressure, ability to develop expertise within the shortest possible time and with minimum supervision. So, these kinds of requirements in effect, work as obstacles for entering female IT professional in IT related job market.*

Women are also confused about what it takes to get ahead, stated Servon (undated). Around 45 per cent of SET women feel stalled in their careers while 83 per cent are without sponsors. The macho work culture encourages a state of crisis. Risks are perceived as being greater for women. Since women do less to advertise their success, they are relegated as producers rather than as creators. In such condition, women are usually not promoted beyond project management. Social scientists have termed the phenomenon of not giving women higher positions in management as the glass ceiling effect. As shown earlier, very few women get to upper management position in the ICT industry.

Wangmo, Violina and Haque (2004: 110) similarly pointed that in Indonesia, some ICT jobs require commitment to "work extra and long working hours with intensive field visits." Some jobs are only open for male applicants while some set an age bar. These kinds of job application requirements in ICT sector discourage potential female workers.

Conclusion and Recommendations

The study, at the onset, presented data indicating the under-representation of women in the ICT sector – be it at entry-level positions or top executive ones. It then explored the reasons for the under-representation of women in the sector. It first showed how women are digitally excluded from accessing and using digital technologies. Such exclusion has a bearing on women pursuing ICT careers, as they need to overcome socio-cultural barriers in order to become familiar and adopt digital technologies.

When women make career decisions, their role models discourage them from studying math, science, engineering and technology. The reason is the gendering of professions. Women are told that by nature, they are poor in ICT. Hence, fewer women sit in ICT examinations in secondary school and take up ICT-related vocational education. The same trend was shown at the tertiary level.

For women who entered the ICT profession, a macho work culture proves too difficult for them. Women experience sexual harassment along with extreme work pressure, odd working hours, confusing career paths and the glass ceiling effect. In this light, many women leave the profession in the ages of 35 to 40 – no longer able to balance between work and family given responsibilities at home and of motherhood. From all these data, it may be surmised that women are socially and systematically excluded from the ICT sector at different points in their life cycle. Women are a high risk group for digital exclusion, discouraged to study courses leading to ICT jobs and discriminated against once they start working or persevere in male-dominated ICT professions.

How to attract more women to the ICT sector and keep them there? Cohoon (2010) suggested active recruiting, mentoring, encouragement and appreciation, inclusive effective pedagogy, feedback for realistic assessment, flexible work arrangements, minimise and inoculate against stereotype threat, inhibit implicit bias, etc. Gras-Velazquez, Joyce and Derby (2011) mentioned several micro level initiatives by companies and organisations to attract women to the ICT sector.

These include companies such as Pfizer, CISCO, Intel, General Electric, etc.

Omamo, Abagi and Sifuna (2005: 6) specified an enabling environment for success where there is freedom of choice. For them, empowerment is associated with acquisition of the right knowledge, skills and attitudes that would enhance one's chances of excelling in their careers and leading a healthy and comfortable life – being able to access basic needs and services of life. They added that "unless Kenya adopts far more people-oriented education and development policies and strategies, it is likely not to be able to motivate and attract the majority of women to feel free to access and appropriate ICT for their own development and that of their communities."

Wangmo, Violina and Haque (2004: 124) recommended the mainstreaming of gender in national ICT policy and in related policies and regulations. They likewise mentioned the need to provide the necessary support to enable wider access of women in ICTs through the expansion of ICT infrastructure. Women should also be taught ICT skills. The point being made, in the end, is that to improve this situation, every country, organisation and person should do their part to address the issue of women under-representation in the ICT profession. There should be a concerted effort to end their social exclusion at every point of their life cycle.

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Applications of 3G Technology: Views of Teachers and Students in Dhaka City

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Abstract

Bangladesh recently touched a new milestone in Information and Communication Technology with the inauguration of commercial testing of Third Generation (3G) services through the state-run mobile service provider Teletalk. Teletalk will distribute 400,000 (4-lac) 3G-enabled Subscriber Identity Module-SIMs' for the capital Dhaka primarily. 3G is expected to open new windows for mobile phone users. It's a giant leap for Bangladesh. The advantages of 3G services include faster data connectivity, which means downloading contents will consume lesser time and web surfing will be a lot more fun. It will facilitate optimum usage of data intensive applications through uninterrupted video streaming on phones, video calls and MMSs. The service will bridge the gap of education standards between Bangladesh and rest of the world. This paper evaluates how teachers and students of Bangladesh can effectively use 3G. Understanding the impact of 3G, especially in education, could be seen as strategically crucial for Bangladesh moving forward as the country can enter a new epoch through wide use of 3G. Pedagogues will have central roles to play in taking education forward through the use of 3G and the way ICT is integrated in education. Two key areas have been addressed in this paper: an analysis of 3G and its impact on teachers; and an evaluation of the students' abilities to think critically, especially when 3G is concerned.

Keywords

Applications, 3G, education system, e-learning

Introduction

Third generation (3G) has dominated technological evolution in the world for about a decade. In Bangladesh however, 3G is still about to make way in. The state-run mobile service Teletalk is providing this facility. Teletalk is distributing 400,000 (4-lac) 3G-enabled Subscriber Identity Module-SIMs' for the capital Dhaka primarily (www.bdnews24.com, 2012). 3G is expected to open new windows for multimedia phone users. Many devices are integrating 3G functions to ensure benefits and best experiences for users. The speed, efficiency and connectivity will be better than before. The technology offers faster connectivity, with contents streamed like never before. The application services such as video call and its clarity will be enhanced when both parties communicate using 3G.

Generally the First Generation (1G) of wireless technologies is used for the needs of voice services. The Second Generation (2G) started with digital content transportation but at low speeds. General Packet Radio Switching (G.P.R.S) and Enhanced Data rates Evolution (E.D.G.E) made it possible to run any educational application at speeds of 128 Kbps (Kilo Bits Per Second) and 384 Kbps. The third generation (3 G) makes applications run at incredibly high bit rates with an affordable price (http://en.wikipedia.org/wiki/History_of_mobile_phones).

According to Bangladesh Telecommunication Regulatory Commission (BTRC), the total number of cell phone users has reached 97.475 million at the end of November 2012. The total number of internet subscribers has reached 29415.693 thousand at the end of July 2012 (http://www.btrc.gov.bd). Now-a-days students all over the world are "digital natives". They are growing up in a decidedly digital world. Digital learning educates students using the same technology they use for communication and entertainment outside of school. Also, teachers too are engaged with the technology for research, assignments and other communication. Some of them prepare their lectures using the internet, while some even deliver their lectures to students by using the internet. Many studies (Attewell, 2005; Murat et al, 2008) have revealed in the past that mobile technologies have considerable potential to enhance teaching and learning across all education sectors. Their impact on student behaviour, enthusiasm, motivation and progress is well documented, especially in some conventional schools in the UK (Cook et al. 2007).

The National Training and Simulation Association and the U.S. Department of Education studied that technology based instruction can reduce the time students take to reach a learning objective by 30 to 80 per cent. According to a meta-analysis and review of online learning studies by the U.S. Department of Education, on average, students in online learning conditions performed better than those receiving face-to-face instruction. (Means et al., 2009)

Third Generation can bring a profound impact on economic landscape of Bangladesh. It can widen the scale of services in the rural areas such as the scope of education through e-learning and healthcare through telemedicine. Students at rural schools and colleges can gather knowledge on different topics, develop

themselves better with an interest in regular education, thanks to the new technology and faster internet connectivity. (Singha, 2012)

In this paper I examine how teachers and students can effectively reap the benefits of 3G in Dhaka city. Also, understanding the impact of 3G, especially in education, could be seen as strategically crucial for Bangladesh moving forward as the country can enter a new epoch through wider use of 3G. Teachers will have central roles to play in taking education forward through the use of 3G and the way ICT is integrated in education. Two key areas have been addressed in this paper: an analysis of 3G and its impact on teachers; and an evaluation of the students' abilities to think critically, especially when 3G is concerned.

The results and analysis of the applications of 3G among the college and university teachers and students in Dhaka city have been presented within a comparative framework. The hypothesis of this research work has found that the teachers and students in Dhaka city maintain positive views about 3G mobile phones for academic purposes and towards facilitating the facilitate education system of Bangladesh.

Literature Review

Globally, 3G technology adoption has maintained a steady growth. Also, there has been a wide range of 3G diffusion levels across the world. In Bangladesh however, it is a new dimension. No research therefore was available in this particular field in Bangladesh. This study has however, obtained research on the technology elsewhere outside Bangladesh.

The region of Asia trumped all others in 3G adoption with close to 52 per cent of the world 3G market share as early as in 2006 (ITU, 2006). More recently, Asia-Pacific was home to an estimated 158 million 3G subscribers in 2008 and is expected to reach 564 million subscribers by 2013 (Suppiah, 2009). Historically, Korea, Italy, Japan, Portugal and Hong Kong were the top five 3G mobile economies in terms of 3G mobile penetration rate (ITU, 2006). According to the official ITU report, while the number one 3G nation, Korea, had a penetration rate as high as 25.95 per cent, the number five country, Hong Kong, reached only about one third of Korea's rate (8.19 per cent). It is evident that there are significant regional differences in the number of 3G subscribers. While close to half of the 3G subscribers are located in the region of Asia, less than thirteen per cent of them are in Europe.

Pew Research Centre's Internet & American Life Project finds that almost a third of American adults have used mobile devices to access the internet, and 19 per cent of survey respondents had used a smartphone or other cell phone to access the internet the day before the survey (Horrigan, 2009). Pew Research found that for people ages 18-29, access to information on-the-go is a more important aspect of mobile technology (60 per cent) than staying in touch with others (57 per cent).

Teenagers are slightly less likely to go online using mobile devices than adults or undergraduate students, with only 27 per cent reporting that they access the

internet from their phones. Older teens, who have more disposable income to pay for mobile internet connectivity, are more likely to access the internet from mobile devices than younger teens (Lenhart, Ling, Campbell, & Purcell, Kristen, 2010).

Sakulsri Srisaracam, a lecturer at the Faculty of Communication Arts, Dhurakij Pundit University, said that with the 3G network, "we will see an education everywhere at any time scenario." Lecturers and students will be always connected. They can download contents, textbooks, and learning applications easily onto their mobile devices. They also can interact and keep in touch with teachers. (The Nation, 2012) He also added if lecturers can develop innovative learning, which encourages and engages students to stay connected with learning via mobile devices, the 3G network will prove very beneficial.

Mana Treelayapewat, deputy dean of Mass Communication Faculty at University of Thai Chamber of Commerce, said availability of 3G network will be good for education as it would help improve online learning with greater speed, especially if 3G network can reach the whole country. It will help bridge the gap in education of urban and rural students. (The Nation, 2012)

EDUCAUSE surveyed undergraduate students to find their use of internet using mobile devices. They found that half of the student respondents own a mobile device that can access the internet, but only a third of the students actually access the internet from this device. (Smith et al., 2009)

Cellular connections use the user's cellular network to access internet. Cellular connections can be used wherever the user has a phone signal, though often at slower speeds than WiFi networks. Most cellular connections currently use 3G technology, though carriers (and devices) are beginning to switch to 4G networks. Sprint's HTC Evo released in March 2010 is the first 4G phone in the United States, though a good percentage of the country does not have 4G network access yet (Barrett, 2010). 4G networks are expected to be twice as fast as 3G (German, 2010), which open up possibilities for faster mobile internet use and more reliable video streaming without relying on WiFi connections. People spend time on the mobile internet accessing web portals and social networks or blogs. Using portals has decreased by double digits, but social networking has increased significantly (Nielsen Wire, 2010).

Naveed Siraj, Country Manager, Intel Pakistan said third generation technology can facilitate educational needs to masses to multiply its benefits in different sectors in the future. The educational transformation is inevitable with the availability of relevant content for studies. On the other hand smartphones and tablets are in the reach of masses to connect with the world of information. (The Lahore Times, 2012)

Faculty members at a large Canadian research university related attitudes, skills, and behaviours with their orientation and use of information technology. (Anderson et al., 1998) Based on Roger's two major adopter categories, they defined the faculty members as "earlier adopters" and "mainstream faculty" and provided

strategies for reducing the gap between these two groups. (Roger, 1995) Rogers also added that mainstream faculty used information technologies for research and professional communication applications. But their adoption of these applications in teaching was very low. For this reason, Rogers recommended that to increase mainstream faculty's adoption of computer technologies for instructional purposes, the incentives, training programmes, and barriers should be taken into account in comprehensive adoption strategies.

Carter conducted a computer survey and in-depth interviews to determine computer-based technologies that were being used by the faculty members and the factors that affect their use of these technologies. Faculty attitudes toward using computer-based technologies effectively depended on factors such as the availability of support, resources, and training. (Carter, 1998)

The Technology Acceptance Model (TAM) has been considered the most useful for predicting the acceptance of information technology in consumer context. The theoretical constructs of TAM consist of two basic determinants for attitudes to use a specific system: perceived usefulness and perceived ease of use. (Davis et al., 1989) Susan et al. examined students' perceptions and their acceptance of implementing a laptop programme by adopting Technology Acceptance Model (TAM) as the theoretical framework. (Susan et al., 2006) Cheong and Park adopted an extend TAM model to explore consumer's determinant of acceptance behaviours in using mobile internet. (Cheong and Park, 2005) Factors affecting students' behavioural intention to use mobile learning were based primarily on the TAM. (Park et al., 2011 and Fadare et al., 2011)

Different types of studies were conducted to understand the factors affecting 3G adoption so far. In the study of Phuangthong and Malisawan, primary aims were to examine the factors affecting the user adoption of 3G mobile internet technology in Thailand by using TAM. (Phuangthong and Malisawan, 2005) According to this study, user acceptance is examined by the attitude and intention to use the technology.

Critical Framework

The study followed the "Diffusion of Innovation Model" provided by communication scholar and sociologist Everett M. Rogers. Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system (Rogers, 2003). He added that the study of the diffusion of innovations began during World War II, prior to the establishment of communication study in university schools and departments. To an individual or other unit of adoption, an innovation is an idea, practice, or object perceived as new. The diffusion process typically involves both mass media and interpersonal communication channels. And, in today's world, information technologies such as the internet and cell phones – which combine aspects of mass media and interpersonal channels, represent formidable tools of diffusion (Morris & Ogan, 1996). Most observers agree that the diffusion of innovations is fundamentally a communication process; communication scholars constitute only one of the

dozens of research traditions presently advancing the diffusion field (along with geography, education, marketing, public health, rural sociology, agricultural economics, general economics, political science, and others). Other communication research areas such as persuasion and attitude change and mass communication effects also began prior to the institutionalisation of communication study in university units (Rogers, 1962, 1983, 1995; 2003; Singhal & Dearing, 2006).

For convenience in understanding diffusion research results, the continuous variable of innovativeness is often divided into adopter categories, such as innovators, early adopters, early majority, late majority, and laggards (Rogers, 1983). Rogers' diffusion of innovations theory is the most appropriate for investigating the adoption of technology in higher education and educational environments (Medlin, 2001; Parisot, 1995). In fact, most diffusion researches are related to technological innovations. So, Rogers usually used the word "technology" and "innovation" as synonyms. For Rogers, "a technology is a design for instrumental action that reduces the uncertainty in the cause-effect relationships involved in achieving a desired outcome" (Rogers, 2003, p-13).

This study looks upon the role of 'innovators'. According to Rogers, innovators were willing to experience new ideas. Thus, they should be prepared to cope with unprofitable and unsuccessful innovations, and a certain level of uncertainty about the innovation. (Rogers, 2003) Also, Rogers added that innovators are the gatekeepers bringing in the innovation from outside of the system. Technology adoption process initiates with a tiny number of visionary, imaginative innovators. They often lavish great time, energy and creativity on developing new ideas and gadgets. And they love to talk about them.

Diffusion of innovations research promises to enhance the understanding of how social change occurs, a fundamental issue for all scholars of society. What is the role of technology in bringing about social change? One way to find out is through diffusion research, a micro level study of the macro level issue of social change. Scholarly interest in new communication technologies by communication students has given a special boost to interest in diffusion research in recent years. There is no reason to expect that the scholarly popularity of diffusion research by communication (and other) scholars will decrease in the foreseeable future. Innovations continue to be generated and studied. (Meyer, 2004).

Research Methods

In this study, to find the applications of 3G in education, especially among college and university teachers and students in Dhaka city, the researcher conducted systematic comparative analysis through survey and in-depth interview method. Survey method focused on improving quality and reducing cost. It sought to ensure principles about the design, collection, processing and analysis of survey in connection to the cost and quality of survey estimates. As Groves and others said that, "survey methodology is both a scientific field and a profession. Part of the task of a survey methodologist is making a large set of decisions about thousands of

individual features of a survey in order to improve it." (Groves et al., 2009)

This study took a sample of 200 respondents. The respondents were picked through stratified sampling on the basis of colleges and universities. According to Roger D. Wimmer & Joseph R. Dominick, a stratified sample is the method used to determine adequate representation of a stratum. "Stratified sampling ensures that a sample is drawn from a homogeneous subset of the population — that is, from a population that has similar characteristics." (Wimmer & Dominick, 2011, p-98) In this regard two colleges and two universities from Dhaka city have been picked. The two colleges are Bir Sreshtho Nur Muhammad Public College and Dhaka City College and the two universities are Dhaka University and Daffodil International University.

In every institution 10 respondents were chosen from among teachers and 40 from among students. So the numbers of the teachers are 40 and the numbers of students are 160. Respondents were arranged in a purposeful and quota sampling data collection system. "Purposive samples are used frequently in mass media studies when researchers select respondents who use a specific medium and are asked specific questions about that medium." (Wimmer & Dominick, 2011) He added that in purposive sampling, researchers select respondents who use a particular type of product and are chosen with knowledge that it is not representative of the general population. Roger D. Wimmer and Joshep R. Dominick said about the quota sampling that, "subjects are selected to meet a predetermined or known percentage." In this study 40 teachers and 160 students, who have knowledge about 3G technology, were chosen.

Also, this study has conducted five in-depth interviews that included ICT specialist, academician and government representative. Interviewees were Dr. Shafiul Alam Bhuiyan, ICT Specialist; Dr. Abul Mansur Ahmed, Associate Professor, Dhaka University; Md. Rezaul Karim, Principle, Northern College, Bangladesh and Prof. Dr. Md. Sirazul Hoque, Director (Planning & Development), Ministry of Education, Bangladesh. The interviews were open-ended. The interviews turned around a few innermost questions. Sometimes the researcher was not able to evaluate the interviewees, because of varying information from different people. But Paul d. Leedy and Janne Ellis Ormrod said, these kinds of interviews were "more flexible and more likely to yield information that the researcher hadn't planned to ask for." (Leedy and Ormrod, 2001)

Results and Data Analysis

In this paper, survey analysis has been conducted in six processes consisting of the purposes of using 3G mobile phones both for teachers and students, intention of using 3G mobile phone applications by students and teachers in different purposes of education, 3G will help to facilitate teaching systems, 3G will help to reduce education cost and 3G will improve learning quality. Also, in-depth interviews were accomplished on these areas. 3G mobile phone technology is a new concept to the teachers and students. Respondents of this study do not use 3G mobile phones. But as innovators they are conscious about this technology.

They mentioned their interests about 3G for their particular purposes.

Table 1: Purposes of using 3G Mobile Phone Technology

Purposes of using 3G (MR)	University and College Teachers (n= 40)	University and College Students (n= 160)
Education	35 (87.5%)	74 (46.25%)
Communication (Voice/Video Call)	26 (65%)	151 (94.375%)
Contents Download (.ppt/.pdf/.doc files, images, wallpapers, games, music, video, audio)	23 (57.5%)	97 (60.625%)
Entertainment	18 (45%)	103 (64.375%)
Mobile TV	15 (37.5%)	55 (34.375%)
Daily Life Information Enquiry	15 (37.5%)	36 (22.5%)
Watching Movie	10 (25%)	30 (18.75%)
Location Information Services	9 (22.5%)	52 (32.5%)
Business	7 (17.5%)	14 (8.75%)
Online Gaming	2 (5%)	52 (32.5%)

The table shows that teachers have the highest rate of using 3G mobile phones for education (87.5 per cent), while students are less interested than teachers in this arena. For students, the application of the technology for education (46.25 per cent) is the fourth priority. On the other hand, majority student respondents (94.375 per cent) want to use 3G for communication (video/audio call) purpose. And their second priority is for entertainment (64.375 per cent) while teachers have provided their second priority (65 per cent) in communication (video/audio call). 45 per cent teachers have their intention to use 3G for entertainment purpose. But table-1 shows that by using 3G mobile phones, downloading contents (.ppt/.pdf/.doc files, images, wallpapers, games, music, and video, audio) have the third priority for both teachers (57.5 per cent) and students (60.625 per cent). Sakulsri Srisaracam, a lecturer at the Faculty of Communication Arts, Dhurakij Pundit University, said that teachers and students can download content, textbooks, and learning applications easily onto their mobile devices. (The Nation, 2012) The information technology revolution and the restructuring of capitalism have induced a new form of society-the network society. (Narula, 2001: 29) The success of a technology depends on the model used to commercialise it. The 3G technology has the latent to open many return avenues, and hence wallets, but for the teachers and students' sake it has to be simplified. Students spend time on the mobile internet accessing web portals and social networks or blogs. Using portals has decreased by double digits, but social networking has increased significantly. Websites are an on going source of knowledge.

Table 2: Intention of Using 3G Mobile Phone Applications by Students in Different Purposes of Education

Areas of Using 3G by Students (n=160)	Never Use 3G	Rarely Use 3G	Sometimes Use 3G	Always Use 3G
Searching Web for Studies	2%	26%	18%	54%
Download Academic Contents (.pdf/.doc/.ppt files Video, Audio, Images, Graphics etc)	2%	22%	27%	49%
Discussions with Group Members	4%	27%	21%	48%
Sharing Courses Information	5%	32%	26%	37%
University/College Web Pages	6%	37%	22%	35%
Students Portal Pages	12%	38%	26%	24%
Taking Notes in Class	16%	38%	18%	28%
Doing Home Works (Reading eBooks, journals, articles etc.)	18%	36%	17%	29%
Academic Counselling	21%	30%	26%	23%
Attend Assessment Tests	24%	30%	25%	21%

Students have intentions of using 3G applications in education when it comes to searching websites for studies, downloading academic contents (.pdf/.doc/.ppt files Video, Audio, Images, Graphics etc), discussions with group members, sharing course information, university/college web pages, students portal pages, taking notes in class, doing homework (Reading eBooks, journals, articles etc), academic counselling with teachers and attending assessment tests.

The table shows that, in web searching for study purpose, majority (54 per cent) student respondents will always use 3G mobile phones, while only 2 per cent will never use it in this occasion. 98 per cent (26%+18%+54%) students will use the technology rarely, sometimes and always, respectively. Also, students show more interest in downloading academic contents (.pdf/.doc/.ppt files, video, audio, images, graphics etc) using 3G, although academic purpose was their third priority (Table-1). 98 per cent (22%+27%+49%) respondents have their intention to use 3G mobile phones rarely, sometimes and always. Table-2 shows that, near 50 per cent students always use 3G to download different academic information. Contrarily, students in Dhaka city are less interested to use 3G for attending

assessment tests (24 per cent) and academic counselling (21 per cent) than other purposes. But to use rarely, sometimes and always regarding 3G technology, overall 79 per cent (30%+26%+23%) students in academic counselling and 76 per cent (30%+25%+21%) students in attending assessment tests have expressed intention. Although, majority (24 per cent) students have no intention to use 3G mobile phones for education, table-2 shows that maximum student respondents will use 3G mobile phones for the different purposes of education.

Table 3: Intention of Using 3G Mobile Phone Applications by Teachers in Different Purposes of Education

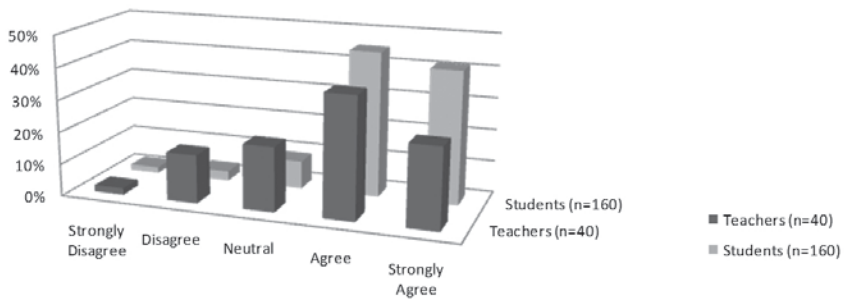
Areas of Using 3G by Teachers (n=40)	Never Use 3G	Rarely Use 3G	Sometimes Use 3G	Always Use 3G
Searching Web for Studies	0%	21%	22%	57%
University/College Web Pages	5%	31%	28%	36%
Sharing Courses Information	8%	30%	27%	35%
Discussion with Colleagues	9%	28%	36%	27%
Download Academics Contents (.pdf/.doc/.ppt Video, Audio, Images, Graphics etc)	10%	32.5%	32%	25.5%
Reading eBooks, journals, articles etc	13%	33%	15%	39%
Teachers Portal Pages	13%	29%	24%	34%
Academic Counselling	19.5%	28.75%	26%	25.75%
Taking Assessment Tests	22%	26%	29%	23%
Preparing Class Lectures	22%	25.75%	30.5%	21.75%

Faculty respondents use 3G applications in education for: searching websites for studies, university/college web pages, sharing course information, discussions with colleagues, downloading academic contents (.pdf/.doc/.ppt files video, audio, images, graphics etc), reading eBooks, journals, articles etc, teachers portal pages, academic counselling with students, taking assessment tests and preparing class lectures.

The table shows that, majority 100 per cent (21%+22%+57%) teachers are interested to use 3G rarely, sometimes and always for searching websites for studies. Both students (Table-2) and teachers have their first intention to use 3G mobile phones in this occasion. But the teachers have less intention (22 per cent)

to use 3G both for preparing class lectures and taking assessment tests. Considering 3G mobile phones in university/college web pages 95 per cent (31%+28%+36%) teachers have their second highest target to use rarely, sometimes and always. Only 10 per cent teachers will never use 3G technology in downloading academics contents (.pdf/.doc/.ppt Video, Audio, Images, Graphics etc) while only 2 per cent students (Table-2) will never use this. To use 3G rarely, sometimes and always, sharing courses information is the third priority 92 per cent (30%+27%+35%). Table-3 shows that 22 per cent teachers – constituting the highest – will have no intentions of using 3G mobile phones in different objectives of education, though it was their first choice (Table 1). But maximum respondent teachers have their intentions to use 3G technology in dissimilar considerations of education.

3G provides a wide variety of files, audio, video and data services. The larger a range of services is, the more powerful the technology. Therefore, greater variety of service can add more value to its consumers (Agarwal et al., 2007). Both students (Table-2) and teachers (Table-3) are less interested for counselling through 3G mobile phones. 92 per cent respondent teachers agreed that 3G would help sharing course information among the students while five per cent respondents of the students rejected this. 87 per cent respondents of teachers agreed that 3G would help to connect and share with student/teacher portal pages while only 12 per cent student respondents refused this. As Nielsen Wire quoted, "people spend time on the mobile internet accessing web portals and social networks or blogs. Using portals has decreased by double digits, but social networking has increased significantly." (Nielsen, 2010). The study also found that 95 per cent respondents of teachers agreed that 3G will help to take necessary information from university or college websites while only six per cent student respondents did not agree with this statement. It is evident in the case of leading 3G economies such as Korea and Japan, which has a solid infrastructure of



	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Teachers (n=40)	2%	15%	20%	38%	25%
Students (n=160)	2%	3.00%	8.75%	45.00%	41.25%

Figure 1: 3G Mobile Phone Will Help To Facilitate Teaching Systems

information and communication environment (Henten et. al, 2004; Srivastava, 2004). Now-a-days websites are an on-going source of knowledge. Students and teachers are primarily dependent on several academically rich websites. They enrich their knowledge and views from these sites. As the Table 2 and Table 3 indicate, 100 per cent respondents of teachers agreed that 3G would help finding websites for study purposes while only two per cent student respondents rejected this.

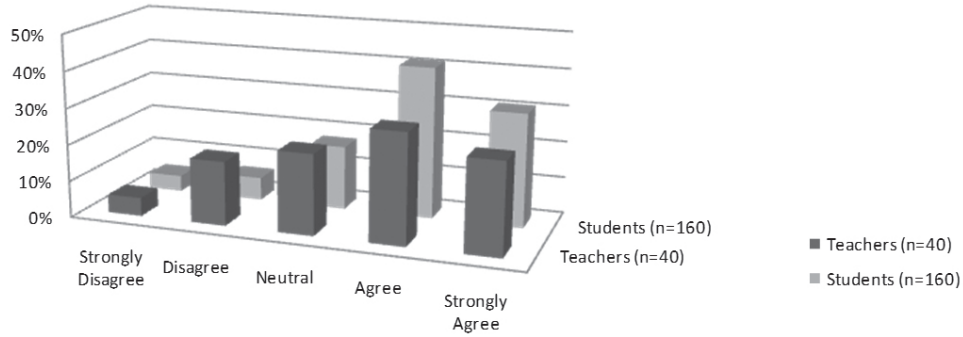
The figure indicates that 35 per cent college and university teachers agreed and 30 per cent strongly agreed that 3G technologies would enhance teaching systems. Among the students 39.38 per cent are agreed and 36.25 per cent strongly agreed with this statement. Only 20 per cent teachers maintained a neutral position while the students' percentage was below 20. Only 5.63 per cent student respondents disagreed that 3G cannot facilitate teaching systems. On the other hand, only 15 per cent respondent teachers disagreed with that statement. No one however, expressed any strong disagreement (0%). So the Figure 1 shows that, 65 per cent respondent teachers and about 76 per cent students agreed that 3G mobile phones would enhance teaching systems.

ICT specialist Dr. Shafiul Alam Bhuiyan said, though the uses of technologies in education has not touched any landmark, 3G is a new dimension. He explained, "First of all, we have to prepare the proper multimedia contents for students. For this reason we need to develop the online system." So if the online system is available only then the faculty members can post data, images, graphs etc. Dr. Bhuiyan mentioned, "The faculties have to create these multimedia applications to post contents through 3G mobile phone." Since internet speed is still too slow in Bangladeshi public and private universities, he believes, 3G technology would pave in a spaces to develop academic contents. So if teachers are able to prepare all those contents, students can use them using 3G devices. He accepted that, at that time it would enhance our teaching system.

Associate Professor Dr. Abul Mansur Ahmed agreed that, a revolution has occurred in cell phone technology of our country. This generation is already acquainted with this technology. In his words, "3G technology will be very inceptive and I believe that it will facilitate our education system. Teachers and students can utilise properly the web resource. 3G technology will make it easy." If 3G technology diffuses rapidly then teachers and students will enjoy its fruition. College principle Md. Rezaul Karim said that making proper utilisation of new technologies in education system comes with certain preconditions. Teachers need proper training on these technologies. He thinks that teachers have to know the appropriate usages of 3G technology. The skilled teachers can then demonstrate how the students can get class materials like lectures, slides, video, audio, graphics or images. Students will learn their courses using 3G mobile phones with pleasure. He mentioned, "I believe that in this way students will be very interested in e-learning by using 3G."

Prime Minister of Bangladesh already inaugurated 3G technology. Prof. Dr. Md. Sirazul Hoque, a director at the education ministry, said that, as a part of

multimedia based education, the government has decided to provide laptops for 20,500 schools. He described, "we have provided training on digital content development for 10,000 teachers. This process will be continued for other teachers." This has been stated in the country's ICT based education master plan. He added, for the first time the government will grant one laptop for one school. All classrooms will be turned into multimedia system and in the future, the management will create ICT lab for every educational institution. He remarked, "Through this process, learning in the classroom will be enjoyable. Teachers can deliver their lectures more conveniently using graphics, video, audio or images. In the process they can make education a joyful experience in their classes. This is the concept of multimedia classroom." A procedure for supplying the relevant materials is going on. The process of delivering internet connection through modem in the schools is also in progress. Dr. Hoque thinks, in this way 3G will be a new facet. Students can reap the benefits of 3G technology in their academic pursuit. In his words, "we have no way to develop our country without new technology. So we should uphold the constructive usages of 3G technology." Education is a steady indicator of wireless phone diffusion because achieving higher education has a positive association with being comfortable with higher technology use. (Wareham & Levy, 2002)



	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Teachers (n=40)	5%	18%	22%	30%	25%
Students (n=160)	4%	6.25%	17.50%	41.25%	31.00%

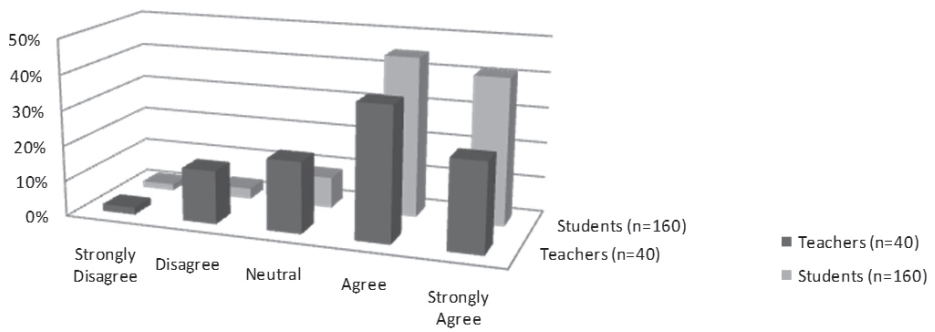
Figure 2: 3G Mobile Phone Will Help To Reduce Education Cost

In Bangladesh there are only 4.6 per cent of the budget is reserved for education sector (http://www.mof.gov.bd, 2012). Students of colleges and universities strongly believe that 3G technology would help reduce cost of education. 31 per cent respondent students strongly agreed and 41.25 per cent agreed about that statement whereas only four per cent students strongly disagreed and 6.25 per cent disagreed. 17.5 per cent respondent students have no comments about this testimonial. The figure also shows that 25 per cent university and college teachers

strongly agreed and 30 per cent agreed about reducing education cost whereas 18 per cent teachers disagreed and only five per cent strongly disagreed. 22 per cent respondent teachers are neutral. Figure 2 shows that, 72.25 per cent students think that 3G can minimise education cost while 55 per cent teachers agreed with this respectively. There is a relationship between cost minimisation and adopting 3G. Singh et al. (2010) examine the factors affecting the adoption of 3G services among Indian people. It adopted the revised Technology Acceptance Model by adding five antecedents: perceived risks, cost of adoption, perceived service quality, subjective norms, and perceived lack of knowledge. (Singh et al., 2010)

How is it possible to reduce education costs by using 3G mobile phone? Regarding this question, Dr. Shafiul Alam Bhuiyan said, it is very difficult to say how it can reduce cost of education. He however, explained, technologies provide us advantages but those are very expensive. Teachers and students need to buy 3G enabled mobile phones, which are expensive. Also, if one wants to read critically a particular article on phone it will be painful for eyes to read it. Also it will take more time to read because the fonts of mobile phone are too small. Moreover, not all contents are available online for free. “We have to pay for those. Teachers and students can find out their essential materials browsing websites. In this regard they can use 3G mobile phone. If all libraries are turned online, then everyone can take the opportunity from there.”

Dr. Abul Mansur Ahmed agreed that, it is possible to minimise education costs by using 3G mobile phone. He observed that it currently takes money to photocopy a reading material. Instead teachers and students can read the materials on their device screens. If the contents are available online then there is no need to go to a library that may be distant. So here 3G technology can cut the cost for all, he said.



	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Teachers (n=40)	2%	15%	20%	38%	25%
Students (n=160)	2%	3.00%	8.75%	45.00%	41.25%

Figure 3: 3G Mobile Phone Will Improve Learning Quality

Participant Md. Rezaul Karim explained, “If the teachers can provide lecture materials on the web this will cut down the cost of education.” State or government needs to make soft copies and PDF versions of all the text books. Only then students can read them using 3G mobile phones. They do not need to buy books any more and can save their cost on photocopies. In this process, 3G can reduce academic costs and students can apply technology in their learning process, he added. Prof. Dr. Md. Sirazul Hoque affirmed that the nation is progressing towards a Digital Bangladesh. 3G technology will be a crucial step to save time.

The figure indicates that students of colleges and universities strongly believe that 3G technology will improve the quality of learning in the education sector of Bangladesh. About 87 per cent respondent students supported this statement comprising of 41.25 per cent strong agreements from among the respondent students and 45 per cent agreements.

On the other hand, the figure also shows 63 per cent respondents of teachers believe that 3G will improve learning quality in education. Among them 25 per cent strongly agreed and 38 per cent agreed. 20 per cent teachers were unwilling to make remarks about this statement while only 8.75 per cent students maintained a neutral position. 15 per cent respondent teachers disagreed with this testimonial where only 3 per cent students disagreed. Among both teachers and students, only 2 per cent strongly believed that 3G would not improve learning quality.

Regarding this statement, Dr. Shafiul Alam Bhuiyan said, technology is not an agent itself. It facilitates the agent. It can’t provide education. Teachers provide qualitative education. For this reason it should be needed to improve the teachers’ quality. If a good teacher uses best technology then his/her learning process would be very effective. Once upon a time schools used black boards in classrooms. At that time there was no scope to provide graphical learning. But now schools can use power point and through this technology they can provide graphics, video, audio, images etcetera. So, finding excellent teachers and attentive students is important. He argued that when a teacher delivers her/his lecture, that time if the students use 3G mobile in the classroom for movie, this would not help improve the quality of education or learning. He mentioned that quality of learning would only improve when 3G technology is used at optimal level for education only.

Dr. Abul Mansur Ahmed said, “I think 3G can play a vital role in qualitative education. It may be from the faculty perspective or the students’ perspective.” He stated that quality enhancement is a relative phenomenon. Technology is now advancing more quickly. Use of latest technology can enhance education level. Faculties can ensure his or her quality through this technology. So in these circumstances he believed, “3G technology will be friendly and contributing to e-learning.” Md. Rezaul Karim added that, students’ qualitative learning will be ensured through listening and applying faculties’ lectures conscientiously. Teachers will provide learning materials through websites and students should be able to get them using their 3G mobile phones. Students will be able to observe

these once more. So they will know how to obtain clear thought about this. If they face any complication to acquire faculty lectures, they should find counselling through 3G mobile phones with the particular teacher. If students miss any class because of their illness or any other cause, they should be able to find the lecture materials through 3G mobile phones. He said, “It could be very feasible to make sure qualitative learning through 3G.” Prof. Dr. Md. Sirazul Hoque said, if we can utilise 3G technology positively, it can ensure qualitative learning. He stated, “In my point of view, 3G will facilitate multimedia classroom facilities for education.” 3G mobile enables the delivery of new services such as mobile internet and mobile multimedia (Foster, 2003).

Conclusion and Recommendations

Adoption of 3G technology in education will be a giant leap for e-learning. This study made preliminary findings from the innovators especially teachers and students about using 3G mobile phone in education. Majority respondents provided their positive attitudes towards 3G. The hypothesis of this research work has found the teachers and students in Dhaka city see the use of 3G mobile phone for academic purposes positively and believe that 3G will enhance the education system of Bangladesh. Most of the respondent students and teachers believe that, 3G will improve learning quality in the education sector of Bangladesh. If 3G is adopted by teachers and students then it is believed that the education of this country will be accelerated. However, 3G mobile phone handsets may be expensive and because of the cost, this technology may be limited to only those who can afford them. For this reason and others, an ill-fated effect of the technological revolution in communication could be further widening the knowledge gap and digital divide. Information technology will not be limited to computer science only; rather mobile phones, radio, television, data collection and processing of information are also to be included and emphasis will be given on its multi-dimensional necessity. (National Education Policy, 2010) Teachers and students can share their materials through 3G mobile phone. So, in this regard 3G can play a significant role in e-learning based education.

This study may have recommended some points. Firstly, the 3G enabled mobile phone companies need to keep their price in a suitable grip, so that teachers and students can afford the technology. For using 3G, mobile phones enabled with the technology should be used. If it is within their reach, they can make optimum use of 3G mobile phone. Secondly, a free internet (wi-fi) facility should be established in colleges and universities for e-learning through 3G mobile phone. Teachers and students can then find easy accessibility to use the technology. Third, mobile operators should minimise the cost of 3G enabled subscriber identity modules, so that students can easily buy them. Fourth, digital contents development training for the teachers requires facilitation. In this way teachers can facilitate their teaching systems in classroom and students can get the materials through 3G mobile phone. Fifth, multimedia educational contents should be made available online. This study shows that if the teachers facilitate multimedia contents in websites, this in turn can facilitate students’ learning system.

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Potentials and prospects of innovative Electro-medical Technology development in Bangladesh

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Abstract

Majority people in the Third World countries like Bangladesh are deprived from the benefits of modern healthcare technology because of many factors. A solution may be seen through empowering the Third World people technologically so that they can themselves manufacture their own equipment. In view of the lack of infrastructure necessary for industry, electro-medical items have a greater potential than conventional products since most of it involves electronics and electrical technology that can be improvised or made locally. Under the author's leadership several healthcare technology products, new technological methods, etcetera, have been innovated and most are being used in hospitals and clinics, at home and in neighbouring countries. They span from simple muscle and nerve stimulator to sophisticated EMG and evoked EMG equipment. Some methodology innovated by the author have been taken up for research by countries in Europe and Korea. New methods integrated with products and technologies for diagnosis and treatment have been innovated by the author's group. There is a high potential for innovative electro-medical technology development in countries like Bangladesh.

Introduction

Healthcare is a basic need of the human being that comes right after food, shelter and clothing. From the birth of the human civilisation, whenever we gathered new knowledge, we tried applying it for our well-being. A solution to a particular health problem may come simply through accident followed by experience, as with ancient methods of herbal medicine. These then led to systematic studies of the inner mechanisms, producing better and reproducible formulations and procedures, resulting in modern medical techniques. Thus,science and technology together contributed to an enhancement of the quality of life of the people.

Every populace in the ancient civilisations had technological innovationsof their own. Gradually with the geographic dispersal of the human race some groups became more inventive than others, based on the types of challenges they faced. For the people in the colder regions of the north, life was difficult and this led to more innovations and competitions for survival than in other regions. This then contributed to a large technological gap leading to more complex situations including political and economic hegemony and large scale technological and economic disparity.As a result,countries of the colder north have to their credit almost all the modern technological innovations in all sectors including medicine, and we in warm countries like Bangladesh have become passive users of technology, becoming an unfortunate member of the so-called Third World, experiencing unprecedented human misery. About 80% of the human population now live in this Third World, and excepting a few city and town dwellers most of their population living in the rural areas are deprived of the services of modern healthcare technology. To cite examples, ECG and X-ray techniques were invented more than one hundred years ago. We can easily guess that 80% of the global population are yet to get benefit of these inventions.Either most of them do not haveaccess to services given by such equipment, or if they have an access, the equipment is more likely to be out of order because of lack of maintenance and repair. We are not sure if the situation will change in another hundred years if things keep continuing the way that they are going now.

Lack of access to medical equipment primarily stems from the high cost of imported equipment, which has its roots in the global technological and economic disparity mentioned above. Medical equipment manufacturers have to have constant research and development (R&D) to keep abreast of latest developments and to keep up in competition. Human resource for R&D is very expensive in these countries. Besides, medical equipment are not sold in large quantities like televisions or computers. So development costs contribute to a greater portion of the price of such equipment. Expenses incurred to get the equipment tested by certified agencies and getting global patent rights are also very high. In short, the existing commercial system developed and maintained by the industrially developed countries make medical equipmentprohibitively expensive for the Third World. Even if funds are managed somehow for a limited number of centres in the Third World, the services are interrupted if something goes out of order. Often these cannot be repaired locally, andin many instances it turns out to be more cost effective to throw the equipment away and purchase a new one. While rich industrial nations can use a medical equipment through decades, we in the poor Third World have the luxury of throwing these away within a few years of procurement, sometimes even after purchase, without being able to use them at all. Because of an intense commercial competition the manufacturers try to keep their techniques secret, so it is very difficult for a Third World engineer to repair such equipment even with the requisite expertise. Some maintenance is possible with direct support from the manufacturer, but because of remoteness of manufacturers, this is also limited to minor problems. Procuring spares also pose a great challenge. With increasing use of software in computers and

microcontrollers in the recent times, maintaining secrecy has become easier and widespread; repair has become even more difficult, almost impossible in some cases.Because of economic considerations, manufacturer's support again may work through sending their own engineers for the more expensive equipment like CT scanners costing crores of taka, but this is not at all feasible for equipment like ECG costing a lakh taka; not to mention the ones costing thousands of taka.Factors beyond these are again experienced due to a severe internal disparity existing within the Third World, partly created and accelerated through adoption of modern socio-political and economic approaches promoted by the North. Due to this internal disparity, getting the services of expert doctors in the rural areas of the Third World seems a far cry.

Therefore, in view of the practicalities of the whole world, we have to think of solutions that can be achievable within the shortest possible time with the minimum of economic resources, and demanding minimum of changes in the existing socio-politico-economic order.This may need bypassing the economic and political norms established over decades. The goal is to provide the best healthcare possible to each and every person in our country, particularly the ones living in the rural areas of the Third World. The sustainability of equipment depends on many factors – technological, environmental and human. The technology definitely has to be of standard quality and safe but it also has to suit the respective environment in terms of temperature, humidity and electrical line voltage fluctuations, etc. It is a common experience that for a foreign medical equipment costing fifty thousand taka, we have to have voltage stabilisation and air conditioning facilities costing much more. Had these issues been considered at the design stage of the medical equipment itself, an extra expenditure of a few thousand takas could have provided the solution, without requiring the additional appliances and the additional infrastructural expenditure. For proper utilisation and sustainability, the design of the equipment should also suit the nature and culture of the users, i.e., it has to be user-friendly.

Most of the above problems can be solved only if the technology is developed by engineers and technologists in each country [1-4]. The manufacture and the businessinvolving such products have also to be done under the leadership of the technology innovator, with him/herself as the decision maker. The author learned this lesson the hard way, through his personal lifelong experience. Looking back to the business history of the whole world, one can see the same picture. Starting from Microsoft, Apple, Sony, IBM, Ford, Marconi, and looking back to the innovators Cartwright, Arkwright and James Watt of the past centuries, it is the same story.Unless the technology innovator turns into an entrepreneur, the product does not spread in the market successfully. The innovator only knows how to rectify errors that are encountered at different places when marketed, s/he only knows how to modify or change to new products that may be accepted by the people at the cost incurred.Therefore, the Government needs to make appropriate changes in the relevant policies to enable such innovators of technology to manufacture and market their products without going through complex compliance issues, and without harassment from agents of the Government, some of whom

may have corrupt self-interests. The Government also needs to adjust the tax policies so that the local manufacturers can have a healthy competition against similar imported equipment. A colonial history has left us with a destroyed industrial infrastructure and a large group of rich importers and traders. The influence of the latter over the past decades, even after independence, has not allowed our Government policies to provide a smooth harassment free environment for the technology innovators to become successful entrepreneurs. Policies of Government should also have necessary conditions for the procurement of local medical equipment that succeeds tests of quality, tested by neutral agencies within the country or outside. Such conditions may exist even now in papers, but these are never implemented.

There are additional benefits if indigenous R&D in medical equipment is promoted. There are diseases that have prevalence in our country but not in the industrially developed countries. Naturally, they will not invest in finding solutions to such problems unless this has a large commercial interest. If a capability to perform research is developed within our country, new ideas and methods will be developed, which will not have a matching solution from other countries.

Therefore, if we sincerely want a solution to help our people, if we want sustained healthcare for all our population, we have to promote local technology development together with a promotion of the business environment for these local innovators. The same is true for the whole of the Third World. Looking at the list of equipment currently in use, excepting the large ones like CT scanners and LINAC machines, most of the smaller equipment can be designed and developed within the Third World if adequate expertise is developed indigenously.

Why Electro-medical equipment?

Electricity and Electronics has brought in a revolution in medical technology in the last century. We have been able to probe various functionalities inside the body, which remained beyond human perception earlier because of a lack of mechanism to detect them. Advent of computer technology has contributed to diagnostic modalities that would be impossible otherwise. Besides, electricity has an intimate working relationship with our bodies and therefore, many diagnoses and treatments are becoming possible with techniques based on electricity. Therefore, it is not surprising that most of the modern medical equipment are electro-medical in nature. Countries like Bangladesh have necessary expertise in the fields of Electricity and Electronics, required to design and develop such equipment. However, the educational curriculum has a wrong orientation. Most of our engineering and technology education teach how a device works, how to test a device, how to install or run a device. The small twist needed to design and manufacture equipment is not found in our curriculum. Simply making this small twist we can achieve a great deal. Although we have a dearth of teachers with such experience, we need to start with whatever is available. Otherwise we will never reach our desired goals. Therefore, promoting the design and development

of electro-medical equipment indigenously will bring a big change in the healthcare scenario throughout the Third World.

How to bring about the Change?

Because we have not gone into technology development and manufacture of indigenous technology based products within the Third World before, the changes mentioned will not come unless some people strive to show examples. Besides, we also need expertise and experience which would not come unless some people dive into the real field.

While studying for PhD in UK, the author realised the necessity of technology to improve the quality of life of the common people. He realised that people in the industrially developed countries have developed technology for their own people. If we want the same for our people, we have to do it ourselves. A foreigner will not do it for us. Furthermore, since s/he is not familiar with the conditions and the nature of our people, it would not be possible for her/him to succeed, even if s/he wishes. Unfortunately, most of our capable minds who were given the opportunity to get higher education in science and technology in advanced countries, for whom the whole of our nation sacrificed, opted to stay back in the industrially developed countries, enriching the rich further. Unless some of us responded to this moral demand, unless policies are made to keep these brains within the country, our people will never be able to achieve a reasonable quality of life. This realisation prompted the author to come back immediately after his PhD in spite of lucrative opportunities and offers from the rich countries.For more than three decades he has concentrated in the development of technology, and more than 80 students did their M.Sc. research under his supervision at the department of Physics till 2008. He has been able to create some examples that are now attracting the youth of this generation. It is heartening to see these young people having a sincere desire to do something to change the lot of the common people, and the author sees a big hope in them. As a result of his endeavour over the last three decades, he has acquired necessary expertise and insight to guide these young people without which this vigour and energy may end up in useless efforts. Recently he has pioneered the setting up of the Department of Biomedical Physics & Technology at Dhaka Universitywhich takes only PhD and MPhil research students at present. About 15 young researchers are working under his leadership which may form a core group for the development of Electro-Medical products and for the development of related methodologies in medicine in the country. In fact, such an effort appears to be a pioneering one in the whole of the Third World and this department has already got the attention of international experts, bodies and organisations who sincerely want to see improved healthcare for all the people on the globe.

Side by side the author has set up an NGO to disseminate the technologies developed by them. Students getting a PhD degree from his department at the University can become members of this NGO giving them an opportunity for taking

the outcome of their research to the common people, and giving them a scope to continue R&D; thereby contributing to the society effectively. Within a few years this group will be prepared to give a leadership to the whole of the Third World.

The author also had an experience of successful entrepreneurship through which he was able to put a new electronic product successfully in the market. This experience is proving very helpful in disseminating the electro-medical products that his group is developing at present. Starting from basic R&D, his group is getting the training for industrial design, manufacturing and marketing, all in one place. It is already within his plans to invite young science and engineering students from the Third World to work here where they will be taught not only R&D, but manufacturing and entrepreneurship too. Through this effort he hopes to be able to spread the mission of taking the benefits of modern healthcare technology not only to the common people of Bangladesh, but to all the people of the World. The author has taken a decision of not taking out patents on his and his group's inventions. Instead they will publish their research outcome and offer the technology free to others once these reach a level of maturity.

Although the target had been the common people of the Third World, some of the research innovations of the author's group have turned out to be of potential use to people in general all over the world. Universities and research organisations in UK, Norway, Korea and Singapore have already started further research on his innovations, and these are expected to make a significant impact in the healthcare technology of the future.

At this point, it is possibly worthwhile to give a brief description of the innovations of the author, together with a brief history, which would exemplify the objective of this article.

A brief history of the author's innovations in the Electro-medical sector

Bone healing using electromagnetic stimulation entry to this exciting field

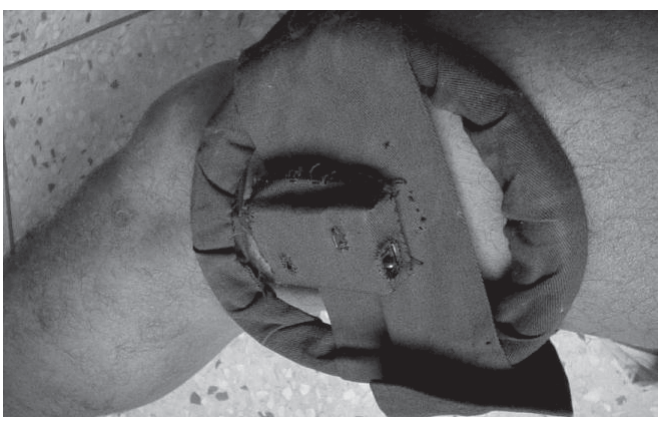

Figure 1: Portable Electromagnetic bone healing stimulator developed in early 1980's.

Although his PhD was in the field of Microelectronics, the author realised that it is impractical to put a microelectronic integrated circuit (IC) chip on the market from Bangladesh. Therefore, he was looking for an appropriate areaof research after coming back in 1978 and joining the Department of Physics of Dhaka University as an Assistant Professor. Initially he started working in the field of solar and wind energy with the support of Professor Muhtasham Hussain, and developed solar water heaters and wind mills. Soon after,he was requested bya senior Professor of his department, (Late) Professor M S Islam, to help with the instrumentation in a bone healing research project. It so happened that his friend Dr. Abdus Sattar Sayed's octogenarian father was in the hospital with a bone fracture. As if in coincidence, a BBC science report on a new research in the USA on bone healing using electro-magnetic stimulation was aired by the Bangladesh Television during that period. It instantly engaged Dr. Sayed, an enthusiastic physicist working at BCSIR to develop this research at Dhaka. For this he came to his friend Prof Islam at the University who in turn got the author into the scene. Together, this trio continued on this work for a few years and found success in a clinical trial carried out at the RIHD Dhaka with the help of orthopaedic experts. The author's expertise in designing electronic circuits, which he took up early from his school days as a hobby, helped the team in developing the necessary instruments at a very low cost, a few thousand takas only, which successfully worked during the two years of clinical trial at the hospital. Before this, the team had purchased equipment imported at a cost of 55,000 takas, but it went out of order after only two days of use. Thus, the author's expertise in designing and developing electronic circuit came to use [5,6]. Subsequently the team further went for research on animals where the author developed an instrument to give electro-magnetic stimulations to 20 rats at the same time [7-10]. On the request of another doctor, Professor Ruhal Haque (currently the health minister), the author developed a portable version of the bone stimulator which is shown in Figure 1.

Link with Sheffield University

The above work, when presented in a conference in Dhaka in 1982 drew the attention of Professor B H Brown of Sheffield, UK who was an invited speaker at the conference. Subsequently an academic link with Sheffieldbegan with Prof Islam and Prof Brown as the co-ordinators, with the support of British ODA. The author soon became a key player in this link programme. Sheffield offered a vast range of work in Medical Physics research, but the author selected items for which he could develop and make the equipment himself from scratch. Obviously the choice went for areas that involved electronic and computerised instrumentation. Seeing the author's interest the scientists at Sheffield came up with open arms to help him gather necessary expertise. First he learnt computer interfacing techniques in 1985 which were at the heart of many modern equipment.Using this expertise he led the development of a bone resonance equipment in Dhaka under a World Health Organisation project at BIRDEM, organised by Prof. M S Islam [11,12].

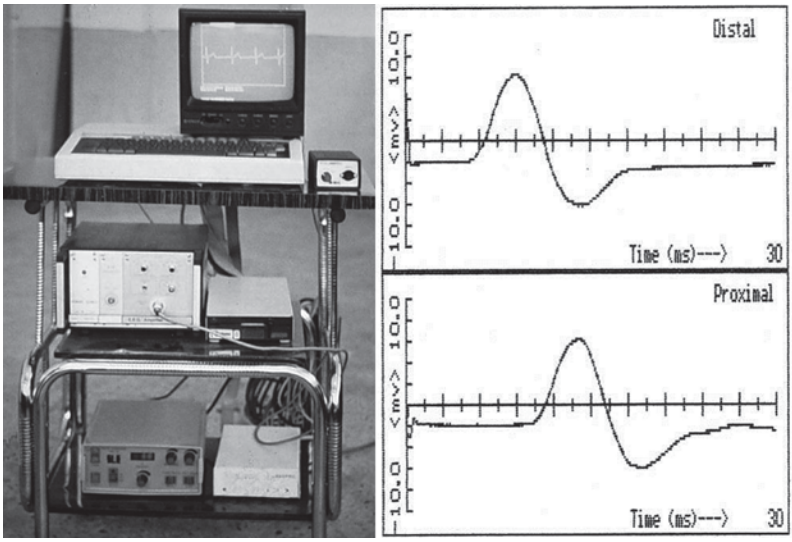

Figure 2: The computerised EMG equipment made in 1988 and two traces of evoked EMG from a patient. The equipment could alsomeasure and display EEG and ECG.

EMG equipment and nerve conduction measurement Innovation of DFL

The author also started developing a computerised EMG equipment with the target of providing investigations on nerve conduction velocity in Bangladesh for which people had to go abroad at that time. With the help of scientists at Sheffield he developed a prototype of the main equipment in 1988 [13]. Developing the necessary software he started giving routine clinical investigation of nerve conduction velocity in the same year, a first in Bangladesh. Under his supervision the same equipment is still being used, even after 24 years, for regular clinical investigation in a hospital. Doctors referring patients to him take clinical procedures based on his reports. Only the computer, the interface circuitry and the software have been changed a few times in this period. Figure 2 shows the original equipment made in 1988 together with evoked EMG waveforms picked up from a muscle. The same equipment could be used to pick up and display single channel EEG and ECG through the use of separate software, which were also developed. Figure 3 shows the current version of the equipment while Figure 4 shows its use in picking up EEG from the brain. Development of a multi-channel EEG is being planned together with Audio and Visual evoked potentials.

However, the desire to equip other local hospitals with this locally developed equipment was not successful although medical experts were satisfied with its quality. Apparently there is no incentive or regulatory support for people at purchasing positions to buy a local product even if it has quality and low price.

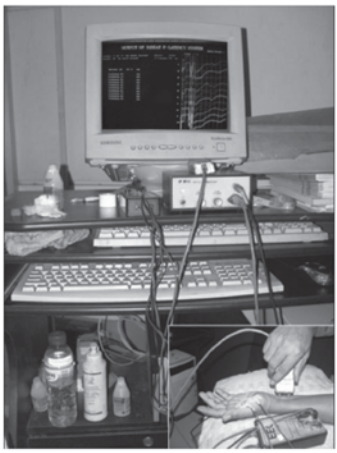

Figure 3: (left):Current version of the EMG equipment.Figure 4 (right): The equipment being used to obtain EEG from brain (single channel)

Further benefit of developing the equipment locally came from the later use of this EMG equipment as described below. With the support of late Prof M Ibrahim of the Diabetic Association of Bangladesh, the author had used his equipment to study diabetic patients at BIRDEM for about two years in the 1990's [14]. There he found out that some diabetic patients with clear symptoms of nerve disorder gave 'normal' values of nerve conduction when measuredusing traditional methods. Actually nerves as shown in Figure 5 are composed of thousands of 'nerve fibres' each and these fibres have different values of conduction velocities. The traditional techniques only measured the fastest of these fibres. This is similar to measuring the running speedof the first person who cuts the tape in a 100 metre sprint in sports, using a stop watch. How the others fared cannot be measured

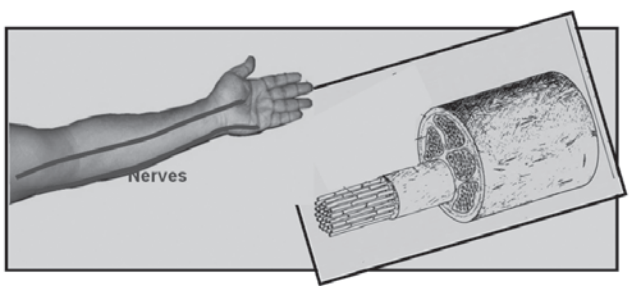

Figure 5: Nerves in our hands (left) and nerve fibres in a nerve (right)

using a single stop watch. In fact other researchers around the globe had realised this problem and have been trying to find out a technique to measure the distribution of conduction velocity or DCV of the fibres in a nerve for a couple of decades but no satisfactory method came Fig.6: Repeat DFLs from the same nerve of several subjects. Horizontal axis: F-Latency, Vertical axis: Number of

occurrence. The correspondence is striking. up that can be used in a clinical setting. The author thought of an entirely new approach in 2002 which was based on a random event called the F-response that occurs during measurement of nerve conduction. He introduced a new parameter that can be obtained by taking multiple F-responses and termed this as 'Distribution of F-Latency' or 'DFL' in short. He established that DCV of motor nerves would be a mirror image of DFL, and hence can be obtained directly using standard EMG apparatus. To give a physiological interpretation of DFL, he combined concepts based on physiology, physics and statistics. In order to test its feasibility, he hypothesised that repeat DFLs from the same nerve of the same subject will be similar in shaping subject to statistical uncertainty. Since the equipment and the software were all developed by the author and his students, they could easily modify the equipment to test the new hypothesis. A student performed repeat experiments on human subjects, and to their excitement, the hypothesis was verified successfully as shown in Figure 6. So they came up with a new method to get DCV from DFL which was simple to measure too [15].

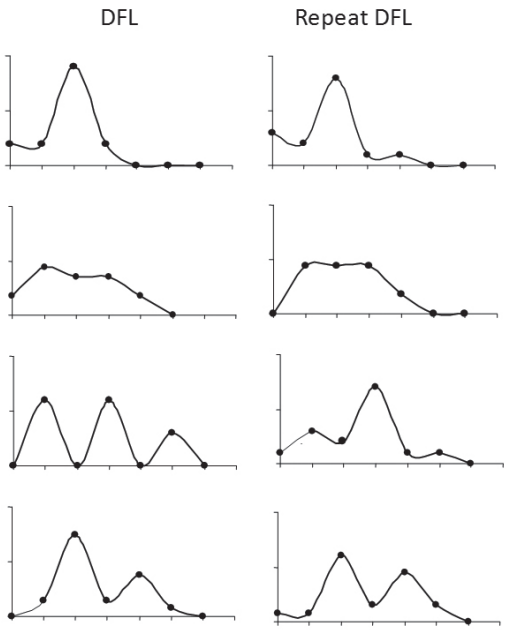

Figure 6: Repeat DFLs from the same nerve of several subjects. Horizontal axis: F-Latency, Vertical axis: Number of occurrence. The correspondence is striking.

Furthermore, they had expected a DFL with a single peak from normal subjects. However, the student noted that some subjects showed double, triple or broad peaks of DFL and also found out that these subjects had diagnosed cervical spondylosis which causes pain and numbness in the neck. The author then went into anatomy and combining his knowledge and experience in several areas came up with hypotheses to explain this unexpected phenomena. His hypotheses

involved compression of nerve branches at the vertebral roots or of descending nerves in the spinal cord as shown in Figure 7 [16,17]. He designed experiments to test out these hypotheses with the help of a more definitive result from MRI (Magnetic Resonance Imaging), available only in a few centres in the country, and initial results were highly encouraging [18]. He also could convince a medical researcher in Singapore General Hospital to carry out a similar study. There they already took data from 24 nerves of 12 subjects – both DFL and MRI, and the correspondence was very good [19]. The author thinks that DFL would become a standard screening test for any disorder of the peripheral nervous system throughout the globe [20].A scientist at University of Nottingham in UK invited the author to discuss this new finding and have already embarked upon a more fundamental research project that involves the use of DFL and MRI.

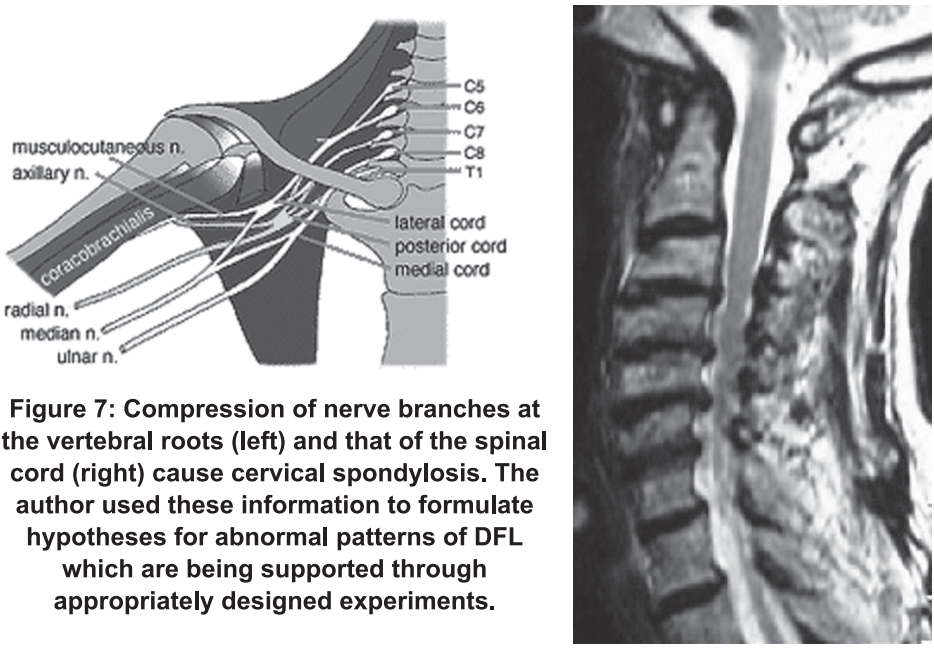

Figure 7: Compression of nerve branches at the vertebral roots (left) and that of the spinal cord (right) cause cervical spondylosis. The author used these information to formulate hypotheses for abnormal patterns of DFL which are being supported through appropriately designed experiments.

Computerised ECG system

Once the technology of a computerised medical equipment is acquired, the expertise helps development of a varied number of equipment. The above expertise allowed the author and his group to develop a computerised ECG equipment as well. Figure 8 shows a prototype developed in the 1990's which could measure and display 3 classical limb leads, mainly targeted for monitoring purposes in Intensive care Units. An output is also shown.

In order to teach the technology of a12 lead diagnostic ECG equipment the author also designed a special ECG training circuitry including its housing as shown in Figure 9. The circuitry was specially developed so that different sections can be isolated from each other for individual testing. This product was used to run an

international workshop at the Islamic University of Technology (IUT), Gazipur in 2007, participated by engineers from 6 countries besides Bangladesh [21]. It was well appreciated by the participants.

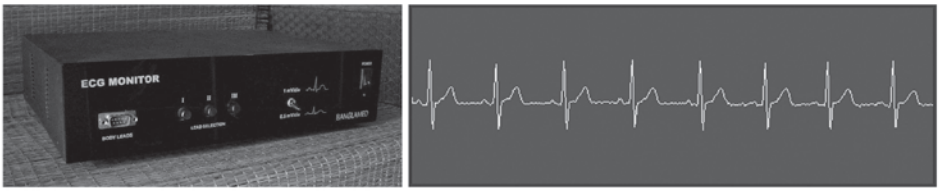

Figure 8: A single channel ECG equipment and its computer output for monitoring purposes, developed in the 1990's.

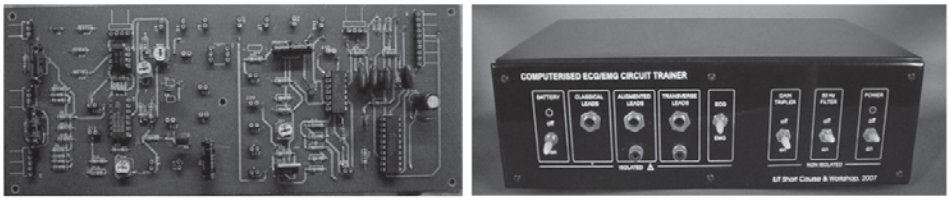

Figure 9: A 12 lead ECG circuit trainer showing both the circuit and the housing, developed in 2007 and used in an international workshop

For the first EMG equipment shown in Figure 2, a British made BBC computer was used and the software was developed using a combination of ASSEMBLY and BASIC languages [22]. For the EMG equipment shown in Figure 3, the more popular IBM compatible microcomputer was used as BBC computers became obsolete. The interface circuitry was developed based on the 8-bit ISA bus, available through connectors in the motherboard of the computers of that period. The software was developed using C++ language in DOS operating systemby a student of the author.As the ISA bus became obsolete later, the author designed an interface using the parallel printer port and developed the software in C language, again under DOS operating system. Both the equipment shown in Figures 8 and 9 were developed using this interface. In recent computers the parallel printer port has become obsolete too, and one is left with no choice but to go for USB port. USB port is great in user friendliness, but is complex for interfacing. Recently post graduate research students in the author's new department have been able to develop USB interfaces from scratch using microcontrollers. Under the author's leadership the students have recently developed a full 12 lead diagnostic quality ECG which interfaces with the computer through an USB port, and gets the electrical power from the same link as well [23]. Necessary power isolation has been developed within the printed circuit board of the ECG equipment. Necessary software has been developed in JAVA language under WINDOWS operating system. All the controls are performed through software, using a mouse. One can select any of the 12 patient lead configurations through Analogue switches. Acircuit element that uses 'Right Leg Drive' technique to reduce common mode noise has been incorporated. A switchable 50Hz notch

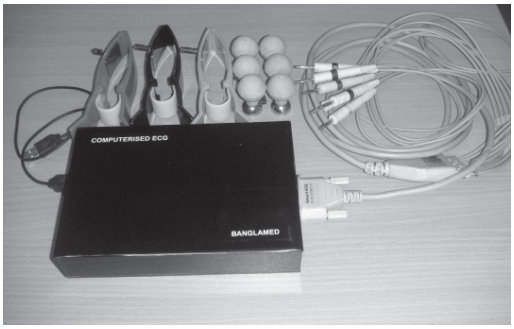

Figure 10: Full 12 lead diagnostic ECG equipment only 125mmx 180mm in size. It links to a computer through the USB port.

filter has also been incorporated. Both these controls are performed through a flick and movement of the mouse. The data can be saved or erased at will. Keeping all the controls and the power source at the computer end the, ECG equipment could be made very compact and small. The whole equipment is housed in a plastic cabinet with a footprint of 125mm x 180mm, and a height of 35mm as shown in Figure 10. For connection to patient,a 10 lead electrode cable, which is commercially available,has been used for the time being.However, this increases the price of the whole unit. It is being planned to develop this cable assembly locally, which will reduce the cost significantly.

It was an interesting experience when we were trying to search and find suitable techniques for switching the 12 leads at the input. Basic ECG amplifier circuits are available at different websites on the internet, but nowhere we could find the details of the 12 lead switching circuit. In fact this part of the designing is done by industries who keep their techniques secret. Therefore, we had to develop the input network and the switching circuitry entirely from our own knowledge and understanding of the basic science. Therefore, this shows the importance of having a mastery over both basic science and technology in order to develop and improvise electro medical equipment at low cost.

Telemedicine for the rural areas

The ECG unit developed was also made part of a telemedicine system that we developed recently [24]. Looking at the practicalities of the Third World, it is understood that providing expert medical manpower in rural health centres is still a far cry. Technological innovations can help bypass this scenario. The recent spread of computers, internet and mobile phones have brought in the concept of telemedicine whereby an expert doctor sitting in a city office can virtually ‘see’ patients and talk to them over a video conferencing system, and can take real time readings of some vital physiological parameters of a remote patient using appropriate instruments at the remote end, with the help of trained paramedics there. Different groups around the world are developing telemedicine systems. In Bangladesh we need thousands of rural centres with such facilities. However, equipping all these centres using imported equipment would be prohibitively expensive. Besides, if any equipment stops functioning the service may not be restored within a reasonable time frame.

Slightly more than a year back the author came to know that the Health Ministry of Bangladesh Government have already set up a computer network with internet facility and video conferencing system to 800 rural health complexes throughout the country. He then made a verbal proposal for developing some equipment locally for installation at the remote centres to which the Ministry agreed. Through consultation with their experts, the group has selected and developed the following digital equipment for this purpose.

i) Digital Stethoscope

ii) Digital Microscope

iii) Digital Colposcope

iv) Digital X-ray Viewbox

v) Digital ECG

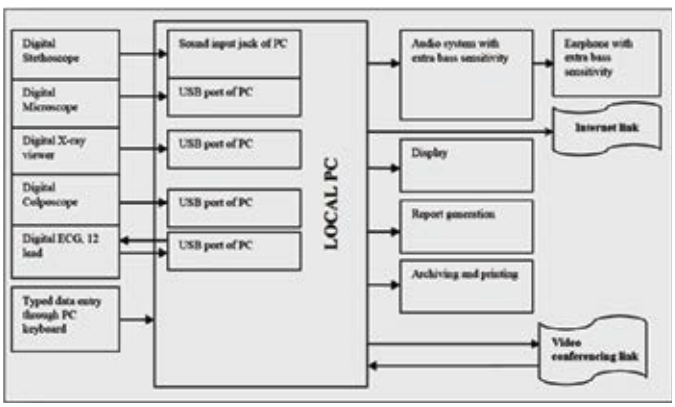

Fig.11: Schematic of connecting the developed instruments to a PC and internet

All of these can send data in real time so that the experts in the city health centre can interact with the paramedic and the patient in real time and make a better investigation. A scheme of connecting these equipment to a local computer and to internet is shown in Figure 11, while the network of telemedicine through the internet is schematically presented in Figure 12. Photographs of the systems developed are given in Figures 13 – 18.

Myoelectric Hand prosthesis

A poorgirl losther right hand while playing with an unknown object lying in the footpath when she was a child. The object turned out to be a bomb left there by miscreants. To give her some regained functionality we are developing a myoelectric hand where she will be able to open and close the thumb through voluntary contraction of muscles in the forearm. The EMG of the forearm muscles, one from the front and one from the back was picked up and analysed. The one showing greater amplitude would control the action of the thumb, which was

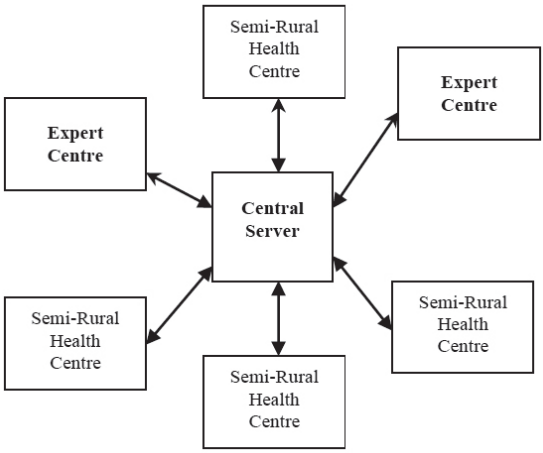

Figure 12: Schematic of telemedicine network

operated using a geared stepper motor. The first prototype is shown in Figure 18together with the test set up which was successful. However, a stepper motor is heavy, and we are trying to develop an alternative using a smaller servo motor. Producing a decent looking hand is also essential, and combining all the requirements with the limited materials and facilities available in Bangladesh, it poses a big challenge. Meanwhile, to give the girl a sense of confidence we have made a cosmetic hand prosthesis using the plastic hand of dressmaker's mannequin at a cost of about 1500 takas. Imported cosmetic hands are available but the cost is about 15 times higher. Figure 19 shows the arm without the hand and the smile of confidence on the face of the girl when wearing the improvised

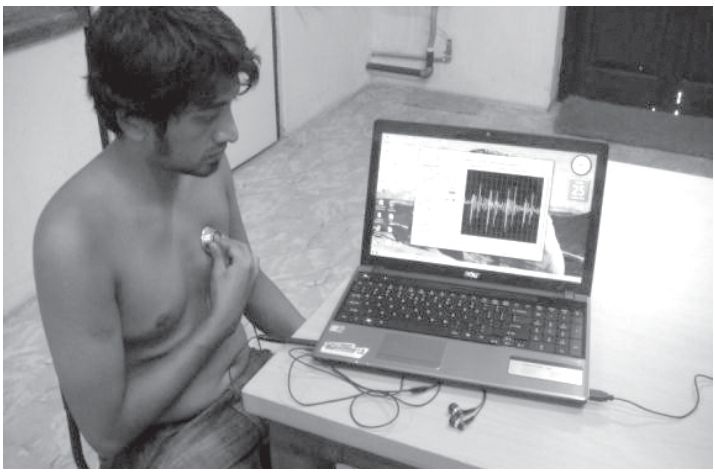

Figure 13: Digital stethoscope in use. A miniature microphone is inserted into the rubber tubing of a standard stethoscope and connected directly to a PC. The output waveform can also be seen using appropriate open source software.

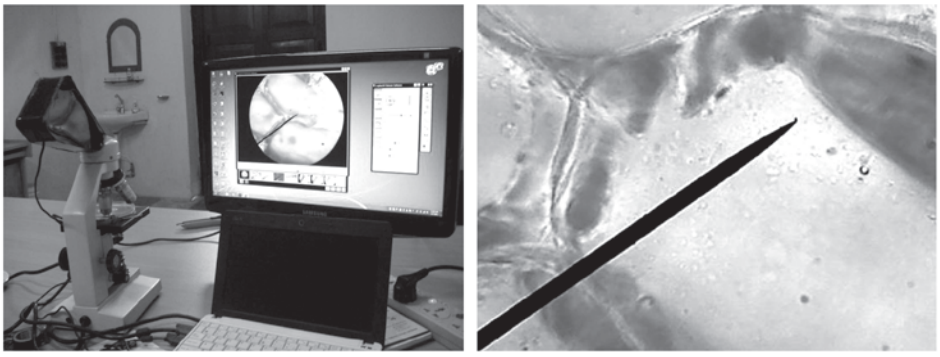

Figure14: Digital microscope (left). A high quality 2MPixel webcam with glass lens was affixed to an ordinary microscope to make a low cost unit. The digital zoom option of the webcam together with selectable magnifications of the microscope makes it very flexible (right image). Still images are captured in JPG format while wmv format is used to save moving images including sound.

Figure15: Digital Colposcope (left) to detect cervical cancer, produced at a fraction of the cost of commercial devices. A colposcope needs to focus and magnify an object at a distance of about 300mm which is not allowed by standard microscopes or telescopes. This unit was improvised from one part of an ordinary binocular telescope (top left) by changing the length between the eye piece and the objective lenses. Again the high quality webcam as used for the microscope gave a picture quality only available with very expensive colposcopes. A photograph of a cervix taken using this device shows the blood vessels clearly (right).

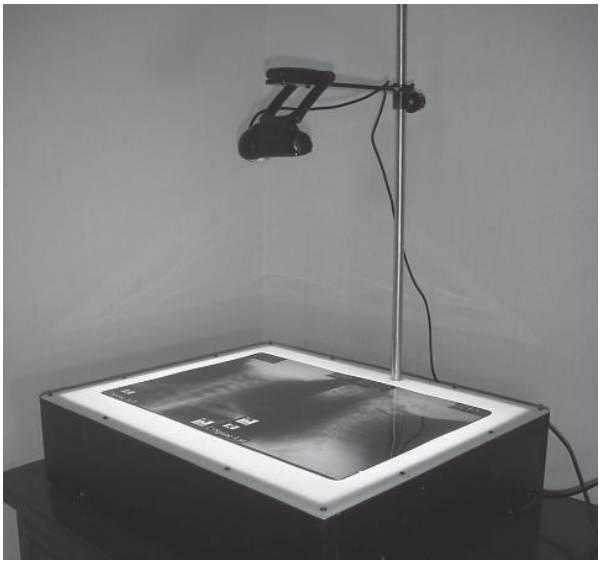

Figure16: Digital X-ray Viewbox (left) and image produced on a computer monitor (right). Multiple white LEDs were used to illuminate the white plastic backing. A high quality webcam was mounted on a stand with adjustable height.

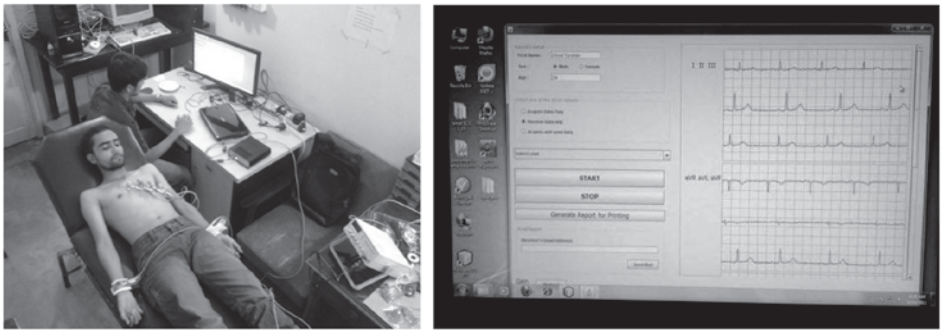

Figure17: Twelve lead diagnostic digital ECG for telemedicine. Real time ECG display at remote location (right) through internet link.

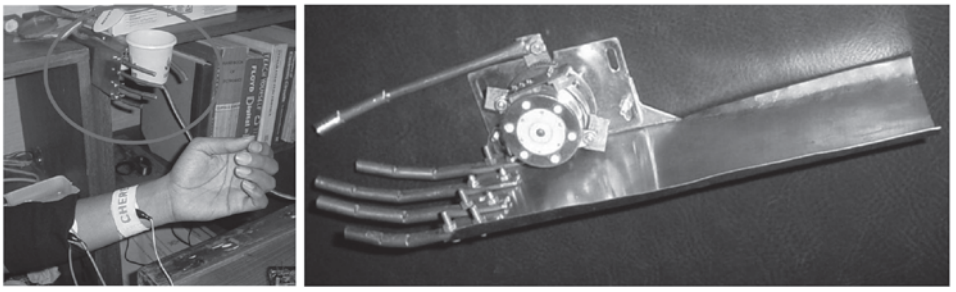

Figure18: First prototype of a myoelectric prosthetic hand (top) and its operational test (bottom) to hold and to release a glass.

Figure19: The disfigured hand and the smile of confidence of the young girl after being recuperated with cosmetic hand prosthesis. With the mechanical spring grip she can now write.

cosmetic hand made by us. Recently we developed a mechanical alternative where the thumb is activated by a spring. Using the other hand she can insert a pen into this spring grip and write. She can also hold a soldering iron and can solder electronic components to a PCB. She can hold a paper and her clothes making her more self-reliant.Again the material cost is hardly 2000 takas.

Low Cost Bone densitometer

Bone degeneration or 'osteoporosis' is a disorder which results in fractures due to a minor fall; even under one's own weight in severe conditions. It occurs more in elderly women. If detected early, special care and medical intervention may help save the subject from serious disability.An instrument named Bone Densitometer,

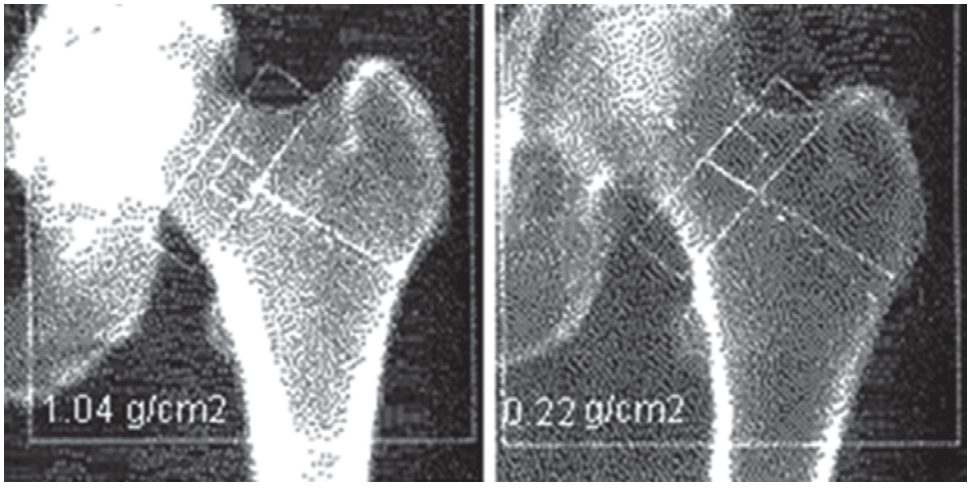

Figure 20: X-ray images of the neck of femur of two subjects: normal (left) and osteoporotic (right)

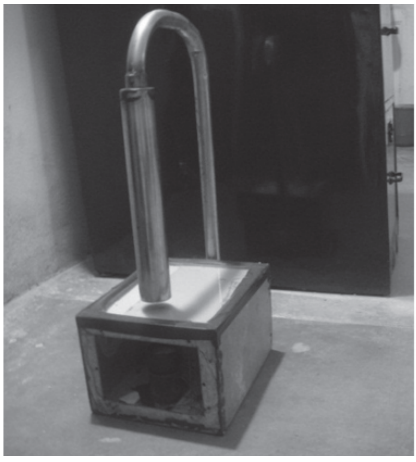

Figure 21: X-ray film optical density measuring instrument developed by the author's group. The X-ray film images is to be placed under the light source, which is within the tube. The light detector and amplifier are inside the box.

based on a dual energy X-ray system can detect this bone degeneration early, but is expensive, and is not available widely in countries like Bangladesh. The author thought of a way to measure bone density using ordinary X-ray facilities available almost in all rural health complexes in Bangladesh [25]. In osteoporosis the bone density decreases and this is particularly detectable in the different trabecular

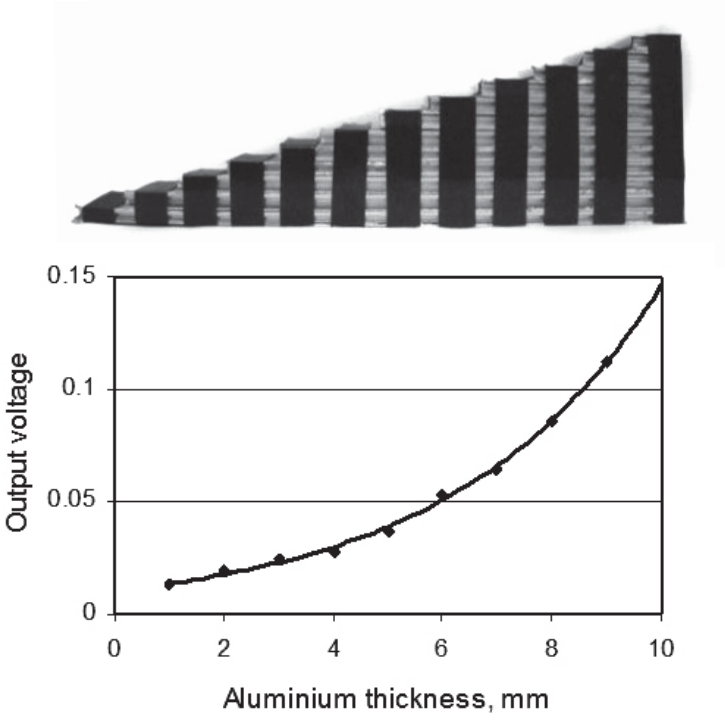

Figure 22: Stack of aluminium to produce different thicknesses (top - bound with black tape), and output voltage against aluminium thickness (bottom – voltage is proportional to light transmission) from an X-ray image of the stack.

bones like the vertebral bones, the neck of the femur and the heel.The two X-ray images of the neck of a femur are shown in Figure 20. The left one is normal with a higher bone density (appearing white in X-ray film) while that for the right one is less, indicating osteoporosis. The idea is to measure the optical density of a normal X-ray image at specified points using an LED and detector system developed for this work by the author's group, as shown in Figure 21. The optical density may also be measured by taking the image of the X-ray film using a digital camera and developing necessary software to measure the average optical density within a certain area.

However, the optical density may depend on a variety of factors like the X-ray exposure time, film speed, concentrationof film developing chemical, development time, etc. In order to cancel out all these variationsa stack of aluminium having different thicknesses was placedalongside a limb on the X-ray film when it is exposed. The optical densities of the finally developed film at several positions of

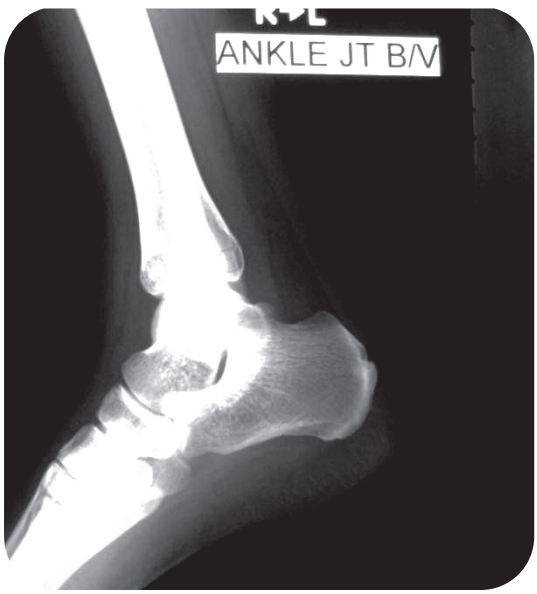

Figure 24: Muscle and Nerve stimulator designed and developed by author for physiotherapy.

the aluminium stack will give a calibration value. Figure 22 shows a stack of aluminium having regions with different effective thicknesses and a plot of measured light intensity (expressed in voltage) due to transmission through the X-ray film. However, this scheme has one flaw. If the X-ray machine voltage remains unchanged, then aluminium will work. On the other hand if the X-Ray machine voltage is changed, the X-ray energy spectra will change, and the absorption of X-rays by aluminium will also change. Therefore, aluminium calibration will fail in such situations. Recently the aluminium has beenreplaced by a piece of cow bone, machined and flattened. This is shown in Figure 23 beside

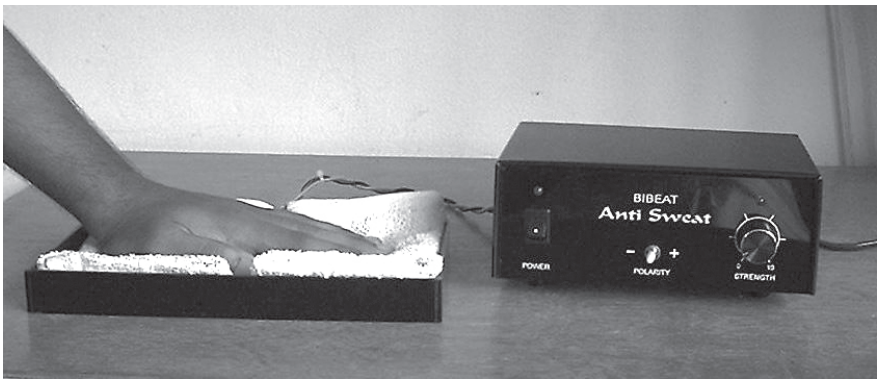

Figure 24: Lontophoresis equipment (Anti-Sweat) designed and developed by author to treat excessive sweating of palms and soles.

the heel (the slightly grooved bar on the right hand side) of a subject. Both the bone under investigation and the calibration bar will have the same absorption spectra with respect to the incident X-ray. The results so far obtained are satisfactory. Some corrections to eliminate the effects of associated soft tissue will be attempted through a compensation technique. This simple technology will contribute greatly to the diagnosis of osteoporosis in countries like ours.

Treatment of excessive sweating of palms and soles

Some people suffer from excessive sweating of their palms and soles (hyperhidrosis) due to various causes. This makes the person suffer in social situations and also in his/her career. On a proposal by a dermatologist referring to research carried out abroad many years back using an electrical technique known as 'iontophoresis', the author embarked on this project for treating such conditions using electrical current. Not much information on the instrumentation was available. So, based on his knowledge of electricity and the human body, the author designed an electrical current scheme to initiate this research and

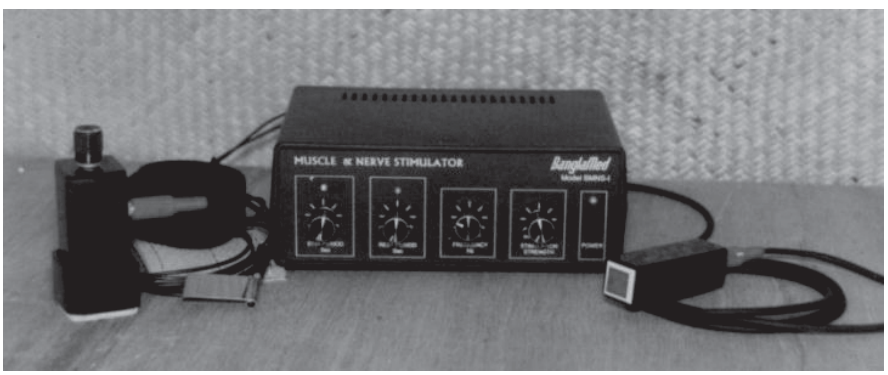

Figure 25: Muscle and Nerve stimulator designed and developed by author for physiotherapy.

accordingly designed and developed an electronic instrument, which was named 'Anti-Sweat'. After carrying out a successful clinical trial for about two years by the dermatologist, the instrument was further improved and adopted for dissemination. However, the treatment is not permanent, one has to repeat the treatment every 6 weeks or so. Therefore the instrument was designed for home use with adequate

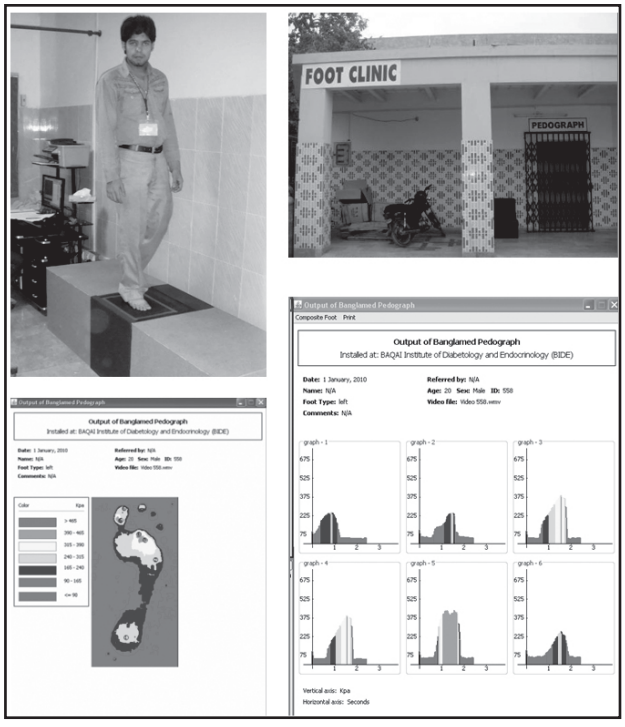

Figure 26: Installation of the designed computerised dynamic pedograph equipment in a hospital in Karachi, Pakistan. Typical outputs are also shown.

safety features. Over the last two decades, hundreds of patients got this equipment for home uses and got relief. Figure 24 shows the treatment being applied using the instrument developed.

Muscle and Nerve Stimulator for physiotherapy

Physiotherapists have to apply electrical stimulation to muscles and nerves to keep the muscle tones intact during periods of nerve inactivity. This may happen due to an inflammation at a certain point on the nerve, or may happen due to a brain stoke. On request from physiotherapists the author designed and developed a muscle and nerve stimulator as shown in Figure 25. There are subtle design challenges to apply the stimulation without letting the patient feel pain. These have been incorporated in this instrument. Local physiotherapists have been using this for about two decades now with great satisfaction. They prefer this equipment over similarly priced ones available from neighbouring countries because of its improved performance and repair service.

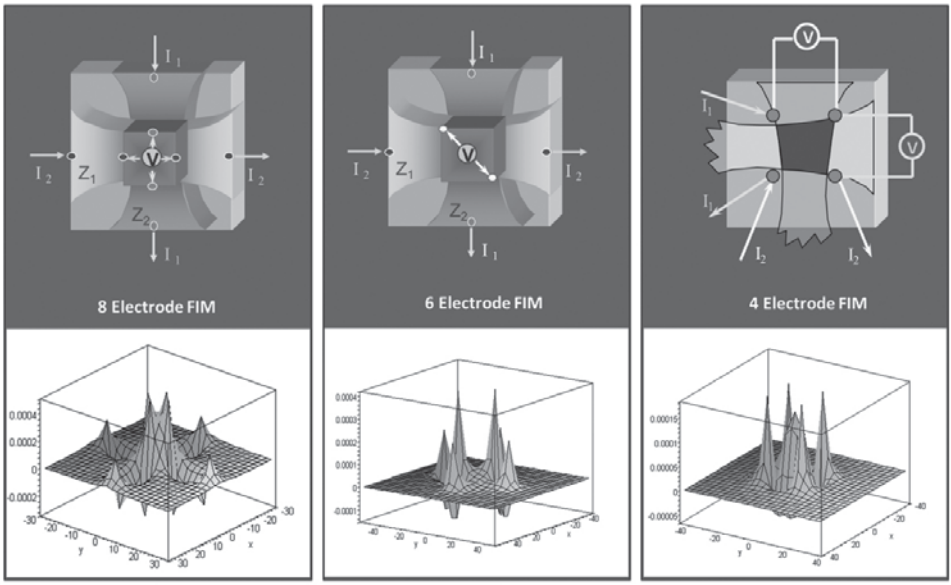

Figure 27:Basic schemes of the 3 versions of FIM innovated by the author. The dark shaded central zones in each are the respective focused zones. The concept has been verified experimentally at Dhaka, and through numerical analysis in UK. The lower 3D plots show the sensitivity obtained using this numerical analysis, later reproduced at Dhaka.

Dynamic Pedograph

Diabetic patients often lack nerve sensitivity in their soles. Due to this they do not feel any pain if their foot has high pressure regions on standing and walking. Gradually ulcers form in these high pressure regions eventually leading to gangrene and leg amputation. This unfortunate eventuality may be avoided if the pressure under the sole of the diabetic patients are checked regularly using a

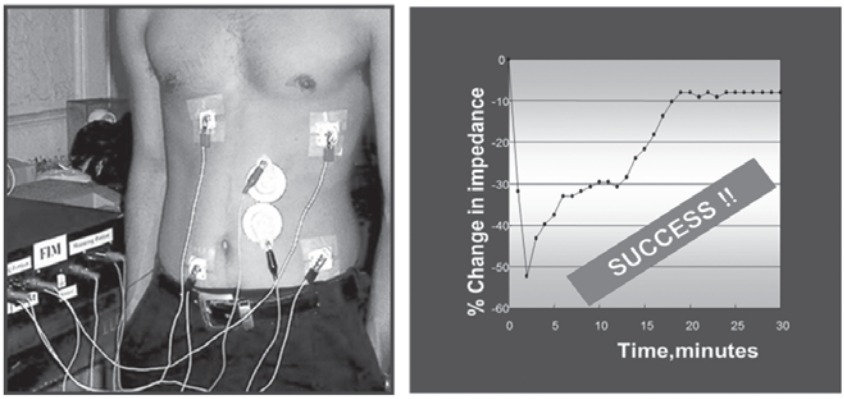

Figure 28: Stomach emptying study using FIM, after a drink of slightly salted water. Instrument developed can be seen on the left. Graph shows expected result.

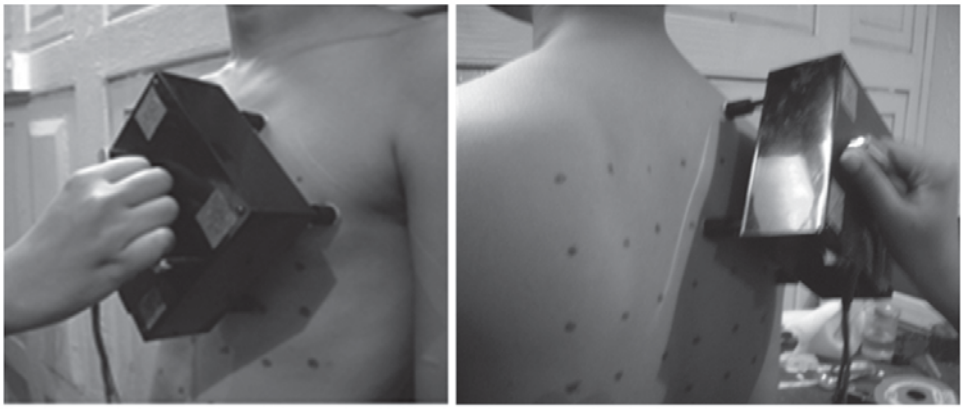

Figure 29: Stomach emptying study using FIM, after a drink of slightly salted water. Instrument developed can be seen on the left. Graph shows expected result.

dynamic measurement system when rubber insoles may be supplied to distribute the pressure. A commercial system is available at a price of about 50 lakh takas. On request from a doctor in a Karachi hospital specialising in diabetes, the author designed a low cost version costing a fraction [26]. This uses the principles of total internal reflection and the whole sensor assembly has been improvised and developed locally in Bangladesh. The pressure distribution appears as an image when a subject works on the active area. The image is captured using a high quality webcam giving images at 30 frames per second. Software developed by a team of youth under the guidance of the author gives a colour coded image of the pressure distribution and the variation of pressure with time at selected points chosen manually. It has been working satisfactorily in Karachi for about two years and they have ordered for a number of such units. The Pedograph installation at Karachi and typical outputs are shown in Figure 26.

Focused Impedance Method(FIM)

Electrical resistance to current is a property of any material. Body tissues may be grossly classified as cells suspended in saline like fluid. The cell membranes are electrical insulators and contain saline like fluid inside. Therefore, these membranes act as capacitors. At dc and low frequency ac, electrical currents have to make their pathways around the cellsthrough the extracellular fluid. The resistance to current therefore, is high. As the frequency of the ac electrical current is increased, the capacitors charging and discharging allow currents to flow straight through the intracellular fluid as well, and the resistance to current is decreased. This variable resistance property with frequency is known as impedance which can give a great deal of information within the body. When lungs breathe in air, the gross impedance is increased compared to the situation when the lungs collapse during breath-out. Similarly stomach impedance changes on eating food. Again, for many organs the electrical impedance changes with

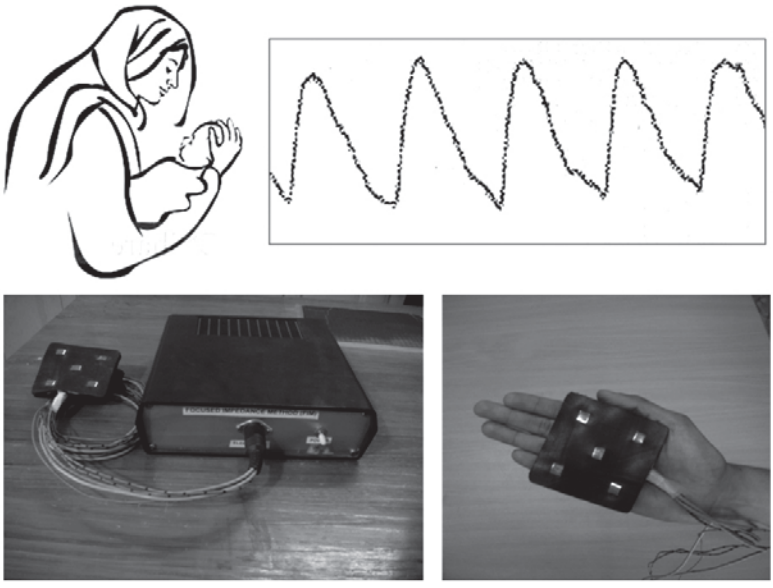

Figure 30: Respiration rate measurement in babies using a hand worn flexible electrode probe. The compact FIM instrument has to be linked to a computer or a mobile phone for this application.

diseases and disorders. Therefore, electrical impedance appears to have a potential in physiological study and diagnosis of diseases and disorders.

The main problem with electrical impedance measurement is that, since current flows in all dimensions, it is difficult to localise the sensitive region to a particular organ of choice. Professor Brown at University of Sheffield pioneered an electrical impedance tomography (EIT) method giving a 2 dimensional image using a ring of 16 electrodes fixed around the limb in question (Figure 26) [27]. Although the image looks similar to a CT scan, the pixels in the image has contributions from objects in 3D in a complex way [28.29], and are not very meaningful individually. Only a collective integral of many pixels within a large zone may give some useful information on adequately large organ. The author reasoned that since many pixels are being integrated in the above, it may be possible to get similar information using a much simpler method. This eventually led to the innovation of the FIM techniques in his laboratory [30]. Three versions of FIM have been devised and the electrode configurations are shown in Figure 27 [31, 32]. I1 and I2 indicate two independent currents perpendicular to each other, and V indicates measured potentials for each of these two respective currents. Usually an alternating current at frequencies between 5kHz and 1MHz are applied for human body measurements. With constant current amplitude, the measured potential V is directly proportional to electrical impedance Z in the respective direction, the sensitive zones being shown by the lightly shaded zones in the figures in the mid-regions, extending both horizontally and vertically. A sum of the two Z values

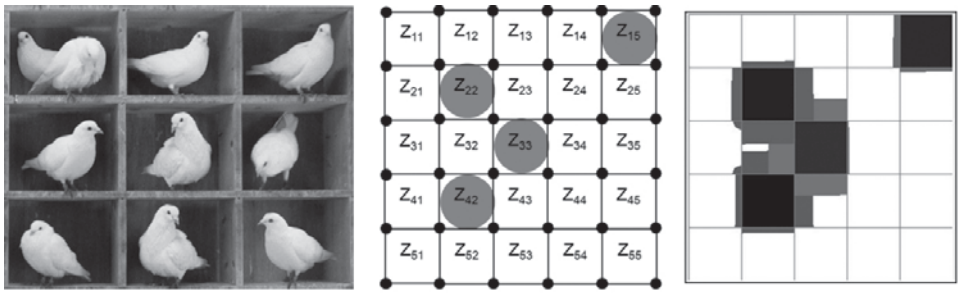

Figure 31: A pigeon hole (left). Pigeon Hole Imaging (PHI) concept using a square matrix of electrodes (middle) based on 4-electrode FIM measurements in each matrix element. Simulated PHI (right), based on experimental sensitivity distribution of FIM for 4 objects placed in different positions gives a successful representation.

in two perpendicular directions give an enhanced sensitivity in the central, almost square region, shown dark shaded. This localisation of sensitivity has been verified by the author's group using simulated phantom experiments, and through numerical analysis by a groupat Warwick University, UK [32]. The latter results, reproduced in Dhaka, are shown in the lower part of the figure.

FIM opens up a vast potential for applications in medicine and other fields of work including geology and oceanography. The author's group has already shown success in the measurement of stomach emptying and lungs respiration [30, 33]. Necessary electronic instruments and specialised electrodes were developed by the group itself. Figure 28 shows a measurement of stomach emptying while Figure 29 shows a specialised spring loaded electrode probe being used to measure lungs respiration [34]. The same arrangement shown in Figure 28 may be used to measure the gastric acid secretion non-invasively. This will have bearing in identifying diarrhoea prone subjects and people with tendencies of anaemia, since there is a link among these physical conditions. Work is being taken up with the collaboration of ICDDR,B. A special handheldflexible electrode set has been prepared for measurement of respiration rate in babies without making them cry (Figure 30). Crying changes respiration rate and makes the measurement useless. This particular set up was developed in response to a requirement put forward by an Australian researcher for detecting pneumonia in babies in the Third World, which would be used in conjunction with heart rate and temperature to give a diagnosis. A mother or a nurse would wear the electrode set in her palm and hold the baby at the thorax when the respiration waveshapes will appear on a computer monitor together with a calculated value of the rate. This set up is awaiting a clinical trial.

The author's group, in collaboration with Warwick University, UK, is also developing multi-frequency FIM system, which they would try for diagnosing various diseases and disorders including pneumonia and different types of cancers. They are also studying the feasibility of a non-invasive test for characterisation of breast lumps, whether these are malignant or benign. The idea is to develop an alternative for biopsy in such cases. The author's group has

developed a technique using FIM to measure the abdominal fat layer under the skin, which is a risk indicator of diseases like diabetes, heart attack and stroke. This is also a monitor of fitness that can be used in sports medicine.

Using a simple four-electrode measurement technique, Professor Brown in Sheffield has already succeeded in detecting cancer of the cervix at an early stage [35]. The author's group is developing necessary instrumentation to see the efficacy of FIM in this application since it is expected to give more localised information. The author's group is also looking at the feasibility of using FIM in identifying blood vessel stiffness that is usually precursor to pre-ecclampsia, heart attack and stroke. This they are trying through FIM measurement on a limb, say arm, and then by manipulating the blood flow, first occluding with a blood pressure cuff and then releasing it, and looking for the resulting relaxation pattern. Even the slopes of the pulsatile variation of blood flow as recorded using FIM, will give information on the vessel stiffness. A combined result may give more confidence in diagnosis. Looking at the applications and the nature of things happening in the body, the possibilities appear endless.

EIT was innovated in the 1980's but it has not produced any viable application so far because of the 3D problems discussed before. Researchers around the world are working to develop 3D EIT using more electrodes in different planes, making it far more complex. The solutions are also posing more challenges and its clinical potential appears doubtful. On the other hand FIM appears more attractive from a clinical point of viewas the instrumentation is simple, and it uses less number of electrodes, and focuses into a target region well. It has already received international attention for medical applications and taken up for research by Warwick University in UK, Oslo University in Norway and Kyung Hee University in Korea.

Pigeon Hole Imaging (PHI)

Both the 6-electrode and the 4-electrode versions of FIM have been extended to produce coarse images that may be useful in identifying the positions of one or more underlying organs, and in following an organ that moves with time, such as with breathing [36, 37]. The name PHI was chosen by the author through resemblance with a pigeon hole as shown in Figure 31. The electrode arrangement is shown in the middle, which is based on the 4-electrode FIM, while some simulated images generated using a preliminary computer algorithm is shown on the right. It appears attractive from an application point of view and a computerised instrumentation using microcontrollers is being developed.

Discussion

The above examples show that it is possible to develop technology working in a Third World country like Bangladesh in spite of lack of infrastructure, materials and an environment which does not promote dedicated research. The examples presented have been made possible due to the perseverance of the author over the last three decades while in the Department of Physics at Dhaka University. This development led to the creation of the new department of Biomedical Physics

& Technology in 2008 of which the author is continuing as the first Chairperson. He is emphasising on PhD level research and besides 10 students from the home department, others are also working with him, coming from different departments of the University, and other Universities as well. It has been possible to create a closely-knit team. The energy and dedication of the youth, led and guided by the author with his long experience in working first hand in technology together with the innovations, has resulted in the production of several innovative electro-medical technologies within a short span of time. The author's group has a philosophy of open source technology. They are thinking not to take out any patents, but will publish and disclose the technology so that others, particularly in the Third World, can reproduce and make these products for benefit of their common population. Several scientists from the advanced countries have endorsed his views on this open source concept and have expressed their support in whatever form possible.

The whole world is gradually realising that unless medical technology is developed and manufactured within each of the Third World countries, a large section of the global population will always be deprived of the benefits of modern healthcare technology. This is a concept with which the author started his professional work more than three decades ago and has been propagating through his speeches at different times in different national and international forums.The expertise and experience that have been synergised through this effort is almost unique in the Third World and the author has started getting a good deal of international attention. Bangladesh may become an example in this field for other Third World countries. May be we can initiate a global open source healthcare technology movement from Bangladesh and contribute to the cause of humanity.

Acknowledgements

The author would like to acknowledge Late Professor M S Islam and Dr.AbdusSattar Syed, without whose pioneering work and leadership he would not be inducted into this exciting field of research and development. He would also like to acknowledge Prof Islam and Professor B H Brown, who initiated the academic link with Sheffield that opened up a vast horizon of Medical Physics for him. The author would also like to acknowledge the British ODA, which sponsored this link during 1983-1992. The author would like to acknowledge the whole hearted support given by all the scientists and technicians in Prof Brown's team in Sheffield in enhancing his capability in electro-medical technology. He would also like to acknowledge the collaboration of medical doctors and scientists at BSMMU (erstwhile IPGMR), BIRDEM, ICDDR,B, Children's Hospital, Trauma Centre, BiBEAT and Tasmia Tahmid's Breast clinic at different phases of the work. Professor Adrian Wilson in University of Warwick, UK, Professor Penny Gowland at University of Nottingham, UK, Professor Orjan Martinsen at University of Oslo, Norway, Professor E J Woo at Kyung Hee University, Korea and Prof Y L Lo at Singapore General Hospital, Dr. Kaiser Alam at Riverside Research Institute, New York, USA, Dr. Md. Zakir Hussain at Square Hospital Dhaka and Dr. Shafiq Sarkar at ICDDR,B need to be mentioned for collaborative research work undertaken, or

being planned. For support and encouragement at earlier times the author would like to acknowledge the legendary Late Professor M Ibrahim of BIRDEM, Prof. Salek Talukder and Prof RuhalHaque (the current Honourable Health Mnister), both at erstwhile RIHD, Prof Rashiduddin Ahmed of Neurosurgery, Prof M Nazrul Islam of Pathology and Prof M A Mannan of Neurology, all at erstwhile IPGMR. Many others helped in different ways and the author would like to acknowledge all of them.The author would also like to acknowledge Prof Barry Allen of Australia, the past President of the International Organisation of Medical Physics (IOMP) for introducing and recommending the author to various persons and agencies including WHO.

The author has received funding from the Ministries of Science and Education of Bangladesh Government at different times besides the regular funding given to the department by the University and some funding from the Bose Centre and the Renewable Energy Centre of Dhaka University.Earlier, funding was also received from BMRC and WHO through Dr. Syed and Prof Islam. The WHO project was obtained through BIRDEM. He has been able to get a private corporate funding from Akij group (Farm Fresh). Recently, he obtained a generous funding from the International Science Programme (ISP) of Uppsala University, Sweden, which is likely to continue for several years. Friends and relatives are also giving him support in whatever form possible. More than 80 students worked for their Master's theses while in the department of Physics till 2008, and about 20 research students from the home department and from other institutions worked or are working with him for their project work/theses during the last 4 years in the new department. The author would like to acknowledge the contribution of all of them without which this development would not have been possible.

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INTRODUCTION

Internet and mobile phone penetration has opened-up new horizons for ICT based services to benefit communities at the bottom of the pyramid. Primarily driven by donors, development agencies, local and international NGOs, civil society, mass media, these services have extended even to the rural areas. Telecenter networks, for example, have reached previously inaccessible places using nonprofit and for profit models.

Although a large amount of work has been done in using ICT for Development, there has been no conscious effort to explicitly capture these initiatives. Hence, there is a pressing need to document success stories, lesson learnt and shortcomings. There is a call to write case studies on projects, programs and policies in this regard. As knowledge has become central to development, it is timely to publish a journal that specializes on ICT for Development issues. Academicians, practitioners and researchers can use the journal as a reference point for their work. It will contribute a great deal to strengthen knowledge management. Simultaneously, it will also enable them to share their experiences, works and knowledge.

OBJECTIVES

The ultimate objective of the working paper series is to articulate, capture and document success stories, best practices, lessons learnt and shortcomings of ICT4D projects or researches in developing countries.

TOPICS:

Academics/researchers/practitioners are invited to submit their work that addresses issues related to adoption, diffusion, and implementation and monitoring/impact assessment of ICT for development projects in developing countries. In fact, ICT4D being a crosscutting issue the working paper series will feature writing from almost any sectors or area namely E-Agriculture, E-Livelihood, E-Governance, E-Health, E-Education, E-Commerce, E-SME, E-Environment, Climate Change, etc in relation to ICT. The WPS encourages papers that are problem-finding, problem solving, forward-looking, sharing relevant experiences and investigating controversial and important issues.

AUDIENCE

The target audience of this working paper series are those who wish to learn how to encourage adoption of ICT, applications and impact assessment, and also researchers who are interested in the diffusion of ICT for developmental projects in developing countries. Therefore, the target audience includes ICT service providers, policymakers, and academics/researchers, students of social science, information systems, and information technology and development studies.

SUBMISSION REVIEW PROCEDURE

Researchers and practitioners will be asked to submit an abstract of the paper. Those whose abstracts have been approved will be invited to submit complete papers. Papers must be written in English. The full paper must be between 4,000 to 9,000 words including all diagrams and references, and in MSWord or PDF format. All submissions must have names, affiliations and full contact details (including email addresses) of all authors. Authors should utilize the APA Stylebook.

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- o Significance of the topic
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- o Significance for practice
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