ICT and Information Highway Development to Support Inclusive High Growth in a Transformational Economy

**Background Paper for the 2041 Perspective**

**Plan. Prepared for the General Economics**

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**List of Abbreviations:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| A2I |  | Access to Information  |  |  |
| ANIS  |  | Augmented National Innovation System  |  |
| BANIS  |  | Bangladesh Augmented National Innovation System |
| BBS  |  | Bangladesh Bureau of Statistics |  |  |
| ccTLDs  |  | Country-code top-level domains |  |  |
| CGE Model  | Computable General Equilibrium Model |  |
| CRS |  | Customer Relationship Management |  |
| CSR  |  | Corporate Social Responsibility |  |  |
| DRM  |  | Digital Rights Management |  |  |
| gTLD  |  | Generic top-level domains |  |  |
| ECNCST  |  | Executive Committee of National Council on Science and Technology |
| EPB  |  | Export Promotion Bureau  |  |  |
| GoB  |  | Government of Bangladesh |  |  |
| GPRS  |  | General Packet Radio Service |  |  |
| HDMI |  | High Definition Multimedia Interface |  |
| HDTV |  | High Definition TV  |  |  |  |
| ICT |  | Information and Communications Technology |
| ICTMB  |  | ICT Monitoring Board  |  |  |
| INSEAD |  | Institut Européen d'Administration des Affaires |
| IOS/iOS  |  | Input/Output Supervisor |  |  |
|  |  | iPhone operating system  |  |  |
|  |  | Internetworking operating system |  |
| IT |  | Information Technology |  |  |
| ITES  |  | IT enabled services |  |  |  |
| KEI  |  | Knowledge Economy Index  |
| LCD  |  | Liquid Crystal Display |  |  |  |
| LED |  | Light Emitting Diode |  |  |  |
| MoE |  | Ministry of Education |  |  |  |
| MoP  |  | Ministry of Planning |  |  |  |
| MOST  | Ministry of Science and Technology  |  |
| NCST |  | National Council on Science and Technology |
| NSTP |  | National Science and Technology Policy |  |
| NIS |  | National Innovation System  |  |  |
| OECD |  | Organization for Economic Cooperation and Development |
| PPP |  | Public Private Partnership |  |  |
| SAM |  | Social Accounting Matrix |  |  |
| SAM-Tech | Technology-based Social Accounting Matrices |
| SCENIS |  | Sustainable Capabilities Enhancing National Innovation System  |
| SISS |  | Sectoral Innovation Sub-System  |  |
| SoC/SOC |  | System on a Chip |  |  |  |
| TFP  |  | Total Factor Productivity |  |  |
| UNIDO |  | United Nations Industrial Development Organization |
| USB |  | Universal Serial Bus |  |  |  |
| VDIVECM |  | Virtual Desktop Infrastructure Vector Error Correction Model |  |  |
| VGA |  | Video Graphics Array |  |  |  |
| WIPO |  | World Intellectual Property Organization |  |

Table of Contents

[List of Tables iv](#_Toc489308427)

[List of Figures iv](#_Toc489308428)

[ICT AND INFORMATION HIGHWAY DEVELOPMENT TO SUPPORT INCLUSIVE GROWTH IN A TRANSFORMATIONAL ECONOMY 1](#_Toc489308429)

[A. BACKGROUND AND OVERVIEW: 1](#_Toc489308430)

[B. PROGRESS IN SCIENCE AND TECHNOLOGY, THE PERFORMANCE OF THE ICT SECTOR AND EMERGING ISSUES FOR BD 2041 VISION OF ICT 3](#_Toc489308431)

[National Science and Technology Policy (NSTP): 3](#_Toc489308432)

[Emerging issues and challenges: 4](#_Toc489308433)

[Bangladesh and the Global Innovation Scene: Focus on ICT 6](#_Toc489308434)

[C. 2041 PERSPECTIVE PLAN VISION, THE REQUIRED OBJECTIVES OF THE ICT SECTOR AND THE FUTURE 10](#_Toc489308435)

[Defining and charting the ICT sub-system in Bangladesh: 10](#_Toc489308436)

[WPIIS Classification: 10](#_Toc489308437)

[ICT Sectors in Bangladesh – Identification and analysis of sub-sectors of ICT in Bangladesh and trends in the ICT industry. Identification of economy wide linkages between the above sectors and between these sectors and the rest of the economy: 12](#_Toc489308438)

[Private Sector contributions and prospects: 24](#_Toc489308439)

[Export Promotion Bureau Program: 24](#_Toc489308440)

[National Innovation System (NIS), Sectoral Innovation Sub-System (SISS), Augmented National Innovation System (ANIS), Social Learning and Complexity: 29](#_Toc489308441)

[An Augmented NIS for Bangladesh and the linkages between ICT industry and science: the Chinese example and prospects for BNIS by 2041: 30](#_Toc489308442)

[D. PROJECTIONS AND STRATEGY POLICY SPACE: OPTIMAL ICT SECTORAL POLICIES FOR INVESTMENT AND INSTITUTIONAL DEVELOPMENT, GIVEN THE PERSPECTIVE PLAN’S NATIONAL ECONOMIC OBJECTIVES TO BE REACHED BY 2041 33](#_Toc489308443)

[Policy priorities from a strategic Perspective and investment requirement: 34](#_Toc489308444)

[Incentive Policies for ICT Facilitation 37](#_Toc489308445)

[An Institutional Recommendation: Setting up an ICT Monitoring Board (ICTMB) with Regulatory Power and State of the Art International Advisors 41](#_Toc489308446)

[E. INVESTMENT REQUIREMENTS FOR THE ICT SECTOR 43](#_Toc489308447)

[REFERENCES: 45](#_Toc489308448)

# List of Tables

[Table 1: Global Knowledge Economy Rankings 5](#_Toc489283547)

[Table 2: Bangladesh in Global Innovation 6](#_Toc489283548)

[Table 3: Number of Establishments 13](#_Toc489283549)

[Table 4: Gross Output 14](#_Toc489283550)

[Table 5: Gross Value Added (Gross Input Cost) (in '000 Tk.) 15](#_Toc489283551)

[Table 6: Value Added at factor cost (in '000 Tk.) 16](#_Toc489283552)

[Table 7: Total Number Persons Engaged 17](#_Toc489283553)

[Table 8: Wages & Salaries (in '000 Tk.) 18](#_Toc489283554)

[Table 9: Exports (in US $ million) 19](#_Toc489283555)

[Table 10: Imports (in US $ million) 20](#_Toc489283556)

[Table 11: Manufacture of Computers and peripheral Equipment 21](#_Toc489283557)

[Table 12: Manufacture of communication equipment 22](#_Toc489283558)

[Table 13: Manufacture of other electronic and electric wires and cables 22](#_Toc489283559)

[Table 14: Manufacture of wiring devices 22](#_Toc489283560)

[Table 15: Manufacture of other electrical equipment 22](#_Toc489283561)

[Table 16: Manufacture of consumer electronics 23](#_Toc489283562)

[Table 17: Category of Income by BSIC 2 digit Code for the year 2012 23](#_Toc489283563)

[Table 18: Needed Waiver/Reduction of Duties/Taxes/VATs 28](#_Toc489283564)

[Table 19: Forecast Gross Expenditures on R&D 36](#_Toc489283565)

[Table 20: Bangladesh - High-technology exports in current prices 36](#_Toc489283566)

[Table 21: Investment Requirements of the Service Sector (taka billion 2017 prices), FY 2031 and 2041 44](#_Toc489283567)

# List of Figures

[Figure 1: Number of Establishments 14](#_Toc489283576)

[Figure 2: Gross Output (in '000 Tk.) 15](#_Toc489283577)

[Figure 3: Gross Value Added (in '000 Tk.) 16](#_Toc489283578)

[Figure 4: Value Added at Factor Cost (in '000 Tk.) 17](#_Toc489283579)

[Figure 5: Total Persons Engaged 18](#_Toc489283580)

[Figure 6: Wages & Salaries (in '000 Tk.) 19](#_Toc489283581)

[Figure 7: Exports (in US $ million) 20](#_Toc489283582)

[Figure 8: Imports (in US $ million) 21](#_Toc489283583)

# ICT AND INFORMATION HIGHWAY DEVELOPMENT TO SUPPORT INCLUSIVE GROWTH IN A TRANSFORMATIONAL ECONOMY

# BACKGROUND AND OVERVIEW:

Since its liberation after a bloody war against the Pakistani military dictatorship, Bangladesh has gone through many ups and downs but particularly since the late 1990s the country has shown great promise by pushing ahead with its development agenda vigorously. Poverty has declined rapidly and economic growth is showing an upward trend reaching between 6 and 7 percent per annum in the second decade of this century. It is realistic to expect a growth rate of 8 percent. However, technological progress and innovation, especially in the ICT sector will be crucial in achieving rapid inclusive growth.

The country aspires to reach upper middle-income country status by 2030, and expects to become a developed economy in the 2040s decade. The transition---indeed transformation--- can be realized through a process of rapid inclusive growth leading to elimination of poverty while increasing the productive capacity and building an innovating learning economy.The cornerstone of an inclusive development strategy is a robust strategy of job creation through employment-intensive export-oriented manufacturing growth.

The ICT sector has both manufacturing and services sector characteristics and both will be discussed in this paper. With regards to the service sector aspects, it is relevant to recall Dr. Sadiq Ahmed’s broader treatment of services in the same series:

A striking aspect of the development of the services sector in Bangladesh is that it not only has responded well to the growing demand emerging from the growth of manufacturing and agriculture activities, it has also positioned itself well in the global market for low-skilled workers, especially to the oil-rich middle-eastern markets. As a result, there has been a rapid inflow of worker remittances that has fueled a huge demand for construction activities and for a range of services in both urban and rural areas. This inflow of remittances has played a major role in transforming the rural economy and contributing to poverty reduction (Ahmed 2015).

While the creation of a better skill sets endowed workers is necessary for ICT, the demand side factors mentioned above also apply to the service oriented parts of the ICT sector.

Ahmed (2017) adds further:

The services sector itself is transforming. As Bangladesh transited from a low-income developing country at the time of independence in 1972 to a lower middle-income country in 2015, the services sector has been steadily transforming from a primarily low-productivity, low-income unorganized services sector dominated by trade, transport and low-end personal services towards more organized and higher-income commercial services.

What Ahmed refers to above for a broader set including ICT, applies with particular force to the latter.

There are, however, many challenges that Bangladesh government---particularly its ministry of planning--- has recognized and is taking steps to address.[[1]](#footnote-1) A recent document from the ministry of planning thoughtfully states**:**

…Bangladesh faces many development challenges that are well summarized in the ongoing 7th Plan as well as in the Delta Plan (BDP 2100). ……As a starting point, the PP proposes 6 developmental goals including 2 higher level national goals set by National Plans:

**Goal 1: Eradication of Extreme Poverty by 2030;**

**Goal 2: Upper middle-income country by 2030;**

**Goal 3: Reducing moderate poverty to less than 5 percent by 2046;**

**Goal 4: High income country by 2046;**

**Goal 5: Building a Bangladesh resilient to environmental degradation;**

**Goal 6: Establishing Bangladesh as a knowledge hub country for promoting a new skilled based society.**

(MoP: Macroeconomic Framework for the Perspective Plan of Bangladesh (2021-2041): Growth Outlook up to 2046: pp.1-3)

In keeping with the above goals, the broad objective of this study will be to explore and determine how an optimal strategy for technological adaptation, adoption, innovation and diffusion with special emphasis on the ICT sector for meeting these goals can be formulated. In particular, the characteristics of ICT, the challenges to innovation and diffusion of ICT and its linkages with other sectors in the economy will be examined in detail. The role played by innovating entrepreneurs using the market as a discovery mechanism and the significance of effective PPP (Public Private Partnership) will be examined carefully.

Ultimately the goal of S& T---including ICT--- policies and institution building must be to improve the living standards of people. For this purpose, extending Sen’s capabilities approach to human well-being to S&T systems, I have coined the term ***SCENIS*** or Sustainable ***Capabilities*** ***Enhancing National Innovation System***. Building a SCENIS is what I advocate for Bangladesh. Although the technical issues cannot be discussed here further for lack of space, I have developed two versions of a computable SCENIS model that could be implemented in Bangladesh with further appropriate data gathering and building in particular, a sequence over time of SAM-Techs or disaggregated Technology-based Social Accounting Matrices as consistent economy wide databases.

# B. PROGRESS IN SCIENCE AND TECHNOLOGY[[2]](#footnote-2), THE PERFORMANCE OF THE ICT SECTOR AND EMERGING ISSUES FOR BD 2041 VISION OF ICT

## National Science and Technology Policy (NSTP):

The need for faster technological development in general is increasingly recognized by the government of Bangladesh. Within the general goal of promoting faster technological development in general, identifying the ICT sector as strategic for long term planning in Bangladesh is the right move. Here too, a comparison with Korea and Taiwan is instructive. From very humble beginnings in the 1950s and even 1960s, these economies have moved to niches in ICT industry that are now crucial for their growth and further development. Like these economies at an earlier stage of development, development plans of Bangladesh have also emphasized science and technological research to hasten technical progress and productivity. It has been recognized that such progress can be achieved through adoption and adaptation of imported technologies as well as development of indigenous technologies.

Indeed, a *National Science and Technology Policy(NSTP)* has been formulated and adopted by the Government. The NSTP has laid down the directions for S and T activities and research, institutional and manpower development, dissemination and documentation facilities. The *National Council for Science and Technology (NCST)* determines S and T policies, reviews the activities of different institutions and provides direction towards S and T research and activities. In the area of technical education, the main focus of the government has been to expand technical universities at the district level, spread the outreach of the information and communications technology (ICT) and support the adoption of agricultural technology. There is a separate ministry of Science and Technology that is dedicated to strengthening scientific progress and development of technology.

The spread of ICT revolution has received particular emphasis based on the personal attention provided by the Honorable Prime Minister under her *Digital Bangladesh Initiative*. Digital Bangladesh is an integral part of the government’s *Vision 2021*. The Digital Bangladesh initiative consists so far of four key priorities:

* Developing human resources ready for the 21st century.
* Connecting citizens in ways most meaningful to them.
* Taking services to citizens’ doorsteps.
* Making the private sector and market more productive and competitive through the use of digital technology.

Bangladesh made important strides during the Sixth Plan in utilizing technology to bring in tangible transformation in all four areas. Progress made in bringing government services to the doorsteps of citizen is probably the area where Bangladesh registered most significant progress. Vertical (with government ministries and agencies) and horizontal (i.e., with citizens) policy advocacy and development interventions have resulted in a number of citizen-centric e-initiatives and services such as multimedia classroom and teacher-led education content development in public schools, mobile phone based health service from Upazila Health Complex, agricultural and other livelihood information and services (*e-Tathyakosh*) online through grassroots outlets. These are at an early stage of implementation but they constitute a concerted effort to bring government closer to the people through use of technology. According to the available information, a number of acts, policies and guidelines are already in place to guide the nation towards the realization of Digital Bangladesh. The ICT Policy 2009 and the ‘Strategic Priorities for Digital Bangladesh 2011’ documents also contain elaborate work plans. Because of the cross-cutting nature of the vision, these work plans encompass priorities in almost all development sectors. These policies and regulations have provided a first round enabling environment for the implementation of the Digital Bangladesh enterprise. Furthermore, *the ICT Policy 2009* document has now been updated to *ICT Policy 2015*.

With regards to ICT-based education, under the *‘Secondary and Higher Secondary ICT based* *Education Project’* 20,000 multimedia corridors (MMCs) in educational institutes have been established, with each MMC having one internet connectivity, one laptop and one multimedia. Computer labs have also been set at 192 educational institutes with the provision of training to both the teachers as well as students. From this author’s fieldwork experience, it can be asserted that Bangladesh is already further along this route than Malaysia was when it announced and began to implement its MMC strategy earlier.

Emerging issues and challenges:

Nevertheless, it must be admitted that progress in nurturing the knowledge economy has been slow. As a young economy Bangladesh is still has to go a long way to catch up to the standards of the global knowledge economy. The latest available ranking of the Knowledge Economy Index (KEI) prepared by the World Bank puts Bangladesh at the low end of 137 out of 146 countries (Table 1). Other South Asian countries and competitors, like Vietnam and China, are ranked higher. Bangladesh has made important strides in the area of ICT over the past few years. Even so, in the global context, the ICT performance is also considerably behind. Importantly, there is a huge gap in the area of science and technology compared to global standards that will require substantial long-term effort.

Table 1: Global Knowledge Economy Rankings

We see a similar pattern in other reports. For example, in the Global Innovation Report 2015, prepared by Cornell University, INSEAD and WIPO, Bangladesh was placed at 129th position among 141 countries. I discuss this in light of the most recent Global Innovation Report in more detail in the next sub-section. In a recent report to assess the country competitiveness with respect to the exploitation of Role of Technology and Innovation in Inclusive and Sustainable Industrial Development, UNIDO has placed Bangladesh at the 77th position among 141 countries. Bangladesh’s relative performance in intellectually property promotion is also quite low. For example, in 2015, only 112 patents have been filed in Bangladesh. By way of contrasting, in 2015 Vietnam and India filed 679 and 23,844 patents respectively. However, China far exceeded these countries by filing 1,010,406 patents in 2015. Even the contrast with Vietnam shows a very weak position of Bangladesh in global knowledge, innovation and sustainability fields. Low values of relevant indices indicate that Bangladesh lags behind others; but more optimistically, it also has large untapped opportunity to make rapid advances in Science and Technology leading to higher as well as sustainable and inclusive economic growth through technology-driven productivity increase.

Another noteworthy project is The Access to Information (A2I) project in the Prime Minister’s office which has been designed to encourage all government Ministries, agencies and local government bodies to develop and implement plans to apply ICT in their respective spheres with the aim of improving services to citizens and enhancing accountability and transparency of governance. The broad sweep of the A2I project includes the logistics and operational aspects of connectivity, maintenance, availability of skilled people, and training of people and incentives for performance. Meeting these challenges in a timely manner and forming PPPs to enhance people’s capabilities through A2I will go some distance towards meeting the six goals mentioned at the beginning.

There are infrastructural issues relevant for assessing the potential of electronic ICT-based educational aids and particularly multimedia classrooms. Multimedia classrooms very often do not function or produce the expected benefits in learning outcomes, because infrastructural supports such as electricity is lacking or erratic, teachers have not been adequately prepared, infrequent and regular internet access etc. It has also been observed that provisions for maintenance of equipment and services have often not been made, particularly in the rural areas.

Let us now turn to a closer look at Bangladesh’s innovative capacities in the context of the most recently available global and country studies.

## Bangladesh and the Global Innovation Scene: Focus on ICT

The encouraging ---though not too much so—fact is that recently Bangladesh has advanced by a few places to no. 114 in the GII rankings.

Table 2: Bangladesh in Global Innovation

|  |  |
| --- | --- |
| Population | 162911.00 thousand |
| Gross Domestic Product (GDP) | 225.76 US ($) billions |
| GDP per capita, PPP$ | 3606.65 US ($) thousands |
| Global Innovation Index (GII) 2017 rank | 114 |
| [.] | Strength |
| [.] | Weakness |

|  |
| --- |
| Global Innovation Index |
|  | Rank | Score |
| Overall | **114** | **23.7** |
| Innovation Efficiency Ratio | 93 | 0.5 |
| Innovation Input Sub-index | 113 | 30.6 |
| Innovation Output Sub-index | 108 | 16.8 |

|  |
| --- |
| Institutions |
|  | Rank | Score |
| Overall | **122** | **40.3** |
| Political Environment | 117 | 29.6 |
|  | Political stability and absence of violence/terrorism | 116 | 35.8 |
|  | Government effectiveness | 111 | 23.4 |
| Regulatory Environment | 117 | 36.6 |
|  | Regulatory quality | 118 | 18.4 |
|  | Rule of law | 102 | 19.0 |
|  | Cost of redundancy dismissal | 119 | 54.5 |
| Business Environment | 116 | 54.8 |
|  | Ease of starting a business | 93 | 81.7 |
|  | Ease of resolving insolvency | 121 | 27.0 |
|  | Ease of paying taxes | 104 | 55.6 |

|  |
| --- |
| Human Capital and Research |
|  | Rank | Score |
| Overall | **124** | **12.0** |
| Education | 126 | 16.1 |
|  | Expenditure on education | 111 | 12.7 |
|  | Govt. expenditure on education per pupil, secondary | 100 | 5.1 |
|  | School life expectancy | 103 | 30.0 |
|  | Assessment in reading, mathematics, and science | n/a | n/a |
|  | Pupil-teacher ratio, secondary | 106 | 17.3 |
| Tertiary education | 106 | 17.0 |
|  | Tertiary enrolment  | 99 | 11.2 |
|  | Graduates in science and engineering | 82 | 28.2 |
|  | Tertiary level inbound mobility | 106 | 0.4 |
| Research and development (R&D) | 88 | 2.8 |
|  | Researchers | n/a | n/a |
|  | Gross expenditure on R&D (GRED) | n/a | n/a |
|  | Global R&D companies, average expenditure top 3 | 43 | n/a |
|  | QS university ranking average score top 3 universities | 69 | 5.6 |

|  |
| --- |
| Infrastructure |
|  | Rank | Score |
| Overall | **95** | **37.0** |
| Information and communications technologies (ICTs) | 95 | 39.0 |
|  | ICT access | 109 | 30.6 |
|  | ICT use | 113 | 10.6 |
|  | Government’s online service | 60 | 62.3 |
|  | Online e-participation | 82 | 52.5 |
| General infrastructure | 71 | 35.5 |
|  | Electricity output | 107 | 1.2 |
|  | Logistics performance | 86 | 27.8 |
|  | Gross capital formation | 25 | 56.6 |
| Ecological sustainability | 96 | 36.4 |
|  | GDP per unit of energy use | 18 | 48.6 |
|  | Environmental performance | 120 | 41.8 |
|  | ISO 14001 environmental certificates | 112 | 1.1 |

|  |
| --- |
| Market Sophistication |
|  | Rank | Score |
| Overall | **103** | **38.3** |
| Credit | 96 | 25.4 |
|  | Ease of getting credit | 119 | 25.0 |
|  | Domestic credit to private sector | 77 | 16.8 |
|  | Microfinance institutions’ gross loan portfolio | 16 | 34.4 |
| Investment | 99 | 32.4 |
|  | Ease of protecting minority investors | 67 | 56.7 |
|  | Market capitalization | 40 | 15.8 |
|  | Venture capital deals | 91 | 0.3 |
| Trade, competition, & market scale | 82 | 57.1 |
|  | Applied tariff rate, weighted mean | 121 | 30.9 |
|  | Intensity of local competition | 69 | 68.5 |
|  | Domestic market scale | 32 | 64.5 |

|  |
| --- |
| Business Sophistication |
|  | Rank | Score |
| Overall | **99** | **25.6** |
| Knowledge workers | 84 | 29.4 |
|  | Employment in knowledge-intensive services | 74 | 34.4 |
|  | Firms offering formal training | 72 | 24.4 |
|  | GERD performed by business enterprise | n/a | n/a |
|  | GERD financed by business enterprise | n/a | n/a |
|  | Females employed with advanced degrees | n/a | n/a |
| Innovation linkages | 81 | 23.5 |
|  | University/industry research collaboration | 116 | 25.7 |
|  | State of cluster development | 72 | 44.0 |
|  | GERD financed by abroad | n/a | n/a |
|  | Joint venture/strategic alliance deals | 84 | 3.7 |
|  | Patent families filed in at least two offices | 116 | 0.0 |
| Knowledge absorption | 105 | 24.0 |
|  | Intellectual property payments | 104 | 2.0 |
|  | High-tech imports | 48 | 31.3 |
|  | ICT services imports | 119 | 2.3 |
|  | Foreign direct investment, net inflows  | 91 | 49.5 |
|  | Research talent in business enterprise | n/a | n/a |

|  |
| --- |
| Knowledge and Technology Outputs |
|  | Rank | Score |
| Overall | **96** | **16.0** |
| Knowledge creation  | 95 | 4.5 |
|  | Patent applications by origin | 110 | 0.3 |
|  | PCT international applications by origin | n/a | n/a |
|  | Utility model applications by origin | n/a | n/a |
|  | Scientific and technical publications | 110 | 3.4 |
|  | Citable documents H index | 63 | 9.8 |
| Knowledge impact | 72 | 29.2 |
|  | Growth rate of GDP per person engaged | 16 | 73.8 |
|  | New business density | 101 | 0.5 |
|  | Total computer software spending | 77 | 14.9 |
|  | ISO 9001 quality certificates | 114 | 1.3 |
|  | High-tech and medium high-tech output | 84 | 11.0 |
| Knowledge diffusion | 112 | 14.4 |
|  | Intellectual property receipts | 98 | 0.1 |
|  | High-tech exports | 107 | 0.5 |
|  | ICT services exports | 78 | 10.0 |
|  | Foreign direct investment, net outflows  | 90 | 30.8 |

|  |
| --- |
| Creative Outputs |
|  | Rank | Score |
| Overall | **110** | **17.6** |
| Intangible assets | 104 | 30.1 |
|  | Trademark application class count by origin | 92 | 7.8 |
|  | Industrial designs by origin | 42 | 11.8 |
|  | ICTs and business model creation | 103 | 49.5 |
|  | ICTs and organizational model creation | 104 | 42.0 |
| Creative goods and services | 125 | 1.1 |
|  | Cultural and creative services exports | 83 | 0.2 |
|  | National feature films produced | 87 | 0.2 |
|  | Global entertainment and media market | n/a | n/a |
|  | Printing and publishing output | 99 | n/a |
|  | Creative goods exports | 100 | 2.1 |
| Online creativity | 102 | 8.9 |
|  | Generic top-level domains (gTLDs) | 111 | 0.4 |
|  | Country-code top-level domains (ccTLDs) | 123 | 0.0 |
|  | Wikipedia yearly edits | 103 | 26.3 |
|  | Video uploads on YouTube | n/a | n/a |

Scrutinizing the extensive data in the table above, two facts and trends stand out. First, Bangladesh is behind the middle-income countries in both hard and soft infrastructures of research and development. Secondly, even in the soft part regarding education and training, the progress has been very slow and faltering. Thus, acceleration of the appropriate areas of hard and soft infrastructures for R & D needs to be a top priority.

It should also be noted that Bangladesh remains weak in on line creativity, especially in Country-code top-level domains (ccTLDs). It is shocking that although the publishing industry has grown as evident from Boi Melas and other cursory evidence, there is apparently no systematic data base for year to year information about this vital knowledge industry. It is likewise surprising that Bangladesh’s cultural and creative services exports are so low-scoring. The H-index performance is encouraging but not overwhelmingly so. Leaving aside the critiques of the index, even moderately productive research departments in the US have average scores over 20.

However, it is heartening that Bangladesh scores well in Industrial designs by origin. It is also moderately starting to move towards ICT improvements. ICTs and business model creation shows some improvement but there is a long distance to go to catch up with India. A similar picture emerges in ICTs and organizational model creation also. Compared to global innovation frontier in ICT briefly captured above, Bangladesh needs to focus on a strategic sector like ICT to catch up quickly and meet the goals of the perspective plan for Vision 2041.

We now turn to the specifics of assessing the ICT potential for Bangladesh and what needs to be done to build this part of the Bangladesh national innovation system(BNIS) by the 2040s.

# C. 2041 PERSPECTIVE PLAN VISION, THE REQUIRED OBJECTIVES OF THE ICT SECTOR AND THE FUTURE

It is clear from the previous discussion that the ICT sector is both capable of and so far, falls short of contributing to its full potential for fulfilling the perspective plan vision mentioned in section A of this paper. We now take a closer look at the ICT sector and suggest strategic policy and institutional moves to fulfil the plan vision.

## Defining and charting the ICT sub-system in Bangladesh:

### WPIIS Classification:

Before discussing the relation between ICT sectors and economic growth, innovation and development, it is first necessary to have a clear definition of the ICT sectors. The most widely accepted definition so far is the one agreed to at the April 1998 meeting of the Working Party on Indicators for the Information Society (WPIIS) and subsequently endorsed at the September 1998 meeting of the Committee for Information, Computer and Communication Policy of OECD. The following principles underlie the definition.

For *manufacturing industries*, the products of a candidate industry:

* Must be intended to fulfill the function of information processing and communication including transmission and display.
* Must use electronic processing to detect, measure and/or record physical phenomena or to control a physical process.

For *services industries*, the products of a candidate industry:

* Must be intended to enable the function of information processing and communication by electronic means.

Based on these principles the ICT sectors are identified within the revised classes of the International Standard Industrial Classification (ISIC). In manufacturing and services the following four digit sectors are included:

*Manufacturing*

* 3000-Office, accounting and computing machinery
* 3130-Insulated wire and cable
* 3210-Electronic valves and tubes and other electronic components
* 3220-television and radio transmitters and apparatus for line telephony and line telegraphy
* 3230-Television and radio receivers, sound or video recording or reproducing apparatus, and associated goods
* 3312-Instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process equipment
* 3313-Industrial process control equipment

*Services*

* 5150-Wholesaling of machinery, equipment and supplies
* 7123-Renting of office machinery and equipment (including computers)
* 6420-telecommunications
* 7200-Computer and related activities

In short, roughly there are three broad categories of the new ICTs: (1) computing, (2) communicating, (3) Internet-enabled communication and computing. Strictly speaking, not all of ICT sectors are digital, or at least not yet. Even within the digital part, the pre- and post- internet distinction is historically important and relevant for the developing economies. This applies for example for cell phones that became smart phones with the integration of telephony and microcomputer-based internet transactions. Bangladesh has made great strides in utilizing smart phones and as recent developments show, there is still much untapped potential in the service sector use of smartphones.

We can roughly dissect the digital economy’s infrastructure into its pre-Internet and Internet eras. Before the Internet, a host of information technologies came into existence, which provided computing power on a platform-specific system, usually centralized (e.g. a central mainframe with terminals) or distributed within a local area. The advent of the Internet (and its precursors, the U.S. government-funded research networks like the defense research network - ARPANET) was a critical event because it set up the basic infrastructure, standards (e.g. protocols for communication) and technologies, that enabled large scale, distributed and platform-independent information exchange and manipulation. This “single” system allowed the introduction of literally unlimited sources of information, or access points to it, in a *scaleable* fashion, i.e., without increasing numbers of constraints or decreasing economic “returns to scale”. The first computing functions consisted of basic email and file transfer capabilities like *ftp* and *gopher*, but these were soon coupled with basic “Web” technologies, like the development of the first browsers and the standards and technologies of the “World Wide Web”. The “World Wide Web” further improved the remote accessing and manipulation of information, and ensured that all information could be “web-based”, and therefore potentially viewable/downloadable by anyone connected to the Web. All these set the stage for electronic commerce to take place, since the connection of such large numbers of people to all the sources of information provided a potentially enormous market never possible in the history of markets.

### ICT Sectors in Bangladesh – Identification and analysis of sub-sectors of ICT in Bangladesh and trends in the ICT industry. Identification of economy wide linkages between the above sectors and between these sectors and the rest of the economy:

I present below the relevant available ICT Data for Bangladesh. As mentioned earlier, it should be noted that the data for the ICT manufacturing sector is currently only available for a few years (the latest being 2012). Using the Bangladesh Survey of Manufacturing Industries, I have compiled data on establishments, gross output, total persons engaged and salaries and wages of each component. Since the report did not provide any profit calculation, I have instead included data of Gross Value Added (Gross Output-Input Cost) and Value Added at Factor Cost (Gross Value Added- Indirect Cost). Using International Trade Centre as the primary source, I have compiled the data on export and import of the given ICT and related sectors. However, there are some data limitations.

1)      Due to the difference in BSIC code, data for the year 2012 has been shown on a separate sheet. As the earlier years used BSIC Rev 2 and the latest year used BSIC Rev 4, I have resorted to the sectors that are most similar to those defined under BSIC Rev 3.1. Thus, there may be a discrepancy between the codes and descriptions used for each manufacturing product.

2)      The BSIC codes given in the file are taken directly from the Manufacturing Surveys and may not necessarily match the ISIC codes for OECD classification.

3)       In tables 9 and 10 below, the export and import data related to the ICT sector are defined under ISIC Rev 3.1. This dataset covers many of the ICT manufacturing products mentioned in the OECD classification scheme. However, the data are only available for four years (2012-2015).

In table below and the corresponding graph, we note that much of the earlier growth occurred between the mid 1990s and 2000. The growth under the second BNP regime was particularly slow. For sectors 3836 and 3000 (Computing & Accounting Machineries),3841(electronics) and 3839 (other general-purpose machinery), there was negative growth in number of establishments. Fortunately, gross output continued to show increases, as shown in Table 4. Table 5 shows slow growth in gross input cost implying perhaps stagnant wages and some mismeasurement of capital cost. Table 6 on Value Added at Factor Cost registers growth in several ICT sectors but shows little progress in computing machinery. We’ll discuss this on the basis of extensive interview with some industry leaders.

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| ICT Classification Under BSIC Rev-2 and 3 |
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| **Table 3: Number of Establishments**  |
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| **BSIC Rev-2 (as used in MIS) and Rev 3.1 for 2005-06** | **Year/Description** | **1992-93** | **1995-96** | **1997-98** | **1999-2000** | **2005-2006** |
| 3836 & 3000 | Computing & Accounting Machineries |   | 3 | 3 | 3 | 2 |
| 3839 | Other General-Purpose Machinery | 49 | 61 | 93 | 64 |  |
| 3841 | Electronics Including Machinery Appliances | 14 | 28 | 14 | 7 |  |
| 3842 & 3220 | Radio and Television | 23 | 32 | 38 | 31 | 36 |
| 3843 | Electrical Appliances | 13 |  | 18 | 12 |  |
| 3844 & 3130 | Insulated Wires & Cables | 12 | 12 | 12 | 11 | 44 |
| 3845 & 3210 | Electric Bulbs and Tubes | 8 | 8 | 16 | 18 | 22 |
| 3847 & 3120 | Electronic Components | 4 |  |  | 1 | 30 |
| 3849 | Electrical Apparatus | 134 | 143 | 122 | 121 |   |
| Source: Report of Bangladesh Census/Survey of Manufacturing Industries |  |  |  |

Figure 1: Number of Establishments

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| Table 4: Gross Output |
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| **BSIC Rev-2 (as used in MIS) and Rev 3.1 for 2005-06** | **Year/Description** | **1992-93** | **1995-96** | **1997-98** | **1999-2000** | **2005-2006** |
| 3836 & 3000 | Computing & Accounting Machineries |   | 7800 | 7800 | 7816 | 49755 |
| 3839 | Other General-Purpose Machinery | 247389 | 164899 | 187397 | 1170832 |  |
| 3841 | Electronics Including Machinery Appliances | 94910 | 81560 | 5537 | 498181 |  |
| 3842 & 3220 | Radio and Television | 914578 | 1282061 | 2023611 | 2217112 | 2501656 |
| 3843 | Electrical Appliances | 174201 |  | 624736 | 398396 |  |
| 3844 & 3130 | Insulated Wires & Cables | 724697 | 1669315 | 11062226 | 9090272 | 2089148 |
| 3845 & 3210 | Electric Bulbs and Tubes | 842202 | 1170748 | 2942578 | 4567064 | 1363209 |
| 3847 & 3120 | Electronic Components | 59351 |  |  | 27859 | 115276 |
| 3849 | Electrical Apparatus | 699624 | 6732789 | 4208753 | 3817188 |   |
| Source: Report of Bangladesh Census/Survey of Manufacturing Industries |  |  |  |

Figure 2: Gross Output (in '000 Tk.)

Table 4 shows moderate growth that will need to be accelerated consistent with the plan vision for 2041. Although production in most categories shows healthy growth trajectories, two basic areas --- Insulated Wires & Cables and Electric Bulbs and Tubes---show a decline. Since electrical goods sector as a whole did not shrink and electronic components part kept growing, most probably, the gap was made up for by imports. Without a sufficiently detailed imports map year by year, it was not possible to check this conjecture directly. It could in part be also accounted for by price inflation in these sectors. A comparison with VA at factor costs in table 12 suggests that this may have happened.

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| Table 5: Gross Value Added (Gross Input Cost) (in '000 Tk.) |
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| **BSIC Rev-2 (as used in MIS) and Rev 3.1 for 2005-06** | **Year/Description** | **1992-93** | **1995-96** | **1997-98** | **1999-2000** | **2005-2006** |
| 3836 & 3000 | Computing & Accounting Machineries |   | 4403 | 4403 | 4418 | 10488 |
| 3839 | Other General-Purpose Machinery | 89488 | 41742 | 84160 | 417734 |  |
| 3841 | Electronics Including Machinery Appliances | 25963 | 35058 | 5033 | 208295 |  |
| 3842 & 3220 | Radio and Television | 368725 | 447897 | 807918 | 1229290 | 1129338 |
| 3843 | Electrical Appliances | 54914 |  | 240107 | 154901 |  |
| 3844 & 3130 | Insulated Wires & Cables | 308903 | 1112185 | 10070519 | 8149383 | 592751 |
| 3845 & 3210 | Electric Bulbs and Tubes | 366936 | 560194 | 1155655 | 2345189 | 1119374 |
| 3847 & 3120 | Electronic Components | 26483 |  |  | 7674 | 82830 |
| 3849 | Electrical Apparatus | 441453 | 2273814 | 2052942 | 1863695 |   |
| Source: Report of Bangladesh Census/Survey of Manufacturing Industries |  |  |  |

Figure 3: Gross Value Added (in '000 Tk.)

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| **Table 6: Value Added at factor cost (in '000 Tk.)** |
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| **BSIC Rev-2 (as used in MIS) and Rev 3.1 for 2005-06** | **Year/Description** | **1992-93** | **1995-96** | **1997-98** | **1999-2000** | **2005-2006** |
| 3836 & 3000 | Computing & Accounting Machineries |  | 2981 | 2981 | 2996 | 4887 |
| 3839 | Other General-Purpose Machinery | 65035 | 31000 | 76124 | 292088 |  |
| 3841 | Electronics Including Machinery Appliances | 10843 | 28344 | 3328 | 106700 |  |
| 3842 & 3220 | Radio and Television | 165306 | 245769 | 373777 | 905778 | 1106904 |
| 3843 | Electrical Appliances | 34152 |  | 128863 | 82838 |  |
| 3844 & 3130 | Insulated Wires & Cables | 196292 | 743376 | 9836455 | 7930171 | 550082 |
| 3845 & 3210 | Electric Bulbs and Tubes | 207235 | 328266 | 363106 | 660490 | 931726 |
| 3847 & 3120 | Electronic Components | 18852 |  |  | 6187 | 80275 |
| 3849 | Electrical Apparatus | 398335 | 1615071 | 1636018 | 1453892 |   |
| Source: Report of Bangladesh Census/Survey of Manufacturing Industries |  |  |  |

Figure 4: Value Added at Factor Cost (in '000 Tk.)

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| **Table 7: Total Number Persons Engaged** |
| **BSIC Rev-2 (as used in MIS) and Rev 3.1 for 2005-06** | **Year/Description** | **1992-93** | **1995-96** | **1997-98** | **1999-2000** | **2005-2006** |
| 3836 & 3000 | Computing & Accounting Machineries |  | 36 | 36 | 36 | 58 |
| 3839 | Other General-Purpose Machinery | 1510 | 1253 | 2562 | 6099 |  |
| 3841 | Electronics Including Machinery Appliances | 395 | 490 | 182 | 895 |  |
| 3842 & 3220 | Radio and Television | 1938 | 1971 | 2669 | 1549 | 10480 |
| 3843 | Electrical Appliances | 929 |  | 3499 | 2136 |  |
| 3844 & 3130 | Insulated Wires & Cables | 1749 | 2396 | 2316 | 2185 | 2537 |
| 3845 & 3210 | Electric Bulbs and Tubes | 730 | 764 | 1588 | 2036 | 1285 |
| 3847 & 3120 | Electronic Components | 172 |  |  | 795 | 420 |
| 3849 | Electrical Apparatus | 5870 | 27129 | 20654 | 18829 |   |
| Source: Report of Bangladesh Census/Survey of Manufacturing Industries |  |  |  |

Figure 5: Total Persons Engaged

Table 7 is an important indicator of the contribution of the ICT sectors to people’s well-being via employment generation. Again, the record of BSIC 3836 and 3000 is weak, and Electric Bulbs and Tubes and Electronic Components show declining employment from 2000 to 2006. More recent data for these sectors are not available; but the healthier overall growth figures for more recent years suggest a possible recovery and expansion.

The conclusion that can be drawn provisionally is that on the whole ICT sectors generate relatively decent number of jobs at relatively decent pay and benefits; but there is much room for increasing the scale and scope, generating more output and employment. My field work observations also indicate large variances both within and between firms. The potential for both quantitative and qualitative improvements by 2041 is enormous in this area.

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| **Table 8: Wages & Salaries (in '000 Tk.)** |
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| **BSIC Rev-2 (as used in MIS) and Rev 3.1 for 2005-06** | **Year/Description** | **1992-93** | **1995-96** | **1997-98** | **1999-2000** | **2005-2006** |
| 3836 & 3000 | Computing & Accounting Machineries |  | 1072 | 900 | 900 | 2222 |
| 3839 | Other General-Purpose Machinery | 25517 | 19883 | 49288 | 209900 |  |
| 3841 | Electronics Including Machinery Appliances | 5711 | 13397 | 2598 | 28555 |  |
| 3842 & 3220 | Radio and Television | 39409 | 48934 | 75887 | 123041 | 347515 |
| 3843 | Electrical Appliances | 23041 |  | 58924 | 40967 |  |
| 3844 & 3130 | Insulated Wires & Cables | 40475 | 51985 | 72067 | 67831 | 113290 |
| 3845 & 3210 | Electric Bulbs and Tubes | 30461 | 75561 | 284329 | 379731 | 125358 |
| 3847 & 3120 | Electronic Components | 3969 |  |  | 3097 | 9447 |
| 3849 | Electrical Apparatus | 71086 | 596323 | 337255 | 369152 |   |
| Source: Report of Bangladesh Census/Survey of Manufacturing Industries |  |  |  |

Figure 6: Wages & Salaries (in '000 Tk.)

Here the average compensation within the ICT industry as a whole shows wide variation. (compute averages for each BSIC). Ahmed (2017) points out with respect to wage dispersion in services:

As expected, there are large productivity differentials within the services category. Highest productivity is found in professional services, such as Finance, Telecoms and ICT.

What we find from our closer look at ICT in particular is that the industry both in services and in manufacturing shows wage dispersion and wage growth.

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| **Table 9: Exports (in US $ million)** |
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| **BSIC Rev-3**  | **Year/Description** | **2012** | **2013** | **2014** | **2015** |
| 3000 | Office, accounting and computing machinery | 4.7 | 3.5 | 6.9 | 2.3 |
| 3130 | Manufacture of insulated wire and cable | 0.8 | 0.3 | 0.6 | 0.4 |
| 3210 | Manufacture of electronic valves and tubes and other electronic components | 8.9 | 10 | 8.1 | 4.7 |
| 3220 | Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy | 2.8 | 1.6 | 7 | 14.6 |
| 3230 | Manufacture of television and radio receivers, sound or video recording or reproducing apparatus, and associated goods | 1.6 | 0.4 | 1 | 0.4 |
|   | Manufacture of electricity distribution and control apparatus | 0.8 | 1 | 1.8 | 1.8 |
| Source: International Trade Centre |  |  |  |  |

Figure 7: Exports (in US $ million)

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| **Table 10: Imports (in US $ million)** |
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| **BSIC Rev-3**  | **Year/Description** | **2012** | **2013** | **2014** | **2015** |
| 3000 | Office, accounting and computing machinery | 332.1 | 336 | 371.3 | 388.4 |
| 3130 | Manufacture of insulated wire and cable | 70.6 | 95.8 | 120.1 | 108.2 |
| 3210 | Manufacture of electronic valves and tubes and other electronic components | 117.4 | 116.3 | 127.8 | 152.7 |
| 3220 | Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy | 510.7 | 668.6 | 933.4 | 800.5 |
| 3230 | Manufacture of television and radio receivers, sound or video recording or reproducing apparatus, and associated goods | 84 | 132.3 | 186.9 | 216.5 |
|   | Manufacture of electricity distribution and control apparatus | 147.1 | 177.3 | 212.1 | 245.9 |
| Source: International Trade Centre |  |  |  |  |

Figure 8: Imports (in US $ million)

It seems that Bangladesh has an opportunity to use the imported inputs for ICT to create an export base for ICT products and services.

**ICT Classification under BSIC Rev – 3.1 and 4: Year 2012**

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| **Table 11: Manufacture of Computers and peripheral Equipment** |
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| **BSIC Rev-3.1** | **BSIC Rev-4** | **Year/Description** | **2012** |
| 3000 | 2620 | No. Of Establishments | 13 |
| Gross Output | 2263950 |
| Gross Value Added (GVA) | 672051 |
| Total Persons Engaged | 1027 |
| Wages and Salaries | 172374 |

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| **Table 12: Manufacture of communication equipment** |
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| **BSIC Rev-3.1** | **BSIC Rev-4** | **Year/Description** | **2012** |
| 3220 | 2630 | No. Of Establishments | 46 |
| Gross Output | 18,301,100 |
| Gross Value Added (GVA) | 5657179 |
| Total Persons Engaged | 10,787 |
| Wages and Salaries | 1570348 |

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| **Table 13: Manufacture of other electronic and electric wires and cables** |
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| **BSIC Rev-3.1** | **BSIC Rev-4** | **Year/Description** | **2012** |
| 3130 | 2732 | No. Of Establishments | 183 |
| Gross Output | 107,980,235 |
| Gross Value Added (GVA) | 28794867 |
| Total Persons Engaged | 11,623 |
| Wages and Salaries | 1476801 |

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| **Table 14: Manufacture of wiring devices** |
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| **BSIC Rev-3.1** | **BSIC Rev-4** | **Year/Description** | **2012** |
|  | 2733 | No. Of Establishments | 143 |
|  | Gross Output | 3,069,530 |
|  | Gross Value Added (GVA) | 1104056 |
|  | Total Persons Engaged | 5,325 |
|   | Wages and Salaries | 345758 |

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| **Table 15: Manufacture of other electrical equipment** |
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| **BSIC Rev-3.1** | **BSIC Rev-4** | **Year/Description** | **2012** |
|  | 2790 | No. Of Establishments | 219 |
|  | Gross Output | 18,468,887 |
|  | Gross Value Added (GVA) | 5876186 |
|  | Total Persons Engaged | 7,845 |
|   | Wages and Salaries | 783949 |

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| **Table 16: Manufacture of consumer electronics** |
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| **BSIC Rev-3.1** | **BSIC Rev-4** | **Year/Description** | **2012** |
| 3230 | 2640 | No. Of Establishments | 90 |
| Gross Output | 19,057,589 |
| Gross Value Added (GVA) | 4447755 |
| Total Persons Engaged | 4,576 |
| Wages and Salaries | 584051 |

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| **Table 17: Category of Income by BSIC 2-digit Code for the year 2012** |
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| **BSIC code and description** | **Category of other income** | **Value (in '000 Tk.)** |
| 26: Manufacture of computer, electronic and optical products | Total | 467,027 |
| Income from others' raw materials | 118,122 |
| Investment and other income | 321,630 |
| Income from selling of raw materials | 27,274 |
| 27: Manufacture of electrical equipment | Total | 1,033,683 |
| Income from others' raw materials | 182,619 |
| Rental and leasing assets | 85,303 |
| Investment and other income | 39,906 |
| Bonus and premium | 2,396 |
| Income from selling of raw materials | 723,459 |

One particular issue with regards to the human component of ICT sector is noteworthy. Although the skill set in ICT in terms of education and training is better than other sectors, still there is a skills gap here too. As Ahmed (2017, pp19-20) states:

The skills situation in the formal services is better. Modern services such as ICT, telecoms, financial sector, aviation, international shipping and professional services are the largest employer of the graduates of the tertiary education system. Although there are quality differentials among supply sources of the tertiary education network, the expansion of these services is usually constrained by supply of specialized skills needed. In particular, the ICT industry is constrained by supply of skills.

### Private Sector contributions and prospects:

Much of the manufacturing and services described are by private sector firms. In the service category, as discussed earlier, there have been several successful e-delivery of services firms. Perhaps BKash is the most prominent. As I observed, there are variations of quality in the private sector and not all firms are financially transparent or accountable corporate entities. Another problem is a kind of growth ceiling that experts in the ICT field have identified. It seems that the industry has not been able to break out from an overall size of exporting 700 million dollars annually[[3]](#footnote-3) in an upward direction.[[4]](#footnote-4)A close study of the most recently published industry document from BASIS SOFT EXPO 2017 confirms this assessment by Bangladeshi experts.[[5]](#footnote-5)The document asserts that more than 300,000 professionals are involved; but this seems an overestimate.

BASIS SOFT EXPO 2017 document states that there are now more than 4500 enterprises with 56 per cent of the total revenue coming from software related firms and 44 per cent from ITES related firms. According to BASIS research, exports from 382 BASIS companies in 2015 was US $594.73 million. There is also *an upper bound estimate* of US $ 761.5 million. But this is based a generous assumption that 25 per cent of the IT and ITES sector firms are exporters.

One area of success, as mentioned before, is the extension of ITES through smart mobile telephony. In my view, more important than the success of just selling mobile phones are the creative ways firms like bKash are starting to provide important services to the people.

### Export Promotion Bureau Program:

In the 1990’s there was much hype about IT everywhere and outsourcing was beginning to draw attention as a new business. India had just started to use outsourcing on a small scale. Through the Export Promotion Bureau (EPB) of Bangladesh program in Malaysia, Mahboob Zaman and others attended this program and found that all the participating countries were concerned about the possible digital catastrophe known as the Millennium bug or Y2K bug. They also learned that India was already prepared with to solve the crisis. This proactive stance gave an advantage to India and it drew increasing amount of investments and strategic corporate alliances in this sector.

Leading Bangladeshi ICT entrepreneurs met N. R. Narayana Murthy, the co-founder of Infosys. Narayana Murthy made some suggestions regarding start-ups and new ventures. He also explained the whole system of Infosys to them. According to a later publication, the Bangladeshis reported:

It was evident that Infosys concentrated on its key activities – software development. The rest of the activities inside their campus were outsourced. It helped them to remain focused and to put 100% of the effort in one basket.

After successful projects like Chittagong Custom House Automation (CCHA), companies like Datsoft are going into mobile applications as new lines of business. Given the increase in the number of mobile phone users and the use of different mobile applications it was possible to form a company solely dedicated for developing mobile software. In September 2013, DataSoft founded a small spinoff mobile applications company. This company, called MobioApp is the first software company in Bangladesh that was employee owned. MobioApp Limited distributed its share capital not just to the key managers and the board of directors, but also among the employees of the company.

It is impressive that MobioApp has already developed mobile application software for Android, iOS, Windows phone and Blackberry and is carrying out continuous innovation. For the implementation of such an innovation strategy, MobioApp has recruited employees from different backgrounds including Software Development, Communications, and Creative Arts & Crafts. Notably, MobioApp not only has experienced business developers, but also has recruited students who work as interns or on part time basis. The employees are given in-house training in different areas of software development to maintain the continuous innovation in mobile applications. It is then not surprising that MobioApp has developed a number of mobile applications for the local market like 71, Ekusher Boi, Kid’s Starter, Balanced Diet, Salat-Ramadan-Masjid etc. Being a booklover, I am pleasantly surprised that an application called *Boipoka*(Bookworm) is the “…flagship product of the company”.

People connected with the company proudly pointed out:

It has been nominated for 'mBillionth Award South Asia 2014'. Among 300+ Mobile Apps from all over South Asia, Boipoka is in top nine. For better publicity in the local market, MobioApp had a stall for Boipoka in the 2014 Ekushey book fair. The increasing popularity of eBooks among the book readers around the world inspired MobioApp to develop Boipoka with which readers can get eBooks on their smartphones or tablets. By downloading and installing Boipoka, a reader has access to Boipoka’s online bookshelves. In those bookshelves, the reader can find his/her desired books and purchase them. Customers outside the country can also purchase books from the app by using their credit cards. All the books are protected by Digital Rights Management (DRM) to impose technological restrictions for controlling what users can do with material on digital media platforms like eBooks. (DS Biz pp6-7)

It may not be impossible to brand Bangladesh as the land of mobile applications if the young learners take the lead and train in this area to make important contributions in the near future. In addition to the above area, ICT companies in Bangladesh are assisting microfinance organizations and formal Banking sector.

As a partner of Temenos (the world leading banking software provider), one company has successfully implemented Temenos T24 in 5 commercial banks in Bangladesh which includes Prime Bank Limited, EXIM Bank Limited, Janata Bank limited, Agrani Bank and Mercantile Bank. Temenos T24 (T24) is a complete front- to back-office, Customer Relationship Management (CRM) and product lifecycle management software platform that powers core banking operations. It is a 24-hour real-time banking application that provides multiple application server support to a huge number of users. The system also eliminates the need to run End of Day processing. It ties together multiple channels, and provides CRM functionality and true non-stop processing in a single system (DS Biz, p.9).

In other areas, the application of sophisticated software with advanced computers are proceeding from infrastructure projects to e-governance. Many firms in this sector are also progressive in terms of their recognition of corporate social responsibility (CSR). My conversations with some of the leaders showed that consistent with their level of education and at least for some, a background of their involvement in our war of liberation in 1971 and with progressive student activism prior to 1971, these corporate leaders are cognizant of CSR.

Since I wish to focus on the future, it is pertinent to pick one solidly performing manufacturing firm. With this purpose in mind I now turn to a Case Study of an actual IT company in Bangladesh. For reasons of confidentiality, I will not name the company. But it is a leading, progressive IT company with a lot of promise. I will discuss one particular product development idea and the problems that arise in this particular context to give the reader a concrete picture of innovation prospects and problems in this area.

One of the computer products that this company is interested in is aptly called **A1-** All-In-One computer (A1), which includes a LED Monitor, Keyboard and Mouse with low-powered consumption SoC; which can be manufactured and assembled in Bangladesh. The leaders interviewed also provided an overview of the spare parts required for the product along with guidelines on the vast array of applicable devices and assembling solutions for modern day computing need.

The goal is to develop, hardware, software and provide IT enable services, which includes Hardware Design/Development, manufacturing and assembly of different devices to build the IT infrastructure for Bangladesh progressing towards the broad goal of building an innovation system. Even where the country is dependent of import items, the goal is to build and train and skilled labor forces for meeting Bangladesh’s needs in software development, management and administration. The company seems to be committed to capturing its niche in the world market in providing state of art technology and services at a fraction of global average cost. The company’s goal---stated concretely--- is to manufacture the computer hardware and provide IT enable services. It is planning to build on its existing expertise in Software/Hardware, and IOT Design and Development. It already provides enterprise level software and hardware, along with IT services across the global market. The concrete objectives are to eventually capture the niche in the world market in providing state of art technology in IOT, VDI, Virtual Reality, Drone and other related items in a cost-effective manner--- manufactured and assembled in Bangladesh at the Hi-Tech Park in KaliaKhor.

Bangladesh requires desktop level computing power on each person’s desktop, which can be a laptop and/or a desktop and/or Virtual Desktop Infrastructure (VDI) product uses a Private cloud technology in such a way that each person will be using a small device called A1 with a Keyboard, and a Mouse to experience a full desktop computing environment without having to have a traditional laptop or a desktop. A1 is a platform independent software that will run on Windows7, Windows10, Androids and Linux desktop environment, where a person can use Microsoft Office product, Adobe Illustrator/Photoshop for Graphic Design and any applications, able to surf the Internet. This technology has already reduced the cost of owning desktop exponentially and is closing the gap of Digital Divide for Bangladesh market. Therefore, it promises to be a cost-effective way to promote the Honorable Prime Minister’s campaign for “Digital Bangladesh”.

A1 can coexist with existing environment or can function independently. With the rise of cloud computing in the world and the IT changes that are taking place in Bangladesh for digitization, within offices and institutes, by having A1 produced in Bangladesh, the local firms can provide an inexpensive desktop to address the IT challenges.

The author found that A1 technology could be deployed in any enterprises, institutions and schools in Bangladesh to cut down 50% of the desktop/laptop cost to build an IT infrastructure. This technology will be applicable for small, mid and large size IT infrastructures and will provide a low-cost solution to access the full functionality of a desktop with merely a fragment of IT budget. Among the concrete needs are the factory build-up materials such as:

1. Conveyor Belt Table 50/100/200 ft. long
2. Plastic imprint 2-color machine to print our name and logo on the frame
3. Molding and other metal based manufacturing tooling machines
4. Tools & electronics devices required to build an assembly and manufacturing plants

It is important for our economic planners to understand the need for removing/reducing tariffs and/or providing subsidies as part of a coherent industrial policy for Vision 2041. Here is a concrete partial list:

Table 18: Needed Waiver/Reduction of Duties/Taxes/VATs

|  |  |
| --- | --- |
| No.  | Category Name Specification  |
| 1 | Electronic monitor mother board |
| 2 | Invertor  |
| 3 | Panel wire FI-X30H/DP2X15P/250mm  |
| 4 | Power cable 1.5m UK standard plug  |
| 5 | Power board  |
| 6 | Keyboard & receive board with line14P2.0/8P2.0-5P2.0/400mm  |
| 7 | Receive board CL-24LED-B  |
| 8 | Keyboard CL-24LED-A  |
| 9 | HDMI cable  |
| 10 | Cabinet size 18.5/19 inch  |
| 11 | Back cabinet  |
| 12 | Front cabinet  |
| 13 | Base plate |
| 14 | Metal Plant inner  |
| 15 | Panel metal(down/side) metal  |
| 16 | Screw PA3\*8 mainboard\*4/invertor\*2/keyboard\*2/received\*1/panel metal\*2  |
| 17 | Package carton with foam color gift box  |
| 18 | PE plastic bag 39\*55cm  |
| 19 | Instruction manual  |
| 20 | LED and LCD Panel 16:9, 18.5 or 19 inch A+ grade  |
| 21 | Glass protection of the 16:9 18.5/19 inch LED panel Apple or other model  |
| 22 | SOC based mother board with 2/4/8GB RAM, 32/64/128GB SSD, Low Power Consumption CPUs, 4\*USB2.0, 1\*Rj45, 1\*Headphone port, 1\* Audio, 1\*TF card slot, 1\*standard HDMI, WIFI/BT, 2.4G wifi and Power Adapter 20VDC/3 Amps |
| 23 | Memories |
| 24 | Hard Drives |
| 25 | DC Power Supplies |
| 26 | Rechargable batteries |
| 27 | HDTV or TV controller boards |
| 28 | VGA Cable, connectors |
| 29 | HDMI to VGA Convertors |
| 30 | GPRS Modules or circuits board |
| 31 | Micro-controllers - 8bit, 16bits, 32 bits and 64 bits |
| 32 | MiniUSB Cables |
| 33 | RS232 Connectors and cables |
| 34 | Capacitors and registors |
| 35 | Optical Mouse |
| 36 | Computer mother board and accessories |
| 37 | AC to DC power convertors |
| 38 | Windows10 Pro or other OS |
| 39 | Wifi circuit board |
| 40 | On/off switches, cables, connectors |
| 41 | USB COM port board and cables |
| 42 | Special electronics and circuits |
| 43 | Special electronics components |

It is my hope that this brief but detailed concrete case study illustrates the practical problems faced by some of our truly patriotic entrepreneurs. In the final section, I will list many other possible strategic policy orientations and steps.

I now turn to a brief discussion of my extensions of the idea of National Innovation System(NIS) in order to pose the problems of and prospects for an appropriate NIS for Bangladesh or BNIS y 2041.

### National Innovation System (NIS), Sectoral Innovation Sub-System (SISS), Augmented National Innovation System (ANIS), Social Learning and Complexity:

The National Innovation System or NIS--- also abbreviated as NSI or National System of Innovation---- can be broadly definedas the intersectoral flow of technology and information in the economy including households and individuals, productive enterprises and various institutions including both public and private educational and R& D institutions. All these can form a network which under appropriate circumstances can generate a self-sustaining innovative process on the national level.(Freeman 1987,1995; Nelson 1992,1993a,b, 1994, 1995; Lundvall 1992; Edquist 1997; Kim 2000; Kim and Nelson 2000; Lee 2006,2008; Lee and Lim 2001; Lee and Kim 2009; Khan1998, 2002, 2004a,b,2011, 2012,2013, 2017;Khan and Matin 2011) . According to this approach, which I generally follow with some modifications described later, technological development requires a system of well-functioning institutional networks and such development when it occurs results from this complex system of relationships among different groups of actors who respond to appropriate policies in the socio-economic system. Most advanced countries are already societies with highly evolved NIS and SISS. Some NIEs in the Asia-Pacific region like China, India, Korea and Taiwan are developing such NIS and SISS with various degrees of success. Many poor countries are far behind. This is an example of what I mean by the unevenness of the global economy and globalization as a process.

My previous work on NIS and RIS (Khan 2002 and 2004a,b in particular) of the requirements of technical progress shows that we need both a deeper understanding of the disequilibrium processes at work leading towards multiple equilibria, and the economic implications of the complexities of the production and distribution aspects of new technologies. It is with a view towards capturing these complexities leading towards multiple equilibria that an alternative conceptualization of technology systems transition in terms of an *Augmented* NIS (ANIS) has been formulated by some economists (Khan 1993; James and Khan 1997; Khan 1998, 2001a,b;2002,2004a,b; Gabriele and Khan 2010). In addition to capturing both equilibrium and disequilibrium features of technological transitions, this broad approach can illuminate *distributional* issues as well. Since poverty alleviation remains on the agenda of the national governments of Bangladesh as one the six goals discussed at the beginning, it can be argued that from this perspective at least the new approach has obvious relevance for Bangladesh. The key analytical results for policy purposes will be described shortly; but first let us take a closer look at the concept itself and see how it can be applied to specific technologies and NIS in a particular Asian country where the NIS is comparatively recent in origin and development. From here on, I wish to highlight the fact that my framework can be viewed as simply a variety of Augmented NIS (ANIS) and its various subsystems and therefore, I will be using the more general term from now on which also has the virtue of maintaining intellectual continuity with NIS and at the same time augment the range of the concept. One important extension captured in my formulation is the explicit consideration of *both factorial and household income distributions* which interact in a causally reciprocal way with the technology systems including the ICT- SISS.

### An Augmented NIS for Bangladesh and the linkages between ICT industry and science: the Chinese example and prospects for BNIS by 2041:

As an example of a recent and successful example of the process of creating an Augmented NIS we can look at China. The argument here is not that Bangladesh is like China but rather that China’s rapid state-led public private partnership (SL-PPP) presents a somewhat novel model for other Asian countries to follow with local modifications and variations. The claim is not that China has adopted an innovation system that is totally different, but rather that in addition to the SL-PPP model, there is finally some official recognition in China that issues related to distribution and the maintenance of reasonably harmonious social relations cannot be completely neglected in overall development strategy including the strategy for innovation.

China's Augmented NIS has witnessed remarkable advances since the early 1980s, as a result of a series of reforms aimed mainly at improving its effectiveness and closing the excessive gap which traditionally separated university-based research activities from the technology absorption and innovation needs of the enterprises system. The main thrust of reforms has been to diversify the country's Augmented NIS and to strengthen its market-orientation (or market-compatibility), but the role of centrally-managed large, long-term research programs has also been enhanced. These reforms, along with the ever-expanding availability of financial resources made possible by economic growth and by the strong role of the national state, have allowed China to achieve remarkable advances. This has also led to the prospects for deeper integration with other Asia-Pacific economies through both international trade, investment and joint technological and infrastructural projects.

Several organizational and institutional structures which proved their validity in the context of developed market economies are also being studied, experimented with, and in some cases adopted in China, but such a pragmatic approach does not amount to an attempt to ape Western examples. The most visible change in China's Augmented NIS is probably the progressive shift of the bulk of R&D activities away from universities and specialized research centres and towards industrial enterprises. However, universities participate in many of the most ambitious basic research endeavours, and often play a crucial role in their implementation. For instance, universities carry out about 1/3 of the "863 projects" and 2/3 of the projects funded by National Natural Science Foundation (NNSF) (Wu (2007), Hu and Jefferson 2004). In order to re-balance the roles of the different actors in the R&D scene in favour of the academia, the Chinese government is earmarking an increasing volume of funds to elite universities, mainly through the Ministry of Education (MOE). Elite universities are expected to lead in national R&D programs and projects, facilitate technology diffusion and pullovers, promote spin-off companies, incubation centres, and open laboratories for R&D sharing, to bridge-in foreign technology and partners. This emphasis on the role of universities in engaging directly in the development, production, and commercialization stages of their research results has been dubbed "forward engineering " by Lee. According to him, forward engineering is a peculiarly Chinese component of the "Beijing Consensus", a comprehensive and proactive catch-up strategy very different from the "Washington Consensus" and partly, but not fully similar to that followed before by other successful Asian latecomers such as Korea and Taiwan (see Lee 2006a, b). Among other initiatives, a very important one was project 211, aimed at funding the construction of campuses and developing new academic programs in key scientific areas all over the country during the 1996-2000 Five-year plan period.

In China, as elsewhere in the Asia-Pacific, R&D expenditure is positive and significantly correlated with firm productivity. The contribution of government R&D to firm productivity works mainly through an indirect channel, via the promotion of firms' own R&D, which appears to be a more effective policy tool than direct R&D grants. Other key sources of production improvement and innovation growth are each firm's absorptive capacity, the production network, openness, and managers' education. Market-oriented, competition-enhancing innovation system reforms are improving the effectiveness of the incentive structure and fostering S&T linkage activities. With respect to the impact of ownership type, SOEs perform worse than collective and private firms in terms of production performance, but not in terms of innovation capabilities grants. The choice of innovation types among Chinese SOEs depends on the turbulence in the environment, and on the organizational resources, with market forces and internal governance simultaneously influencing SOEs' innovation patterns. In many SOEs, managers apply the technical innovation audit tool for benchmarking, thereby improving their ability to choose among different types of innovation mechanisms.

Due to the influence of the two main stakeholders (government and end-users), firms with a higher degree of government involvement and a correspondently lower degree of openness to the market exhibit a more widespread use of innovation mechanisms, thereby apparently contradicting the positive relationship between market focus and innovativeness traditionally posited by “Western” innovation management theories. This phenomenon is due largely to strong government interference in SOEs' behavior, in a context of relatively weak IPR protection. The government puts a paramount emphasis on long-term investments and makes a great effort to promote technological innovations, targeting them as important indicators of SOE performance and awarding resources to SOEs accordingly[MOST, 2005](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6VC6-4R2H6P7-2&_user=1922970&_coverDate=01%2F31%2F2008&_rdoc=4&_fmt=high&_orig=browse&_srch=doc-info(%23toc%235946%232008%23999639998%23676343%23FLA%23display%23Volume)&_cdi=5946&_sort=d&_docanchor=&_ct=11&_acct=C000055306&_version=1&_urlVersion=0&_userid=1922970&md5=460b54532ca8eb0dfddd11cb11de27c8#bbib27) MOST (2005). Documents of state policies on science and technology. Ministry of Science and Technology of China.). SOEs rely more on government-allocated resources, and therefore tend to perform better in areas that are encouraged by the government, such as new product development. As new product output is an important indicator of SOE performance, SOEs are incentivized to operate at the frontier of new product development. In our view, in spite of the relevance of static inefficiencies and distortions, SOEs' "distorted" behavior in the static sense can be associated with dynamic advantages in terms of innovative capacity and technological progress, with major spillovers benefiting the national economy as a whole. One also needs to take into account the existence of virtuous synergies with the non-state-owned sector.

Notwithstanding China's Augmented NIS’s remarkable strengths, remaining challenges are formidable. For instance, Wang (2006) identifies a dualistic pattern in China's of technological development, with the export-oriented segments of the economy being relatively isolated from those producing mainly for the domestic market. Zeng and Wang (2007) and Gabriele and Khan (2010) stress the weight of constraints such as an insufficiently developed institutional framework, relatively low overall educational attainments, the lack of a large pool of world-class talents, the embryonic stage of indigenous innovation capacity, and insufficiently developed linkages between R&D and industrial enterprises. Other researchers point towards China's persistent weaknesses in technological cooperation between universities and industry, the inadequate integration of the country's Augmented NIS into the global innovation networks, and the need to develop a comprehensive , more refined technological strategy in order to achieve effective technology transfer from foreign technological leaders, while at the same time maintaining an appropriate balance between indigenous innovations and technology imports.

Without being exhaustive, one last feature of the still evolving Chinese Augmented NIS can be mentioned. Since the beginning of the new regime in the 21st century the increasing social and political tensions which inevitably accompany worsening income distribution have been noted carefully. The worsening distributional situation sets China apart from the other East Asian latecomer innovators. The new regime seems committed to changing the distributional picture and managing social and political tensions effectively. The overall macroeconomic and innovation policies are influenced by these goals.

While Bangladesh is far from the technological frontier in 2017, an optimal strategy for catching up through Original Design and finally original equipment manufacturing in various areas including ICT software and hardware can be formulated and thus a BANIS or Bangladesh Augmented National Innovation System can be launched to yield some fruits by 2030s.

# D. PROJECTIONS AND STRATEGY POLICY SPACE: OPTIMAL ICT SECTORAL POLICIES FOR INVESTMENT AND INSTITUTIONAL DEVELOPMENT, GIVEN THE PERSPECTIVE PLAN’S NATIONAL ECONOMIC OBJECTIVES TO BE REACHED BY 2041

There are some crucial problems in the ICT sector in particular if Bangladesh is to meet its ambitious targets for the Perspective Plan by 2041. As identified by Ahmed (2017, pp.23-24):

Bangladesh is a relative new comer to the ICT sector. The emphasis gained momentum in the wake of the leadership role provided by Prime Minister Sheikh Hasina through the Digital Bangladesh initiative developed in the context of Vision 2021 (Government of Bangladesh 2009). The 6th Five Year Plan (Government of Bangladesh 2011) put considerable emphasis to the implementation of the Digital Bangladesh Initiative. Considerable progress has been achieved (Government of Bangladesh, 2015). However, much of the ICT focus has been in improving the connectivity and service delivery inland within the country. The impact on export of ICT services has been relatively modest when compared with the global market prospect. …[E]arnings from ICT exports have grown from $247 million in FY 2010 to $595 million in FY2014. This is a welcome increase but pales into insignificance when compared with ICT earnings of $105 billion in India in FY2015 (World Bank 2016). Even after allowing for size effects, India’s exports of ICT services amounts to 5 percent of GDP whereas it is less than 0.3 percent of GDP in Bangladesh. The global market for ICT services is large and India has successfully tapped this market even while expanding ICT services domestically. An important target for the services exports for the Seventh Plan will be to boost the penetration of Bangladesh into the global ICT market through a well thought out ICT strategy that looks at both domestic market and also the global market. This progress will then lay the basis for longer-term growth of ICT exports.

The past experience suggests a number of factors that constrain the growth of ICT exports. First, although a significant number of educated and qualified entrepreneurs have started ICT ventures during the last couple of decades, most are trapped in the ‘small size-low growth’ situation because of funding constraints. Second, there are severe gaps in both quantity and quality of human resources for the software industry. This is due to institutional deficiency of the tertiary ICT-related educational institutions (lack of industry orientation of teaching resources, slowness of curriculum modernization etc.) as well as inadequate quality input from the higher secondary education system to the tertiary level. Third, high cost of bandwidth deters growth of domestic market for ICT. Fourth, the absence of IT park/software Technology Park, high internet cost, no redundant submarine cable, and power shortages are some of the common infrastructural problems for most of the IT enterprises. …Finally, the growth of export of ICT industry is below the expected level due to inadequacy in entrepreneurial dynamism, limited overseas marketing budget and absence of government level initiatives in promoting country brand. Policies and facilities are not friendly for value added service providers in the mobile phone industry.

One of the most important operational questions for planning adequately for S and T in Bangladesh---ICT in particular---is regarding the impact of technical progress including ICT on output, employment, incomes of households and their wellbeing. Although a Social Accounting Matrix based formal CGE model is necessary for answering this question technically and carrying out a number of relevant counterfactual policy experiments[[6]](#footnote-6), it can be inferred from the existing models and data that on the whole there are great gains in these areas to be made from investments in R and D and production in innovative technologies.

## Policy priorities from a strategic Perspective and investment requirement---future developments in internet architecture, big data and AI and the tasks for Bangladesh:

In the broadest terms---consistent with initiatives such as A2i--- there are two complementary sets of strategic S&T package of policies for the ICT sector, both of which can be advocated in various degrees of mixtures:

1. Supporting (via preferential fiscal, financial and other policies, subsidies, investment and capital goods support) existing S&T private firms and promote startups etc. This would be a directly market-oriented, private sector centered strategy based on a sector-specific industrial policy aimed primarily at medium-term goals such as growth and technological upgrading of manufacturing output and exports and GDP growth. Yet, it would only indirectly be conducive to the establishment of an (augmented) National Innovation System.
2. Supporting primarily public S&T centers, institutions and infrastructure. This would be a public sector-centered strategy with a more long-term horizon, that might imply a lower GDP growth in the short and medium term. Yet, it would be the most clearly focused on the goal of creating an (augmented) National Innovation System.

Quantitatively, from the strategic planning perspective, policy makers must find targets for each year starting in 2018 to increase R&D expenditures so that by 2041 it reaches 2 per cent or more of GDP. Tables 19 and 20 below give the available R&D /GDP ratio for recent years, and the R&D-intensive export sectors. Bangladesh needs to increase the R&D /GDP ratio to at least 1% by 2025 and then gradually to 2% by the 2040s. Exports from R&D-intensive sectors should also be increased by 10% a year and by a higher percentage than that from the 2030s onwards perhaps by 2 per cent a year reaching the 25 to 30 per cent range eventually. This will be crucial for increasing productivity in the ICT sector and total factor productivity (TFP) overall. As the planning document correctly notes on p. 13:

In order to achieve the high and sustained economic growth to be an UMIC country by FY31 and a HIC by FY41 TFP must grow at an average rate of 2.7 during 2021-2031 and 3.6 during 2032-2041 periods respectively. Increasing the average TPF from 0.3 observed in the last decade to 2.3 to 4.5 range will be a massive undertaking….

For high technology sectors---particularly the ICT sector---optimal use of R&D that can facilitate increase in human capital investment and institutional efficiency, removing infrastructure gaps, higher enrolment ratio, and good governance is the goal recommended in this paper. Specific studies using the input-output structure and social accounting matrices can be undertaken for this purpose in order to come up with specific targeted R&D program within the ICT sector and other high technology sectors.

|  |
| --- |
| **Table 19: Forecast Gross Expenditures on R&D** |
|   | **R&D as % GDP** | **GERD PPP bil. USD** |
| 2014 | 0.70% | 3.75 |
| 2015 | 0.70% | 4.04 |
| 2016 Estimated | 0.70% | 4.32 |
| 2017 Forecast | 0.70% | 4.62 |
| Source: Battelle, R&D Magazine, International Monetary Fund, World Bank, CIA Fact Book |
|  |
| \*GERD= Gross Expenditures on Research and Development |
| \*PPP= Purchasing Power Parity (issued to normalize R&D investments) |

|  |
| --- |
| **Table 20: Bangladesh - High-technology exports in current prices** |
| Date | Value | Change, % |
| 2011 | 39,378,724 | 24.89% |
| 2010 | 31,530,160 | -16.92% |
| 2009 | 37,952,009 | -35.58% |
| 2008 | 58,908,946 | -55.94% |
| 2007 | 133,700,302 | 469.40% |
| 2006 | 23,480,859 | -15.00% |
| 2005 | 27,624,176 | 73.00% |
| 2004 | 15,967,424 | 6.74% |
| 2003 | 14,958,984 | 127.65% |
| 2002 | 6,571,088 | -28.00% |
| 2001 | 9,126,275 | -13.83% |
| 2000 | 10,591,240 |   |

 Source: World Bank

\* High-technology exports are products with high R&D intensity, such as in aerospace, computers, pharmaceuticals, scientific instruments, and electrical machinery. Data are in current U.S. dollars.

What seems best for a country like Bangladesh is to find a strategy that uses the stronger elements of both public and private sectors as well as continue to strengthen these elements through policy and institutional reforms. This is one reason why in addition to analyzing available macro and sectoral data, I have also included observations from field work up to and including individual firm level observations and analyses.

The investment through PPP in the ICT sector should specifically do the following:

* Plan to install the second submarine cable connection for expanding high speed internet facilities as soon as feasible.
* Plan to finish Phase II of implementation of broadband internet connectivity under the South Asia Sub-Regional Cooperation (SASEC) initiative.
* Within the Research and Development budget earmark 25% for ICT from 2020 to 2030, and as the absorptive capacity of the ICT sector increases, then in keeping with the goal of increasing TFP further between 30 and 40 per cent from 2031 to 2041.
* Study the examples of Korea and Taiwan carefully and build ICT parks through PPP initiative for developing capacity, attracting expatriate scientists and technicians and train the future ICT-capable workforce.

### Incentive Policies for ICT Facilitation:

Within the basic framework of public, private and NGO partnership, removing barriers to private investment including FDI in ICT loom as an important task. As the planning document acknowledges, learning from the positive results of others Bangladesh can improve its scores on doing business by deregulating procedural aspects. It can improve the drive to motivate greater private provision of ICT services by appropriate substantive deregulation of ICT sector activities promoting ease of entry and expansion of capacity. The government should ensure that the line Ministries related to ICT engage in constructive dialogue with ICT manufacturers and service providers. *Inter alia*, these can be facilitated through public meetings with business chambers and conducting special purpose surveys as necessary to obtain specific feedback on regulatory burden or other constraints faced by the producers and suppliers. Such practices will undoubtedly help attract foreign investment in export-oriented ICT manufacturing and services and enhance technological progress, service quality and export competitiveness. Joint venture with foreign partners in ICT should be encouraged along with import of technical skills in this sector.

In addition, domestically the Government should invite private sector and non-profit sector for increasing broadband connectivity in rural area. The local entrepreneurs should be incentivized to cooperate in extending internet service to every local community. Tax incentives may be necessary for this. The Government should act on tax policy changes---including import duties on ICT components, as discussed in the previous section--- swiftly so that incentives for private investment increase. At the same time, careful monitoring of performance so that the private ICT sector is competitive internationally will need to be in place. This is discussed further in the sub-section on institutional innovation.

The strategy advocated here is consistent with the broad goals of Bangladesh government.

Indeed, a number of policy moves supported in principle by GoB and consistent with A2i and similar initiatives can be adopted for the ICT sector. Without being exhaustive or definitive, the following are perhaps the most critical from an ICT development policy administration:

 • Introduction of appropriate legal and policy instruments for the implementation of science, technology and innovation (ST&I) in ICT.

 • Strengthening of intellectual property rights regime (e.g. enactment and enforcement of laws, strengthening of administrative and judiciary institutions) in a step-by-step process with careful review of specific ICT contexts in Bangladesh.

 • Promotion of evidence-based awareness concretely about the importance of ICT among politicians, bureaucrats, researchers, managers, administrators, academics, professionals, members of the public and other stake holders

 • Mobilization of sufficient research and training funds, venture and investment capitals from government, public, private and external sources for the promotion and application of ICT

 • Strengthening and development of infrastructure to support ICT development

 • Strengthening and development of ICT production facilities

 • Strengthening and development of research facilities and capabilities for the ICT sector under public and private sector managements on acquisition, transfer, adaptation, development, diffusion and management of local and imported technologies and research on applied and basic sciences

 • Promotion of co-ordinated (multi-institutional & multi-disciplinary) ICT national research programmes on cross-sectoral issues

 • Creation of R&D facilities for physically and otherwise disadvantaged groups

 • Strengthening and development of capable ICT human resources at different levels-vocational (nonformal and formal), school, pre-university, university, formal post-graduate and non-formal postgraduate (continuing education and training) to meet the needs of research and production systems of different sectors

 • Promotion of innovative production and marketing systems in public and private sectors involving innovative technologies, products, processes, services and institutions

 • Establishment and strengthening of regulatory regimes (e.g. regulatory and enforcement authorities) for effective promotion of ST&I in public and private sectors

 • Strengthening and establishment of institutions for standardization of S&T based products and services

 • Strengthening and development of S&T capacities and capabilities for effective management of natural disasters (e.g. floods, cyclones, droughts, earthquakes, tsunamis, SLR and landslides)

 • Promotion of pro-active collaborative relations among government organizations, public & private production systems, research organizations, universities and professional bodies for effective use of trained manpower, natural and physical resources for sustainable development

 • Promotion of international cooperation in S&T education and research in achieving national development objectives

 • Formation of technical advisory committees in all relevant ministries (including MOSICT) for dealing with S&T matters with relevant scientists and technologists to assist them

 • Dissemination of information on sectoral policies, policy instruments, natural resources, production facilities, research facilities, development of S&T manpower and relevant institutions to all concerned through print and electronic media for undertaking S&T based development programme

• Development of concrete guidelines for proper utilization of the findings- Policy formulae, Strategies, Methods, Committees, Secretariat, Financial rules and regulations, Implementation procedures, Monitoring and Evaluation, Refreshing etc.

• Creation of database of R&D organization and professionals with provisions of regular updating

It should be noted that the ministry of Science and Technology has been proactive in setting up a centrally institutionalized mechanism under the title, *National Council on Science and Technology (NCST*) and an Executive Committee of NCST called ECNCST. Thus, the government already has an institutional mechanism in place. The urgent task is to ensure that it is functioning adequately with sufficient funding and competent professionals in way that is transparent and accountable to the public.

Given the institutional structure in place, Bangladesh in its attempt to create a BNIS by 2041, can try to strategically shift the bulk of R&D activities away from universities and specialized research centres and towards industrial enterprises. As we can see from the most visible change in China's Augmented NIS is probably this progressive shift of the bulk of R&D activities away from universities and specialized research centres and towards industrial enterprises is a cornerstone for the transition to a high middle-income country and eventually to a high-income country. However, just as in China, our universities must participate in many of the most ambitious basic research endeavours, and often play a crucial role in their implementation. The government needs to set up more specialized S&T universities in different regions and invite experts within the country and outside to develop curricula that train students in R&D work for up and coming sub-sectors of ICT industries in particular.

In order to encourage the different actors in the R&D scene in and out of the academia, the government needs to earmark an increasing volume of funds to elite universities, mainly through the Ministry of Education (MOE). Elite universities should be expected to lead in national R&D programs and projects, facilitate technology diffusion and pullovers, promote spin-off companies, incubation centres, and open laboratories for R&D sharing, to bridge-in foreign technology and partners. But this must occur in partnership with the most advanced companies in technologically sophisticated fields, particularly in advanced ICT sub-sectors. This should be part of all 5-year plans with as much concrete details regarding objectives, targets and the means to achieve them within a fixed time horizon.

A short run action program can be launched within the next 3 years to promote specifically university-industry links for R&D. A policy action group with scientists, engineers, economists and entrepreneurs can be set up for this purpose. The goal of this group should be to set up state technology transfer centres in four to six leading universities, with adequate funding and the most competent leadership that can be recruited nationally and internationally. It is vital strategically, to promote the commercialization of viable technological achievements. Bangladesh should also undertake tax write offs and incentivized subsidies policies for university-based start-up companies. As in China, these start-ups should be seen as crucial channels through which universities can contribute to national and local economies. For a country like Bangladesh emphasis on distributed computing such as the cloud computing mentioned before in the context of A-1 concept developed in Bangladesh will be strategically rewarding.

As in China and elsewhere in the Asia-Pacific, in Bangladesh too, R&D expenditure can be linked to performance so that such expenditure leads to a positive and significant correlation with firm productivity. The contribution of government R&D to firm productivity can work mainly through an indirect channel, via the promotion of firms' own R&D, which will be a more effective policy tool than direct R&D grants. However, careful and competent monitoring and a transparent system of rewards and punishment must be developed as in East Asia, for these to work.

Policy makers also need to keep in mind some other key sources of production improvement and innovation growth such as each firm's absorptive capacity, the production network, openness, and managers' education. Market-oriented, competition-enhancing innovation system reforms can indeed improve the effectiveness of the incentive structure and foster the right set of S&T linkage activities, in the ICT sector specifically.

The influence of the two main stakeholders (government and end-users) can lead to a creative synergy when the incentives are transparent and impartially imposed by the government. Hence specific areas of good governance are relevant to S&T and R&D intensive firms. Business laws and corporate governance should be transparent and enforced. While facilitating business and reducing bottlenecks, the state should not be captured by special interests. A responsive and responsible bureaucracy is part of this picture. Therefore, administrative reforms in the government and within the larger private sector firms need to be at the top of good governance priority list.

As new product output is an important indicator of R&D intensive firm performance, high technology firms in Bangladesh should be incentivized to operate at the frontier of new product development ---at first slowly but in an accelerated pace from the 2030s. There are sometimes static inefficiencies in R&D and these should be minimized as soon as possible without losing much time; but the main focus should be on dynamic advantages in terms of innovative capacity and technological progress, with major spillovers benefiting the national economy as a whole.

A dualistic pattern in Bangladesh’s technological development, with the export-oriented segments of the economy being relatively isolated from those producing mainly for the domestic market can also develop. While some of these are inevitable and beneficial with proper reinvestment and distribution of benefits, care must be taken not to become exclusively export dependence for the innovative sectors to be innovative. This is where ANIS in Bangladesh can come into its own in the 2040s.The weight of constraints such as an insufficiently developed institutional framework, relatively low overall educational attainments, the lack of a large pool of world-class talents, the embryonic stage of indigenous innovation capacity, and insufficiently developed linkages between R&D and industrial enterprises can and should be overcome to a large extent by the 2040s and 2050s.

## An Institutional Recommendation: Setting up an ICT Monitoring Board (ICTMB) with Regulatory Power and State of the Art International Advisors

It is clear from both the empirical evidence and the institutional analysis above that the governmental bodies set up to administer the R&D can pursue the goal of building a BANIS with emphasis on ICT more vigorously in the coming years. But given the ambitious goals for Bangladesh 2041, there is no time to lose. A well-funded PPP institutional mechanism will also need competent technical and managerial talent for functioning properly. A better mechanism for monitoring and timely action and agenda formulation is needed. Instead of relying on multiple, overlapping and sometimes dysfunctional bureaucratic formations, it may be possible to set up a relatively autonomous functional body of experts by careful selection from within the government and from the civil society.

For the ICT sector, this could be an ICT Monitoring Board (ICTMB) of experts by drawing upon both local and international pool of competent scientists and managers. The ICTMB should have the authority to get information from all the divisions and districts. It should also have the authority to design a flexible and pragmatic ICT inputs pricing policy where such a policy is needed. Through its professional cadres it could monitor more effectively the supply and demand conditions in a rapidly changing market by developing a Geographically Decentralized ICT Monitoring System (GDICTMB). The GDICTMB will also keep track of import levels and future import needs.

The GDICTMB should have the authority to take steps to promote both market competition and good corporate governance (Khan, 1999, 2004). It should also have the authority to set up laboratories and mechanisms for detecting the quality of ICT products manufactured and services delivered, and supply public prosecutors with the needed information so that the guilty parties who abuse government support can be brought to justice swiftly. Needless to say, there are many organizational and other details that will need to be worked out. But such institutional reforms if carried out competently, will enhance the prospect for stabilizing the ICT markets and lead to further innovation. If and when institutional reforms in ICT sector take hold, producing desirable results, then such boards could be set up for other R&D intensive markets. Further coordination problems will doubtless emerge and have to be tackled. Indeed, the capacity to coordinate effectively is the hallmark of good governance.

Finally, without being exhaustive, some operationally relevant areas of future research should also be mentioned before giving estimates of investment requirements for the ICT sector in the following ultimate section.

First, is an integrated survey of ICT needs and ICT resources and the shortfalls in the latter. This in itself could be a PPP project.

Second, an ICT oriented SAM should be built for both creating a consistent economy wide technical data base and for future modeling for counterfactual policy experiments. Relevant CGE models by technically competent teams of researchers will be a necessary tool for rigorous policy analysis. Such a multistep project---creation of SAM, formulation of model and implementation, training Bangladeshi technical personnel and carrying out policy experiments can be done in 2 to 3 years with provisions for updating every 3 years or so. Though costly in terms of time and money, the payoff will be substantial with future self-sufficiency and learning mechanisms and facilities for Bangladeshi professionals in Bangladesh as part of the value added.

Third, the other alternative is to have modern time-series based models such as VECM that are informed by the advances in time-series analysis of non-stationarities and spurious regression problems among other pertinent econometric issues. These models should allow us to identify clearly the causal links if any, between variables in the long run. Since we are looking up to and beyond 2041, this is an important consideration.

It should be emphasized that the two technical approaches are not mutually exclusive. Actually, my recommendation is to build and make operational both types of models if time and resources allow.

Fourth, some intellectual resources can be devoted to political and social economic analyses. An economic system has complex connections with political and social systems. A complex system of political and social economic analyses will uncover many hitherto unseen linkages revealing both future problems and possibilities for progress.

Fifth, with the help of the above data collection, data integration and rigorous modeling focused studies regarding ICT sector industrial policies including the role of credit and subsidies will need to be carried out.

As mentioned before, these five items do not exhaust the list of future policy-relevant research tasks, but these can provide the knowledge base on which a quantitative target oriented policy platform can be built. There are many challenges for Bangladesh in its bid to meet the six goals identified clearly by the MoP. With proper planning tools, PPP institutions, R&D policies and institutions like the proposed ICTMB the ICT sector can be developed by 2041 to meet these challenges with a high degree of probability of success. The last section that follows presents some preliminary investment requirements estimates projections until 2041 for the ICT sector.

# E. INVESTMENT REQUIREMENTS FOR THE ICT SECTOR EXPORT AND EMPLOYMENT TARGETS AND THE FUTURE TECHNOLOGICAL DEVELOPMENTS FOR BANGLADESH

With proper incentives, as discussed before, much of the investment in ICT sector, esp. from 2030s onwards will come from the private sector. The projected reforms in regulatory and incentive policies along with improved prudential regulations will result in an expansion of private domestic and foreign investment. However, as discussed above, complementary public investments in infrastructure including that in the ICT sector will be a crucial for an effective expansion of private investment leading to an increase in ICT productivity and TFP .

Therefore, in the ICT sector both public and private investment will need to go up as a share of GDP. Since the ICT sector is a mix of manufacturing and services, it is difficult to estimate the exact ICOR and align the investment requirements with the macroeconomic projections of MoP. However, since the sectoral output and exports now are both small, the margin of error even without a detailed input-output and capital coefficients matrix is likely to be small. Furthermore, it is crucial to increase both public and private investments quickly so that an enduring foundation for an innovation sub-system in the ICT sector can be created by 2031. Keeping all these in mind, I use estimates for the ICT sector investments that are roughly in line with the overall ICOR, TFP and other indicative macroeconomic projections of MoP.

Given the growth targets, the total investment target for ICT sector should be at least 3 percent of GDP in FY2031 and can go up by a further 3 per cent by 2041. Public investment should rise to be 25 percent of total ICT investment in FY2021 and remain so throughout the two following decades with upward adjustments if necessary until FY2041, whereas private investment should cover the rest. Most of the public investment will be in infrastructure and facilities discussed before. Private investment will focus on direct productive activities in manufacturing and providing direct services with ICT. The complementarity of the public and private sector investments will result in a crowding in rather than a crowding out.

Table 21: Investment Requirements of the ICT Sector (taka billion 2017 prices), FY 2031 and 2041

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Base FY 2017** | **FY2031** | **FY2041** |
| Public  |  | 519.56 | 2900 |
| Private |  | 1558.69 | 8698 |
| Total  | 156.64 to 234.96 | 2078.25 | 11598 |
| Public (% of GDP) |  | .75 | .75 |
| Private (% of GDP) |  | 2.25 | 2.25 |
| Total (% of GDP) | .8 to 1.2 | 3.0 | 6.0 |

Source: Author’s calculations consistent with GED Macroeconomic Projections and Ahmed (2017)

In the above table, for Base FY, the ICT sector size is known to be less than .3% of GDP but we do not seem to have a precise estimate. Hence, I give the range estimate from .2% to .3% of GDP and I assume for simplicity an average ICOR of 4 which should be close to the actual but unknown value. I then make the calculations consistent with Ahmed (2017). The distribution between public and private investment in 2017 is unknown---at least to this author--- but is probably heavily private for manufacturing with slightly more public investment in services and infrastructure.

For exports, the best 2017 estimate is 611 million US dollars. Given the targets discussed earlier consistent with the perspective plan, by 2031 this figure in constant 2017 dollars will need to be 2320.27 million. After achieving UMIC status in 2031, the exports will accelerate and the target for 2041 when Bangladesh achieves HIC status, the figure can reach 9386.79 million in constant 2017 dollars.

For employment, the 2015-16 figure from BBS is only .2 million. This can be raised to 1.63 million workers by 2031 and eventually to 6.59 million workers by 2041. These are direct sectoral employment figures. More jobs will be created through forward and backward intersectoral linkages and income effects.

Preliminary and approximations as these estimates are, nevertheless the investment requirements here should be treated as the minimum necessary from 2017 to 2041 in order to reach the overall plan targets within this period.

Since ICT globally is a dynamic sector, what does Bangladesh need to do to follow the trajectories of likely future developments in ICT and realize the above targets consistent with the visions such as A2i and the perspective plan ? It is impossible to be definitive or exhaustive in the field of innovation in ICT; but to the best of our technical knowledge---without being exhaustive, the following areas will be important to catch up with in the next ten years:

* 1. The Internet of Things;
	2. Cloud Orchestration;
	3. Distributed Storage;
	4. Alternatives to Java;
	5. Big Data Processing;
	6. Deep Learning in AI(Artificial Intelligence) .

All these areas involve learning from frontier technological practices of today and tomorrow. While consistent with A2i, we should be improving access to internet and the various areas such as e-governance, e-health, e-education etc , we need to develop the human resources and institutions of learning for this. In the next 5 years, internet of things(IoT) will become widespread. The growing adoption of intelligent agents like Amazon Alexa or Google Assistant in more and more devices will lead to new ways of interacting for both businesses and government. There will be edge IoT devices that can act locally based on data they generate, as well as utilize the cloud computing networks for security, scalability, configuration, deployment, and management. IoT will evolve rapidly to cut data ingestion costs and reduce network latency.

We need to move now in order not to be left behind the trends in IoT. Likewise, adopting cloud orchestration and distributed storage will need to be top priorities for the next 10 years. Training our software developers in adopting big data programs such as *Apache Hadoop* and its future developments should also be a top priority.

From 2031 onwards, in addition to the above, the focus should be even more on Big Data. Bangladesh will need to develop technical capabilities in utilizing Deep Learning algorithms and all other areas of AI. By that time, the world will most likely move towards advanced nanotechnology, robotics and ICT-linked AI. We need to have top quality learning institutions to keep pace. Utilizing the skills of highly trained expatriates in specific technical fields should be high on our agenda by 2031.

By 2041, if the above strategy is followed, we should be near the frontiers in AI and ICT . However as Khan(2017b) and others have pointed out, by 2050 there will most likely be a “superconvergence” of ICT, Biotechnology and Nanotechnology with enormous increase in total factor productivity. Bangladesh must not be left behind in this process. The time is now to begin thinking about this prospect in connection with ICT . It is reccommended that an experts group comprised of a majority of scientists in this field in Bangladesh together with a few expatriates of international standing in their respective research communities should be set up to study the prospects of “superconvergence” of technologies in Bangladesh for 2050 and recommend specific policies for all three sectors. For the ICT, the strategy recommended here should take Bangladesh a great distance towards this. However, it will need to be coordinated with the other two sectoral policies.

A last important point is to be alert to the prospects of developing markets in Asia and beyond for ICT exports through strategic alliances with regional partners. This could be pursued in a synergistic manner by participating in a regional innovation system.

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1. For an earlier set of prospective studies see the chapters in Ahmed, Sadiq ed. (2012). *Leading Issues in Bangladesh Development*. Dhaka: University Press Limited. [↑](#footnote-ref-1)
2. Bangladesh Education and Technology Sector Action Plan [↑](#footnote-ref-2)
3. This is the figure given by Hon. Sajib Wajed Joy. “…In fact, Honorable ICT adviser to PM Mr. Sajeeb Wajed Joy, declared that present IT & ITES sector export is US $ 700 million.”(BASIS SOFT EXPO 2017, p. 41) [↑](#footnote-ref-3)
4. Interview with Mr. Munir Hasan and other experts in February, 2017. [↑](#footnote-ref-4)
5. BASIS SOFT EXPO 2017,p. 41 [↑](#footnote-ref-5)
6. This looms as a necessary future technical project. A necessary component is to create a SAM that uses clearly distinguished technological classifications for ICTs. Following and extending the term introduced by Khan and Thorbecke(1988, 1989), we can call this kind of a SAM an ICT-SAMTech. Such a multistep project---creation of SAM, Formulation of model and implementation, training Bangladeshi technical personnel and carrying out policy experiments can be done in 2 to 3 years with provisions for updating every 3 years or so. Though costly in terms of time and money, the payoff will be substantial with future self-sufficiency and learning mechanisms and facilities for Bangladeshi professionals in Bangladesh as part of the value added. The other alternative is to have modern time-series based models such as VECM that are informed by the advances in time-series analysis of nonstationarities and spurious regression problems among other pertinent econometric issues. It should be emphasized that the two technical approaches are not mutually exclusive. Actually, my recommendation is to build and make operational both types of models if time and resources allow. [↑](#footnote-ref-6)