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A Comparative Study of ICT Innovation Policy for the Countries Development Perspective

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Abstract—**In the globalized environment, the economic growth significantly depends on the countries capacity to develop, to apply new technologies and vice versa. Diffusion of information communication technologies is a global phenomenon. Despite of rapid globalization there are considerable differences between nations in terms of adoption and usage of new technologies. This paper aims to draw together the highly eclectic literature on the diffusion of Information and Communication Technology (ICT) Innovation in order to know what have been done, highlight the generic issues, relevant to policy and will initiate further research and develop potential opportunities. This paper also highlight the low level and high level income countries data and ICT policies frame work to draw conclusions and some case studies as an example. The objective is to review the finding the social economic factor for diffusion of ICT Innovation to make policy recommendation for the development of the country.**

Keywords- Information Communication Technology; ICT Development; Innovation; ICT Policy

I. INTRODUCTION

In this paper the literature of Information and Communication Technology (ICT) Innovation Policy is reviewed with a particular interest in finding what social and economical factors that hinder absorption of the ICT innovation.

The paper presents an overview of ICT policy framework of the different countries. Particularly it shows the trend of the selected countries (US, Japan, Canada, China, Thailand, Korea and Pakistan). This comparison allows relating growth patterns of cross countries to support the idea that ICT Innovation policy are likely to affect the country's economic development and specially the diffusion of the ICT innovation.

First, highlight the definitions of the basic keywords in the literature for better understanding about the topic. "Information and Communication Technology (ICT) is the study or business of developing and using technology to process information and aid communications". "Diffusion is the process by which an innovation is communicated through certain channels over time by members of a social system". While "An innovation is an idea, practice, or object perceived as new by an individual or other unit of adoption"[2].

In the true sense every innovation should have goal. Joshep Schumpeter describes invention as an idea executed into being while innovation an idea executed and then applied successfully in practice. Any new thing should only be considered innovation if it serves the purpose of economic gains [3].

The first widely diffused publication that used the concept of a 'national system of innovation' was the analysis of Japan by Freeman (1987). The concept was firmly established in the innovation literature as a result of the collaboration between Freeman, Nelson, and Lundvall in the collective work on technology and economic theory [4][5][6].

The importance of ICT Innovation and its diffusion has been analyzed by other authors in the past. In the book on the Contemporary Global Economic Issues and policies, the author found three fundamental element of economic development while the first key element of the economic development is technological improvement, or innovation in production processes that expand the capability to produce more units of goods and services with the same quantities of input. The second key element of economic development is a broadening of products and markets via product

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innovation, or the conceptualization and production of new types of goods and services [7].

Transmission of ICT is a global phenomenon. In spite of rapid globalization there are substantial differences between nations in terms of the adoption and handling of new technologies. Innovative use of ICT was one of the principal drivers of economic growth over the period 1995-2000 [8].

"There are two important notions about technology diffusion. One is that, in purely economic terms, technology diffusion matters more than pure technological innovation itself. Of course, without innovation there is no diffusion in the same way that without invention there is no innovation. The economic (and productivity and welfare) effects of a given technological innovation are maximized once the diffusion process reaches its saturation stage…In other words, innovation matters, but diffusion matters much more." According to economic terminology the difference in the adoption rates depends on the demand factors, supply factors and regulatory or institutional factor. Demand factors are like net benefits accrued to a potential adopter. Supply factors are for example, how big and how fast are technical improvements in new technology. Regulatory and Institutional factors related to government actions that foster or hinder the adoption of a particular technology [9].

The revolution of the technology which is consider as a bright new set of opportunities is going to be recognized as a threat to the established way of doing things in organizations and society at large. The new techno-economic paradigm is taking place as a different 'common sense' for effective action in any area of endeavor. While competitive forces, profit seeking and survival pressures help to absorb the changes in the economy, the wider social and institutional spheres where changes are also needed are held back by strong inertia stemming from routine, ideology and vested interests. After 20 or 30 years of diffusion of each technological revolution it will lead to an increasing mismatch between the economy and the social and regulatory systems [10].

II. Objective

The United Nations Millennium Development Goals upholds the principle of human dignity equality and equity at global level as it recognizes that nations and peoples have become increasingly interconnected and inter dependent. The declaration realizes that globalization can provide an impetus for economic development of the country. The special attention is to the application of Information and Communication Technologies (ICTs) for development albeit major impediments to the participation of the majority of the people in the developing country in the use of ICT which include among other; lack of adequate investment in ICT and ICT network infrastructure, low level of awareness and ICT education, paucity of trained man power extra. The potential of ICTs to improve productivity, reduce poverty, aid in small and medium microenterprise development and reinforce popular participation in decision making at all levels in developing countries is enormous.

ICT applications are essential components of scientific and technical R&D activities [11]

In the history of mankind, technology has detained a key to political and economic power. The forces with which industrial age technologies altered the world are clearly visible from printing press to jet engine. Industrial technologies propelled the western world and Japan to new heights of progress in virtually all fields of endeavor. The eruption of cultural and social changes as well as the politics rivaled the impressive gains in economic and industrial progress.

P. Romer begins with the observation that technological advancement is responsible for prosperity in much of the developed world. Yet in the developing world this cannot be the binding constraint. We know how to generate electric light, yet many billions do not have access to this amenity. He further suggests that just as countries such as Malaysia and Korea were able to catch up by adopting technologies from the West, so too many developing countries today improve their institutions by adopting policies from stronger states [12].

Solow (1956) model of economic growth that was based on the standard neoclassical assumption. He also included "technological progress" as an exogenous term in his model

$Y = K^{\alpha}(AL)^{1-\alpha}$ [13]

Reference [7] according to Fisman and Werker "The key lessons in Innovation Policy rarely describes an incremental innovation, yet they certainly characterize the wholesale economic success stories such as Estonia and Japan."

III. National Culture & ICT Absorption

As there are various conceptual models for acceptance of technology like Unified Theory of Acceptance and Use of Technology (UAUT) and Technology Acceptance Models. They all explain the factors influencing the acceptance of technology and the determinants of acceptance. The success of ICT depends to a large extent on acceptance of technology, and to this end, there are several factors that influence the adoption namely attitudinal and perceived behavioral control factors. "National culture and the ICT adoption rate of a country are closely related" [14].

According to Carter "we can also now focus marketing effort on targeting innovators. Once we have singled them out and understood what drives them, we can write and design our communications specifically to recruit them. We can also choose whatever media are best to reach them with greatest efficiency. In short, in the late 1990s, we have the capability to focus on innovators. But we still have to know who they are"[15].

The role of ICTs in supporting and improving the national absorptive capacity for imported technology is also important. ….Strategic planning and the choice of niche markets for the exploitation of scientific and technological proficiency can benefit from the use of ICT-based "expert systems" and scientific instrumentation [16].

The ability to exploit external information is thus a critical component of innovative capabilities. We argue that the ability to evaluate and utilize outside information is largely a function of the level of prior related knowledge. At the most elemental level, this prior information includes basic skills or even a shared language but may also include information of the most recent scientific or technological developments in a given field. Thus, prior related information or knowledge confers an ability to recognize the value of new information, assimilate it, and apply it to commercial ends. These abilities collectively constitute what we call "absorptive capacity."

It was confirmed that telecommunication infrastructure, socio-economic factors and cultural values have a significant influence on ICT adoption among countries [17][18][19].

A. Diffusion Theory

Everett M. Rogers in his book "Diffusion of Innovations" explains S-shaped diffusion curve. According to Roger's innovation theory, 16 % diffusion amongst opinion leaders holds the key to product diffusion as a whole. "The S-shaped curve receives strong empirical support. The explanation as to why the curve is observed varies by research paradigm. Communications researchers have focused on information transfer. Economists focus on technological substitutability, uncertainty reduction, and economic advantage. Social psychologists have focused on learning models of innovation diffusion"[20].

B. Globalized World and ICTs Innovation

In the global environment, the economic growth significantly depends on the countries capacity to develop and apply new technologies. Growth is not the process of simple replication. It reflects a never ending flow of inventions, innovations and technological advancements leading to improvement in the production possibilities. Technology and the process of production have changed, and new products and services has introduced. Innovation has enabled doing things in different yet more efficient and cost effective ways.

Transmission of information and communication technologies is a global phenomenon. In spite of rapid globalization there are substantial differences between nations in terms of the adoption and handling of new technologies. Several studies exploring contributory factors including national cultures of information and communication technology adoption have been carried out.

Model of Impact of National Culture on e-Government readiness (e-Government readiness is defined as the aptitude of a government to use ICTs to move its services and activities into the new environment (a similar definition was given in UN, 2003, p. 11).

In the last decade we have witnessed a quick rate of Internet penetration worldwide. Although this Internet diffusion happened on a global scale there are significant differences between countries in terms of how far they went and how fast they have adopted new information and communication. Since the adoption of a new technology varies between countries it is important to construct a composite measure of the country's overall readiness to adopt and use a new technology and also to measure factors that contribute to the adoption of ICT. Various factors influencing Internet adoption have been considered in a number of studies. A country's overall readiness to adopt, use and benefit from using ICT is called country's eReadiness. A knowledge of the factors which make a significant contribution to eReadiness and the country's position on the eReadiness scale would help the country's leaders to identify the strengths and weaknesses of the country's current position and to concentrate on the areas where improvement and further integration of ICT could be made [21].

IV. Frame Work for ICT Policy Evaluation and Impact Measurement

It is very difficult to evaluate the ICT Policy. It has been argued that macro level evaluation is impossible while micro level evaluations are more reliable, where program specific impact on economy to determined. When design a policy, case studies, qualitative and quantitative information and dialogue with policy practitioner are important sources of insight [22].

Kayal proposed a framework from various studies and research on different countries. According to him it is very important for the developing countries to consider the inward transfer and exploitation of technologies from external sources through building absorptive capacities and integration of the components of the system. The framework is given below:[5]

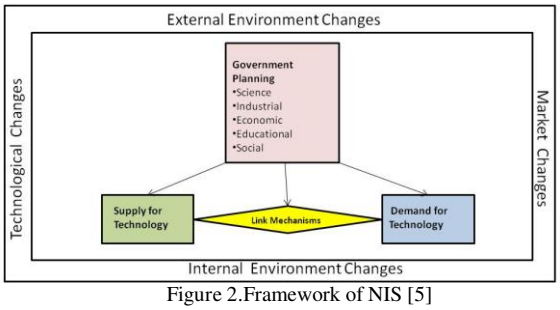


Figure 2.Framework of NIS [5]

Reference [23] The authors proposed a conceptual framework on the bases of ITU 'input-output' Model. In that ICT program is considered as input and the result is considered output. They discussed Heek's 'information chain model' and Sen's 'capability approach', his five instruments: political, economical, social, security and transparency that considered helpful to resolve policy issues.

Another study proposed a comprehensive model for making ICT policies and to monitor and evaluate socio-economic and cultural impacts and development in the use of ICTs. The model is based on system approach, different kinds of national e-strategies and e-readiness models. The model determined five indicators for evaluating and monitoring of ICT effects.[24]

V. An overview of Telecommunication Sector in Different Countries

Thailand:

In Thailand the first National IT Policy, called IT2000 declared in 1996. It was consist of 3 main factors "(i) to build an equitable national information infrastructure (NII), (ii) to invest in people to accelerate the supply of IT manpower and to develop an IT-literate workforce, and (iii) to achieve good governance through the use of IT in delivering public services and in government administration."

The IT 2010 was formed to incorporate the changes for the period of 2001- 2010. IT2010 has set the key development objectives to move Thailand to the "Knowledge-Based Society and Economy (KBS/KBE)". The focus was not just only development of technology instead was on the best use of technology that will be beneficial for national economy and social development. For this they identified principles "Building human capital, Promote innovation and Invest in information infrastructure and promote the information industry". On the basis of "technological and social indicator" the following goal of IT 2010 was established:

1. Raise the technological capability of the country,
2. Increase proportion of "Knowledge Workers".
3. Increase the share of "Knowledge-Based Industries".

To achieve the goals, IT 2010 recognized the five main Flagships "e-Society, e-Government, e-Education, e-Commerce and e- Industry". For the successful implementation "establish the link between the policies and operations of the National IT Committee with the National Telecommunications Committee and National Broadcasting Committee in order to make the most of ICT convergence."[25]. The best practice in ICT development nations as diverse as Canada, Japan and Korea have achieved success in ICT development by effective government strategy. The government plays a role for integration of technology incubation.[26]

Japan:

Japan is the developed country in Asia. Japan has the second largest national science and Technology system in the world after USA according to R& D expenditure and researchers number. Japan is not only lead in the ICT Innovation but also has strong policies. Japanese Science and Technology policy has shifted its emphasis over the past 60 years. The Government changes S&T policies time to time according to technology innovation and current situation. As the government of Japan has announced the new ICT policy in June 2010 [27][28].

Canada:

The Canadian government also initiated a ICT development strategy for connecting the Canada with world to make it most connected country by developing ICT-intensive ''smart communities"[29].

Korea:

The Korea is included in the Asia Tiger. Korea ministry established a vision of a ''knowledge-based economy'' according to this every citizen will have personal computer, the government will accelerate development of an information infrastructure and all the ICT stakeholders will contribute by joint work.[30]

China:

China has 287 innovation policies in which 124 are S& T policies. Different policies that play important roles in China's innovation system, including reform in the public S&T institutions, financial policy, business innovation support structure, human resource policy and legislative actions. It has been analyzed that S&T policy is relatively important for transforming china from a planning oriented to a market-oriented economy. China has attained a sustainable economic growth because of science and technology (S&T) Innovation policy, the evolution by policy maker to reflect the

changes accordingly [31]. China has transformed R&D institutions on Large Scale to the enterprises, intermediary organizations, non-profit organizations and merged them with universities.

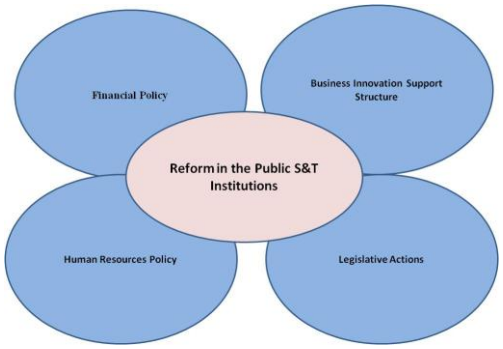


Figure: China Innovation Policy Framework [32]

United States:

In late 1990 America concentrated on improvements in technological and economic performance. The three features are considered the reason for the outstanding characteristics of US national innovation system. These are the role of new small firms in the American economy; the role of the Federal and local state governments, the role of universities. The universities have played a key role in the enhanced progress of the US National Innovation System. "The world leadership of US firms and universities in computer technology and the Internet is singled out as a guarantee of future progress and competitive strength". [33] In another empirical study while taking the case of US it has concluded that innovation is important for economic development and concurrently diffusion has becoming more demanding [34].

Pakistan:

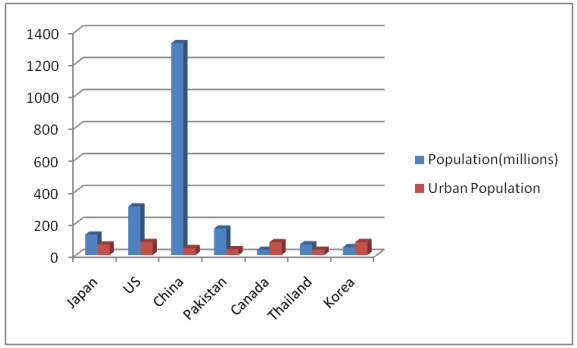
Pakistan is the developing country. One of the issues and challenges in Pakistan is that the government policies should be conducive towards providing quality technological infrastructure as a backbone to run e-government portals in the country. Availability of internet services, Internet bandwidth and speed, Networks preparedness, hardware and software quality play a vital role in e-Governance implementation [35]. With the perspective of the Pakistan economic growth it is analyzed that there is need of an ICT oriented SME policy that addresses its importance in creating value within the business. An awareness of ICT assisted benefits alone would not be sufficient unless barriers to its adoption are overcome [36].

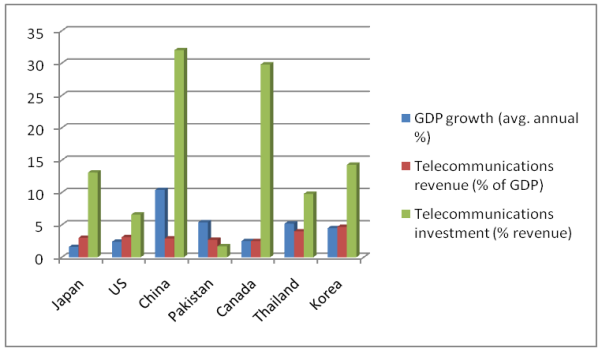
In the first five decade (1947-97), S&T policies remained weakly integrated into the overall development vision. There were no law to regulate the flow of technology and no penalties for using outdated technology. After 2000 Information Technology was declared as the priority area and IT policy launched. Then IT infrastructure expanded S&T budget increased for R&D, in spite of this it is still low at 0.24 % of GNP for civilian R &D while improvement in S&T sector cannot be achieved within this budget. The challenge lies in ensuring consistency of policy, good governance, creating demand for innovation and upgrading in private sector [37].

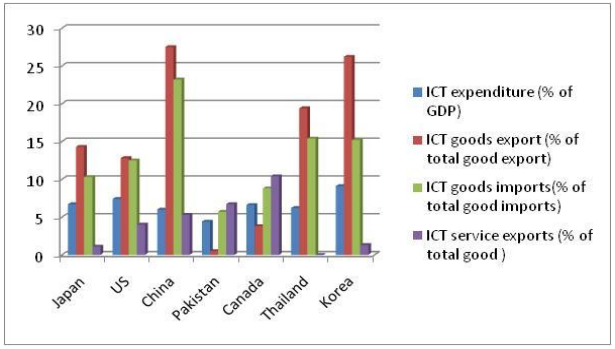
According to the World Bank Indicator on Information Communication Technology United States, Japan, Canada and Korea considered being High Income group, and China, Thailand and Pakistan are in the Lower middle Income group the main indicator for the comparison is given in the table:

TABLE I. ICT INDICATORS OF SEVEN COUNTIRIES [38]

Information Communication Technology Indicator	Japan	US	China	Pakistan	Canada	Thailand	Korea
Population(millions)	128	304	1325	166	33	67	49
Urban Population	66	82	43	36	80	33	81
GDP growth (avg. annual %)	1.6	2.4	10.4	5.4	2.5	5.2	4.5
Telecommunications revenue (% of GDP)	3.0	3.1	2.9	2.7	2.5	4.0	4.7
Telecommunications investment (% revenue)	13.1	6.6	32.0	1.7	29.8	9.8	14.3
ICT expenditure (% of GDP)	6.7	7.4	6.0	4.4	6.6	6.2	9.1
ICT goods export (% of total good export)	14.3	12.8	27.5	0.5	3.8	19.4	26.2
ICT goods imports(% of total good imports)	10.3	12.5	23.2	5.7	8.8	15.4	15.2
ICT service exports (% of total good)	1.1	4.0	5.3	6.7	10.4	…	1.3







VI. Case Studies

In Bangladesh, Grameen Bank's (GB) innovation is Grameen Village Phone(VP). This VP Program provided access to telecommunications to over 45 % of the villages in Bangladesh as at the end of 2005. By way of providing microfinance to villagers to purchase mobile phone Grameen Phone (GP) connection and operated as a pay-phone, providing access to fellow villagers for a charge. This is a unique example for the development of the country through the use of ICTs expanding telecommunications access to rural poor. The model that work are defined and shaped by the specific policy, regulatory and institutional environments and timely available technology [39].

The Dutch government introduced a new policy instrument. An innovation program called "Societal Sectors and ICT" launched to promote and disseminate societal relevant ICT-applications. A study conducted by TNO to understand the Dutch condition in large scale adoption of societal relevant ICT applications. The analyses resulted in the form of policy recommendations. One of the policy recommendations is "Differences in awareness, preparedness and willingness between societal sectors need to be taken into account and lead to different approaches to promote innovative applications" [40].

John Hopkins Institute for Policy Studies in Baltimore offers service to the community through graduate and undergraduate student internships, seminars and briefings, and volunteer activities, each year the Institute's first-year students research a policy issue of particular interest to the City of Baltimore, and present their findings and recommendations to city leaders, community activists, local business owners, and concerned citizens, among others [41].

Silicon Valley, California considered being one of high technology hotbeds which demonstrate a largely private orientation to ICT development in the United States. One of the study concluded ten factor for the high technology development of Silicon Valley Edge "Favorable rules of the game, knowledge intensity, a high quality and mobile work force, results-oriented meritocracy, a climate that rewards risk-taking and tolerates failure, open business environment, universities and research institutes that interact with industry, collaborations among business, government and nonprofit organizations, high quality of life and specialized business infrastructure"[42].

In India M S Swaminathan Research Foundation (MSSRF) a Centre for Research on Sustainable Agriculture and Rural Development has established to harness the power of ICT in the knowledge, skill, economic and social empowerment of rural families based on the principle of reaching the unreached and voicing the voiceless. The MSSRF has collaboration with the D-Lab. D-Lab is a program for International Development at the Massachusetts Institute of Technology (MIT), the purpose is to foster the development of appropriate technologies and sustainable solutions within the framework of international development[43][44].

VII. Conclusion

The literature review presented in the paper leads to form implication that gives directions to influence the ICT policy to increase the ICT access and diffusion in the developing countries. ICT found to be the core development key in most developed countries in Asia. Successful policies should not be only well designed and formulated, but their implementation process is crucial [45]. Policies regarding investment and trade in the Telecommunication are the only choice for the government to leverage ICT diffusion.

The countries US, Japan, China, Canada, Thailand, Korea and Pakistan they are different in the every aspect e.g. population, GDP, ICT usage and expenditure. We compared these countries and highlight the policies framework. This comparison allows relating growth patterns of cross countries to support the idea that ICT Innovation policy are likely to affect the country's economic development and specially the diffusion of the ICT innovations.

By using the policy framework, a ministry can update its current policies, in the context of its current and future economic and social development goals. It can select the appropriate approach for connecting ICT to other policies reform efforts. And it can plan a trajectory for connecting ICT Innovation policies to the economic and social development goals of the country.

As a result of this literature review and comparison of different countries, it is suggested to be focused on economic dimensions of the ICTs Policies instead of other scope and integrate that with other strategies and policies.

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