Tracing ICT Innovation Ecosystem of Pakistan

M. Nadeem Jahangir and Asif Ali Shah

***Abstract* – Innovation Ecosystem plays a pivotal role in facilitating activities that transform ideas into products, processes and services. It is a complex set of environment comprises of various public/private-sector entities whose activities and interactions promote creation of new technologies. Globally, it has become a part of developed and developing nations' priority to have National Innovation Systems (NISs) to encourage such ecosystem as it contributes towards economic development. In Pakistan, same approach has been adopted describing innovation as key driving force for all sectors of economy in recently announced National Science, Technology & Innovation Policy 2012 (NSTIP 2012). In which sixteen key thrust areas have also been highlighted in which Information and Communication Technologies (ICT) sector is one of them which has been chosen for this investigation. In this research, mapping of Innovation Ecosystem of ICT sector of Pakistan has been performed by identifying presence of various stakeholders and their possible interactions. A mapping concept of Osama, A. et al (2015) has been used for providing detailed visual description of ICT sector that would be helpful for policy makers and other public sector administrative bodies in their decision making at the governance level. The mapping reveals that about six categories of organizations are operating within the ICT ecosystem; which are focusing towards producing IT workforce and IT startups. Further, emerging trend of community based science NGOs/NPOs is also been found which sponsor and promote creation of Startups. Academia, whereas changing its role from research creation to research commercialization. Finally, a pattern of Quadruple Helix Model has also been observed in the ICT ecosystem in Pakistan which deserves to be further investigated in future studies.**

***Index Terms* – ICT, National Innovation System, Innovation Ecosystem, Quadruple Helix Model.**

I. INTRODUCTION

Innovation is a recent phenomenon which is one of the important drivers of progress for any organization [1]. Oslo Manual defines it as "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations" [2]. E. M. Rogers defines it in 2003 [3] as "An innovation is an idea, practice, or project that is perceived as new by an individual or other unit of adoption".

Innovation plays a significant role in socio-economic development of a society and creates a global competitive environment for economic activities. Globally, it has become an important ingredient of every business strategy for gaining competitive advantage [4]. Utilizing such characteristics, the concept of 'innovation system' emerged in late 1980s [5]. Extending the same concept, developed and developing countries established innovation oriented National Systems called National Innovation Systems (NISs) in order to get long-term economic growth and prosperity. Such systems converge their focus more towards knowledge creation through *interactions among various actors or entities* having linkages with various public/private institutions playing their part, inform of a network that produces innovation [6]. In some literature, such systems have been described to have 'innovation ecosystems' within NIS. In a broader sense, innovation ecosystem is more about economic system based upon the concept of innovation having role of multiple actors or entities. Mercan & Göktaş defines in [7] that an "innovation ecosystem consists of economic agents and economic relations as well as the non-economic parts such as technology, institutions, sociological interactions and the culture". In another place Durst & Poutanen described innovation ecosystem as the collaborative arrangements of various agents in a hybrid system of different networks [7] which facilitates the activities that transform ideas into products, processes and services [8].

In Pakistan's perspective, an extreme dearth of literature on this subject has been noticed despite of knowing its significance. However, some noteworthy studies does carried-out analyzing and assessing sectoral innovation ecosystems of various sectors. In a study, Speakman. J, et. al in [9] has presented an Innovation Ecosystem of Pakistan comprising of firms, government and knowledge providers as key components.

Another study, titled 'Pakistan Science and Innovation Review 2015' which has recently been published by Pakistan Innovation Foundation (PIF) has given a valuable insight analysis of various sectors of Pakistan's economy especially analysis of science, technology and innovation (STI) related activities and trends. It has also highlighted a detailed description of infrastructure, investments, policy issues, gaps, linkages among various actors/entities working within various sectors of economy. It has also mapped an ecosystem of agriculture sector highlighting various actors or entities of public/private institutions, NGOs/NPOs involved within the system.

Meanwhile Shah, Qureshi and Iffat have also elaborated the conditions suitable for developing ecosystem to establish provincial and national innovation system [10][11][12].

In view of the above, this research laid its emphasis on ICT sector of Pakistan to map its innovation ecosystem by identifying its key stakeholders constituting of various institute, organizations both working in private and public sector.

A. Attributes of Successful Innovation Ecosystem.

The concept of innovation ecosystem is not much differs

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from NIS. In some literature, the characteristics of NIS that have been described are somewhat similar to the characteristics of innovation ecosystem. Freeman has defined NIS in 1987 [6] ". the network of institutions in the public-and private-sectors whose activities and interactions initiate, import, modify and diffuse new technologies". Similarly, Nelson and Rosenberg in 1993 have also identified the similar characteristics [6] i.e. 'interactions' or 'linkages among entities' to NIS approach of interaction. Engler and Kusiak have explained ecosystem as "an environment in which the individual agents (innovation entities) exist and interact" [13]. Oksanen and Hautamäki have said 'innovation ecosystem refers to a dynamic, interactive network that breeds innovation' on p.25[14].

In a nutshell, the concept of innovation ecosystem could not be separated from the concept of NIS. It could be considered that a successful NIS manages various entities which creates an environment (i.e. innovation ecosystem) that facilitates innovation. The same is illustrated in Fig. 1.

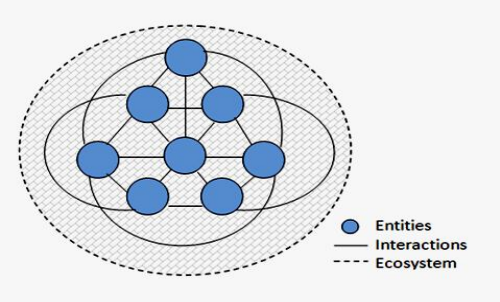

Fig. 1 Showing Innovation Ecosystem. Source: Authors Description

B. ICT and Public Policy in Pakistan

In Pakistan, ICT has been added in a public policy document for the first time in year 1993 in 'National Technology Policy and Technology Development Action Plan'. In that policy document IT has been emphasized to be used as a tool for transforming conventional paper based record keeping system into electronic Database Management System in all public offices [15]. Since then, it has become an integral part of every S&T policy in Pakistan. Even it was the policy decision that made Information Technology as a separate ministry in 2002 for establishing IT infrastructure and encouraging its use in the country.

In early 90s Pakistan was nowhere in software developing countries, even it had lenient IT infrastructure [16]. However, today it is reported as a fastest growing export sector of Pakistan which has crossed $2.5 billion mark with 41 percent of annual growth rate in IT export during 2014-15. Now, it has more than 2000 IT Companies, so far 15 Software Technology Parks (STPs), over 500 Call Centers, several Data Centers, Training Centers, Extended Telecom Infrastructure, Mobile, Gaming & Animation Studios and recently introduced technology/innovation incubating centers which are part of its ecosystem [17].

C. Inclusion of Innovation in S&T Policy of Pakistan

Recently, Government of Pakistan has added the '*innovation*' term in its National Science, Technology & Innovation Policy 2012 as a major driving force of economic activities in the country [18]. In the same policy document, sixteen thrust areas (sectors of economy) have also been identified and highlighted for conducting R&D (Research and Development) activities for obtaining ground-breaking results from each sector as shown in Table I.

Table I. Thrust Areas Described in National ST&I Policy 2012

Sr.	Thrust Areas
1.	Metrology, Standards, Testing & Quality (MSTQ)
2.	Environment
3.	Health & Pharmaceuticals
4.	Energy
5.	Biotechnology & Genetic Engineering
6.	Agriculture & Livestock
7.	Water
8.	Minerals
9.	Ocean Resources
10.	Electronics
11.	Information & Communication Technologies
12.	Space Technology
13.	Materials Science
14.	Nano-Science & Nanotechnology
15.	Lasers & Photonics
16.	Engineering Sector

Since ICT is one of the key thrust areas of NST&I Policy 2012 to induce innovation in Pakistan, therefore, to achieve desired results of policy decisions, it is important for policy makers to have thorough understanding and awareness of all stakeholders or entities working-in or part of the existing S&T system that can encourage 'innovation' by re-organizing to get positive results. Without having complete awareness of organizational structure, any policy decision could be ineffective and objectives could remain vague and un-achieved.

Hence, keeping in view all factors, entities and circumstances under consideration as discussed earlier following research objectives have been formulated for this study;

1. To identify various stakeholders working within the ICT ecosystem of Pakistan.
2. To investigate the structural linkages and relationships among the identified stakeholders of ICT ecosystem.
3. To map and to highlight possible structural changes within the ecosystem.

II. METHODOLOGY

Selecting methodology is a crucial step for conducting any study. In this research simplistic form of methodology has been adopted for achieving objectives. In this research identification of the relevant entities/actors/public-private institutions has been performed through extensive literature review of relevant research papers, survey reports, case studies and others relevant documents. ICT sector has been

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chosen from sixteen thrust areas of NST&IP 2012 having significant impact in shaping economy of Pakistan.

Further, concept mapping has been preferred for designing structural map of ICT innovation ecosystem similar to the mapping concept of Osama, A. et al in [19] for providing a detailed visual description of innovation ecosystem that would be useful for various stakeholders of the industry specially policy makers in their *evidence-based* decision making at the governance level.

III. THEORETICAL DEBATE

A. *Key Stakeholders/Entities in ICT Sector of Pakistan*

Pakistan's IT/ICT industry has several important actors/entities working within its ecosystem. It comes under the Ministry of Information Technology (MoIT) which is an apex policy making body established in 2002 under whom IT & Telecom Division [20] and National IT Board (NITB) works. It is responsible for planning, coordinating and taking policy decisions in-coordination with other public-private institutions.

Provincial IT Departments/Boards are also important entities which run by the Provincial Governments. They plan, coordinate and execute IT related projects, workshops, conferences, seminars at the provincial and national level. They also facilitate educational institutions/academies for producing highly skilled IT workforce for the industry.

Another important entity of the ecosystem is the Securities and Exchange Commission of Pakistan (SECP) which was established in 1997. It is an autonomous regulatory body which enforces international legal standards and best practices for the protection of investors and economic growth [21].

Ministry of Commerce is also an important entity which is responsible to provide a conducive environment for trade activities for buyers & sellers with the help of its subordinate department called Trade Development Authority of Pakistan (TDAP) which was established in 2006; successor of Export Promotion Bureau (EPB). It represents Pakistan in international trade exhibitions/expos and organizes trade events annually for attracting foreign buyers [22]. Beside TDAP, there are several other bodies like Pakistan Software Houses Association (PASHA), Pakistan Software Export Board (PSEB) and Federation of Pakistan Chambers of Commerce and Industry (FPCC) are playing their leading role in policy making, assessing and accelerating economic growth within the ecosystem [18].

Funding is an important component which helps businesses to achieve its goals. In Pakistan there have been many funding agencies which are working and supporting IT industry. National ICT and R&D Fund is one of them which is governed by MoIT. It encourages research related activities and provides funds for ICT related research projects.

Existing literature also reveal that beside National ICT R&D fund, there are several other science funding organizations working within the system. In which Universal Service Fund (USF), Pakistan Science Foundation (PSF), Higher Education Commission (HEC) and other multinational private companies (like Shell, Toyota, Engro Corp., Mobilink, Bank Alfalah etc.) are few of them which provide funds through various scientific, academic and non-government organizations for promoting STI activities in the country [18][19][23].

Recently, a trend of technology/innovation incubating centers has also been introduced by some of the public, private owned organizations like Invest to Innovate (i2i), Plan9, The Incubator and The Nest i/o. Such centers provide professional environment to learners and helps them in building entrepreneurial skills for establishing start-ups. Punjab IT Board (PITB) and PASHA have played a significant role in disseminating such trend throughout the country.

Academia is also an important entity which produces specialized IT workforce for the industry through its various public-private academic institutions. Higher Education Commission (HEC) is the central body which regulates such public-private academic institutions, provides funds and other facilities for ICT related projects and programs. Vocational Training institutes are governed by the Provincial Education Departments which contributes in providing IT education.

Some organizations like Internet Service Providers Association of Pakistan (ISPAK), National Telecommunication Corporation (NTC) and Pakistan Telecommunication Authority (PTA) are playing their extremely vital role in maintaining the IT infrastructure and ensuring the availability of internet services throughout the country which is the life line of the whole ICT industry. All of above discussed entities are listed in Table II which fulfills first objective of this study.

Table II. List of major actors/entities working within the ecosystem of ICT industry of Pakistan

SR	IDENTIFIED ENTITIES/ STAKEHOLDERS	FUNCTION	SOURCE
1	Ministry of Information Technology (MoIT)	Policy Making, planning; coordinating and initiating IT related projects and programs. Under which IT & Telecom Division and National IT Board works.	[18]
2	Provincial IT Departments/ Boards	Planning, coordinating and initiating IT related projects, programs, conferences, seminar, workshops and use of ICT solutions at the provincial level.	[18]
3	Securities and Exchange Commission of Pakistan (SECP)	It is a regulatory body which registers and enforces international standards and best practices for the protection of investors. Associations like PSEB and ISPAK are also registered by SECP	Official Website of SECP

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4	Ministry of Commerce (MoC)	Cabinet Level Ministry of Government of Pakistan. It plays pivotal role in national economic growth and commerce development. It also grants licenses to trade associations like PASHA.	FPCCI Official website
5	Trade Bodies/Associations	Facilitates Trade of ICT related service. In which PASHA, ISPAK and FPCCI are actively working trade bodies.	[18]
6	Higher Education Commission (HEC)	It regulates universities which produces IT professionals. It also provides funds and other facilities for ICT related projects and programs.	[18][24][19] [25]
7	Universal Service Fund (USF)	It provides funds in form of subsidies for telecom development in under-developed areas.	
8	Pakistan Science Foundation (PSF)	It gives funds for R&D and S&T related activities.	
9	National ICT R&D Fund	It gives funds for R&D activities related to ICT.	[18][23]
10	Private Sector Organizations/ Technology/Innovation Incubating Centers	Public/Private organizations like PIF and other incubating centers like Plan9 owned by Punjab IT Board, i2i is private organization and The Nest i/o is launched by PASHA.	Official Websites of PITB, PASHA and PIF

IV. MAPPING LINKAGES OF ECOSYSTEM

From the above discussion, all of the gathered entities as presented in Table II could be classify into following six specific categories (domains);

1. Funding Organizations
2. Academia
3. Public Sector Organizations
4. Private Sector Organizations
5. Public-Private Organizations
6. Trade Bodies/Associations.

These domains are interconnected with each other through various channels, in which public sector organizations are playing their major role in driving whole system. First category is comprises of *funding organizations* in which majority of the public and foreign funds for ICT related scholarly research work are been channeled through HEC which is a federally administered body. However, there are some other federally controlled funding organizations working within the ecosystem like USF (works under MoIT), PSF (works under MoST) and National ICT R&D Fund (works under MoIT). Foreign funding is also been channeled through these federally controlled organizations but some private organizations (foreign and domestic) do sponsor projects through organizing funding events. This category is connected in parallel with *Academia*, in which HEC remains a central body. It regulates and accredits all universities throughout the country. In Pakistan, Provincial Governors are considered as Chancellors of all universities in their respective provinces. This builds a direct administrative relationship of academia with provincial public-sector entities which are comprises of *Provincial Governments* having respective IT Departments, Federally driven MoITT, PSEB (licensed by SECP) having direct parallel link with the private sector's trade bodies/IT associations like PASHA, ISPAK, CSP and FPCCI and Science NGOs/NPOs.

A recent change in the ecosystem is in the form of technology/innovation incubating centers. These centers conduct capacity building and entrepreneurial skill building courses. Such centers are emerging as a result of combined efforts of both *public-private* entities. Plan9 and PlanX are recent examples, driven by PITB partnering with various renowned foreign and domestic private companies and educational institutions. Some other technology incubating centers like NUST's Technology Incubation Center (TIC), Seed Incubation, Microsoft Innovation Center, National Incubation Center funded by National ICT R&D Fund, COMSATS Business Incubation Centre are some of the recent inclusion, mutually driven by public-private sector organizations. It is also found that most of the entities including recent class of incubation centers; does have a direct/indirect link with *Ministry of Commerce* (MoC) which is a federal government ministry established to facilitate trade of ICT based services.

Combining all six categories of above discussed organizations, a multi-channeled ecosystem of ICT sector appears as depicted in Fig. 2.

V. FINDINGS AND CONCLUSION

The mapping of ICT ecosystem of Pakistan reveals that there are about six major categories of organizations operating within the ecosystem having multiple interconnected channels of communications. It is a complex set of network having a large nos. of public-sector driven entities which are responsible for major policy decisions, managing academia and it's funding from various agencies categorized as 1st, 2nd and 3rd categories.

A cluster of private-sector driven entities also found which are more involved in commercialization or trade related activities which are categorized as 4th category.

It has also observed that beside public and private sector organizations, a new trend of community based organizations i.e. science NGOs/NPOs (Non-Government Organizations/ Non-Profit Organizations) have also been emerged in the ecosystem. Such science NGOs/NPOs are facilitating STI (science, technology and innovation) based activities through establishing technology/innovation incubation centers and sponsoring various ICT related projects by organizing events like ChallengeX Pakistan which is a Startup Competition, Boot Camps for product development, PIF's Karachi Innovation Challenge, PASHA's Launchpad organized annually for facilitating Startups in the country are placed in the 5th category of the ecosystem.

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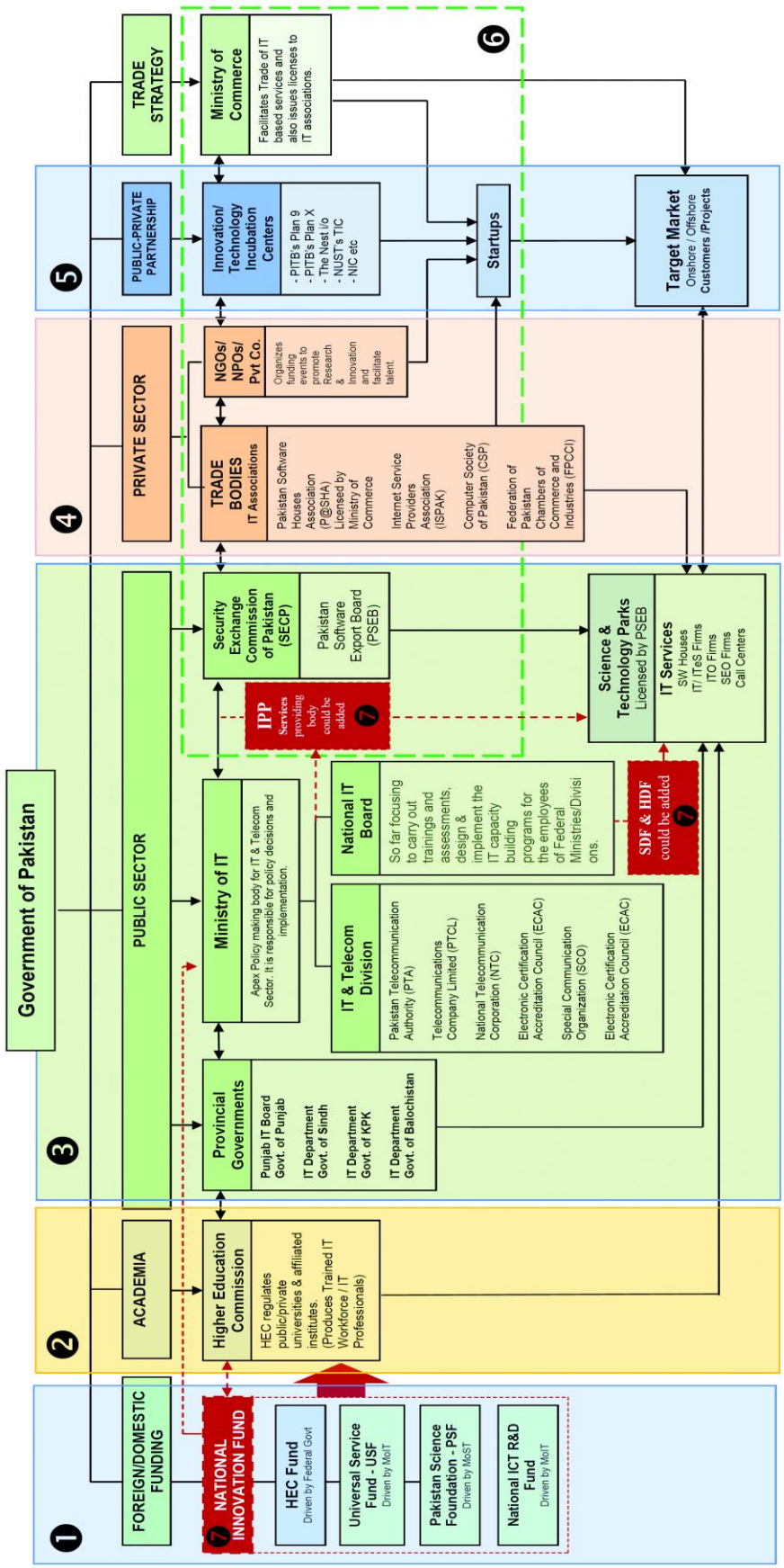

Fig. 2 Showing Mapped Innovation Ecosystem of IT/ICT Sector of Pakistan.

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The 6th category is comprises of those entities which are more focused towards commercializing ICT products and services.

Beside above categorization, a pattern close to the Quadruple Helix model also been observed in the map, in which entities like academia, industry, state and community based organizations are its fundamental components. This pattern looks in its initial stages and could also be an interesting line of reasoning for future studies.

Further, the relevant literature does highlight the complex nature of the ecosystem in which despite of being part of the system; various entities are unable to contribute effectively. For instance, public sector is partnering with private sector for developing infrastructure, organizing events promoting ICT, sponsoring IT projects and scholarships. Private sector is partnering with Science NGOs/NPOs for organizing different forms of events like (boot camps, hackathon, innovation forums, conferences, recruitment drive camps etc.) for hunting IT talent and promoting IT startups. On other hand, academia (universities) is changing its role from research production to research commercialization and collaborating with other international institutions for producing highly skilled IT workforce for the industry which can also be observed in the mapped ecosystem.

All of the above discussed entities are playing their role in two directions; one is to produce IT workforce and second is to produce IT Startups which is the recent trend.

The map also highlights the need for reconfiguring the whole ecosystem as per aspiration of National ST&I Policy 2012 and IT Policy Action Plan 2000 for positive results by addressing following areas;

1. Centralization of the whole ecosystem should be made under one ministry i.e. Ministry of IT and all other provincial IT departments should initiate all public-private events and trade related activities under directives of single ministry.
2. The MoIT should be renamed as Ministry of ICT as it has been globally recognized as ICT.
3. Establishment of Software Development Fund (SDF) and Hardware Development Fund (HDF) proposed to be materialized as per the criteria of IT Policy Action Plan 2000 which is reiterated in NST&I Policy 2012.
4. A separate dedicated entity (indicated in the map as item no.7 with red colored block) is proposed to be established within MoIT providing Intellectual Property Protection (IPP) services in order to counter software piracy and promote authenticity in the ICT industry instead of relying on IPO or liaison officer as stated in Policy Action A40 of NST&I Policy 2012.
5. The NITB which is a recent inclusion; is in its initial stages. In this study, it is proposed to be made more effective by expanding its scope of functionalities. For instance, SDF and HDF could be added in its capacity as indicated in the map as item no.7 with red coloured block.
6. Further, in order to ensure proper utilization and management of funds, an entity as National Innovation Fund (NIF) could be added in the ecosystem which will sponsor all science projects/programs based on innovation at the national level. The same has been committed in National ST&I Policy 2012 in Policy Action A41 and indicated in the map as item no.7th with red coloured block.

Hence, it is concluded that in order to make effective functioning of ICT ecosystem in Pakistan, reconfiguration of ecosystem is needed as per aspirations of the National ST&I Policy 2012 in which (NIF), (IPP), (SDF) and (HDF) entities are required to be introduced in it, aiming to strengthen its Quadruple Helix model which will further strengthen the network, based on university, industry, state and community organizations for economic prosperity.

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