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RESEARCH ARTICLE

Innovation Index Framework for assessing Ranking of Islamic Countries and Innovation Input- Output Indicators for Measuring Innovation Efficiency of Pakistan

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Abstract

This paper presents the framework for measuring innovation capability and Innovation Index Ranking of top 15 most efficient innovative Islamic Countries in the Global Innovation Index 2013. The paper also assesses the Pakistan's position in terms of its innovative capacity and progress in innovation with respect to its ranking and innovation input-output indicators among the Islamic countries. The comparative analyses showed that the incidence of innovation is low in Pakistan compared to other Islamic countries. Pakistan was ranked 137^{th} worldwide and 41^{st} among 45 Islamic countries. Innovation input indicators rankings of Pakistan are : expenditure on education (112^{th}), tertiary enrollment (114^{th}), researcher (HC) per million population (74^{th}), expenditure on R&D (60^{th}) and Innovation output indicators rankings are: domestic resident patent applications per billion GDP (97^{th}) , science and technology articles per billion GDP (71^{st}), high-technology exports (71^{st}), resident trademarks registration per billion GDP (87^{th}). The innovation input sub-index ranking (142^{nd}) and innovation output sub-index ranking (113^{th}) shows that Pakistan is getting more output for its inputs and was ranked at 16^{th} position in innovation efficiency ratio.

Introduction

It is widely accepted and understood that innovation is critical to economic competitiveness and social progress. The sustained and rapid economic growth that began in Western countries in the mid-19th century and is experienced by many emerging economies today is due, in large part, to the systematic creation and exploitation of innovation (Jones & Romer, 2010). Innovation is the predominant source of the new or improved products, processes, and methods of marketing and organization that drive the competitiveness of our business sector; generate the income that sustains our standard of living; alter the way we interact with each other and the natural world; and solve (and sometimes create) the technical and social problems we face. By corollary, it is also well established that when innovation is non-existent (Caselli, 2005) or lagging (CCA, 2009), industries and jurisdictions stagnate or fall behind in economic progress and prosperity (Moretti, 2012). Previously, economists and policy makers focused on R&D-based technological product innovation, largely produced in-house and mostly in manufacturing industries. This type of innovation is performed by a highly educated labour force in R&D-intensive companies. The process leading to such innovation was conceptualized as closed, internal, and localized. Technological breakthroughs were necessarily 'radical' and took place at the 'global knowledge frontier'. This characterization also implied the existence of leading and lagging countries with low- or middle-income economies only catching up. Today, innovation capability is seen more as the ability to exploit new technological combinations and embraces the notion of incremental innovation and 'innovation without research'. Non-R&D-innovative expenditure is an important component of reaping the rewards of technological innovation. There is also an increasing interest in understanding how innovation takes place in low- and middle income countries and an awareness that incremental forms of innovation can impact development. Furthermore, the process of innovation has undergone significant change. Investment in innovation-related activity has consistently intensified at the firm, country, and global levels, adding new innovation actors from outside high-income economies and also nonprofit actors.

The structure of knowledge production activity is more complex and geographically dispersed than ever. A key challenge is to find metrics that capture innovation as it happens in the world today. Direct official measures that quantify innovation outputs remain extremely scarce. For example, there are no official statistics on the amount of innovative activity defined as the number of new products, processes, or other innovations for any given innovation actor, let alone for any given country. Most measures also struggle to appropriately capture the innovation outputs of a wider spectrum of innovation actors, such as the services sector, public entities, and so on.

Materials and Method

The paper is organized as follows. The second section defines the innovation and Innovation Efficiency. The third section provides a brief introduction of metrics and frameworks for measuring innovation. The fourth section presents innovation index framework for assessing the ranking of the Islamic countries. The fifth section describes innovation input-output indicators selected from the Global Innovation Index 2013 to assess innovative capacity of Pakistan. Then the sixth section presents conclusion.

2. Innovation and Innovation Efficiency

2.1 Innovation

Today's world economy has been characterized as a "Knowledge-Based Economy" (OECD, 1996) with knowledge being the most important resource and learning being the most important process (Lundvall, 2003). Innovation is regarded as one of the most important factor in the Knowledge-Based Economy (Asia-Pacific Economic Cooperation, 2000).

The word innovation is derived from the Latin word "nova" meaning new. There are various definitions of ''innovation'' that appear in the literature. Joseph Schumpeter is often thought of as the first economist to draw attention to the importance of innovation. He defined, in the 1930s, five types of innovation (see OECD, 1997, p-28): introduction of a new product or a qualitative change in an existing product; or process innovation new to an industry; or the opening of a new market; or development of new sources of supply for raw materials or other inputs; or -changes in industrial organization.

The article "Innovation Measurement - Tracking the State of Innovation in the American Economy, (2008)" defines innovation as the design, invention, development and/or implementation of new or altered products, services, processes, systems, organizational structures, or business models for the purpose of creating new value for customers and financial returns for the firm. The Oslo Manual, OECD (2005) defines innovation as the implementation of new or significant improved products, operational processes, organizational processes and structures, and marketing methods. Some of the more popular definitions include: "An Innovation is an idea, practice or object that is perceived as new by an individual or other unit of adoption". "Innovations are new things applied in the business of producing, distributing and consuming products or services". "The first commercial application or production of a new process or product".

2.2. Innovation Efficiency

The concept of innovation efficiency is important for innovation policy. Innovation efficiency can be defined as the ability of firms to translate innovation inputs into innovation outputs. Although innovation is not a linear process where inputs automatically transfer into outputs, it is worthwhile to study inputs and outputs as separate dimensions of the innovation process and to explore the following questions: do countries differ in their degree of efficiency of transforming innovation inputs into outputs and have countries made improvements in their innovation efficiency. Innovation efficiency is related to productivity. Higher productivity is achieved when more outputs are produced with the same amount of inputs or when the same output is produced with less input. Innovation efficiency will here be defined similarly: innovation efficiency is improved when with the same amount of innovation inputs more innovation outputs are generated or when less innovation inputs are needed for generating the same amount of innovation outputs. Innovation efficiency can be thus be defined as the ratio of outputs over inputs.

3. Evaluation of Innovation Metrics and Frameworks for Measurement of Innovation

3.1. Evaluation of Innovation Metrics over Generations

Milbergs and Vonortas (2004) have portrayed innovation metrics as evolving through the following four generations (Table 1):

Table 1 Evolution of Innovation Metrics by Generation

First Generation Input Indicators (1950s–60s)	**Second Generation Output Indicators (1970s–80s)**	**Third Generation Innovation Indicators (1990s)**	**Fourth Generation Process Indicators (2000s plus emerging focus)**
• R&D expenditures • S&T personnel • Capital • Tech intensity	• Patents • Publications • Products • Quality change	• Innovation surveys • Indexing • Benchmarking innovation capacity	• Knowledge • Intangibles • Networks • Demand • Clusters • Management techniques • Risk/return • System dynamics

Source: Milbergs and Vonortas, 2004

• First generation metrics reflect a linear conception of innovation focusing on inputs such as R&D investment.

• Second generation complements input indicators by accounting for the intermediate outputs of science and technology (S&T) activities.

• Third generation metrics focus on a richer set of innovation indicators and indexes based on surveys and the integration of publicly available data.

• Fourth generation metrics, grounded in a knowledge-based networked economy, remain ad hoc and are the subject of measurement.

Innovation measures tend to be index-oriented—composites of the perceived components of innovation (e.g., EU Innovation Score Card, Massachusetts Innovation Index, and many other state and country indices) that rank regions or nations with respect to their degree of innovation. However, when it comes to monetizing innovation, the discussion turns quickly to the measurement of intangible assets (Jarboe, 2007; Lev, 2001).

3.2. Global Innovation Index 2013 Conceptual Framework

The Global Innovation Index (GII) is a recognition of the key role that innovation serves as a driver of economic growth and prosperity. It is also an acknowledgement of the need for a broad horizontal vision of innovation that is applicable to both developed and emerging economies, with the inclusion of indicators that go beyond the traditional measures of innovation (such as the level of research and development in a given country). The GII is a valuable benchmarking tool to facilitate public-private dialogue, whereby policymakers, business leaders and other stakeholders can evaluate progress on a continual basis. The Global Innovation Index (GII) offers a means of assessing innovation, evaluating related policy performance and refining innovation policies for optimal growth. It captures performance in two key areas: first, the capability of an economy to innovate (on the basis of five input pillars relating to institutions, human capital and research, infrastructure, market sophistication and business sophistication); and second, an economy's innovation performance in terms of the outputs generated (on the basis of two output pillars, knowledge and technology outputs and creative outputs). The GII measures the degree to which countries and businesses integrate innovation into their political, business and social spheres. The GII "contains a number of metrics which help us to provide a continual assessment of innovation and policy performance in relation to innovation.

Global Innovation Index 2013 is an annual publication of a composite indicator that ranks countries/economies in terms of their enabling environment to innovation and their innovation outputs. The Global Innovation Index 2013 (GII) covers 142 economies, accounting for 94.9% of the world's population and 98.7% of the world's Gross Domestic Product (in US Dollars). Global Innovation Index 2013 (GII) relies on two sub-indices, the Innovation Input Sub-Index and the Innovation Output Sub-Index, each built around key pillars. Five input pillars capture elements of the national economy that enable innovative activities: (1) Institutions, (2) Human capital and research, (3) Infrastructure, (4) Market sophistication, and (5) Business sophistication. Two output pillars capture actual evidence of innovation outputs: (6) Knowledge and technology outputs and (7) Creative outputs. Each pillar is divided into sub-pillars and each sub-pillar is composed of individual indicators (84 in total). Sub-pillar scores are calculated as the weighted average of individual indicators; pillar scores are calculated as the weighted average of sub-pillar scores.

3.3. Indicators-based Frameworks

Using indicators to measure the inputs, activities, outputs, and impacts of innovation is a common practice. This is not surprising since indicators are widely collected, easy to interpret, clearly communicated, and readily comparable across jurisdictions (OECD, 2009). Indicators, if used judiciously, can provide an excellent snapshot of the state of innovation in a jurisdiction and, if collected over a satisfactorily long period, an impression of the evolution of innovation. No single indicator, however, can adequately offer a complete picture of innovation. Each indicator has its own strengths and limitations, with some indicators more suitable for certain industries and others more suitable for certain levels of analysis. As Gault (2010) cautions, care must be taken in using indicators since a single indicator "does not tell the full story," "may need another indicator to give it meaning," "may have to be combined with another indicator," and "may give different results if it comes from a cross-sectional or panel survey."

Hundreds of indicators have been developed to measure innovation (OECD, 2012; National Science Board, 2012; CAHS, 2009), yet there is no general consensus on which indicators convey the most information about innovation. Effective use of indicators requires nesting them in a conceptual framework to measure the inputs, activities, outputs, and impacts that are theoretically, experientially, or policy relevant. Examining indicators in silos — science and technology (S&T) indicators, R&D indicators, firm profitability indicators, and the like — without a conceptual framework, eschews the non-linear and dynamic nature of innovation.

3.3.1. Australia's Innovation Metrics Framework

The Government of Australia's Innovation Metrics Framework Project is an important step towards collecting the most pertinent innovation data, using related yet distinct measurement methodologies, and establishing relations across various levels of measurement analysis. It accomplishes the latter through the development of three sub-projects that integrate indicators at the economy level (sub-project 2), program level (sub-project 3), and company level (sub-project 4) into one logical framework. The most recent report that applies this framework (Innovation System Report) presents a broad range of wide-scoping indicators, integrated across the aforementioned levels of analysis: expenditure on R&D by socio-economic objective and by sector, intangible asset investment, modes of innovation by jurisdiction, and new or improved innovation by mode and industry (Australian Government, 2010).

3.3.2. Finland's Indicator-based Framework

Tekes, Finland's main public research funding agency, has recently developed a leading-edge indicator-based framework (Tekes, 2012). While this framework adopts a straightforward input-activity-output-impact approach, it provides a judicious set of indicators that measure inputs/activities/outputs insofar as they are linked to four classes of impacts: economy and renewal, environment, well-being, and skills and culture. For example, the economy and renewal impact category matches indicators to "impact phenomena:" national prosperity (GDP/capita); overall productivity of the economy (MFP); job creation (net job increase); high growth enterprises (share of high growth enterprises, renewal rate); and, foreign direct investments (FDI/GDP). This classification of indicators by impact class provides a way to qualitatively link innovation investments to impact ("hierarchy of phenomena").

3.3.3. Canadian Payback Framework

Developed in 2009 to measure the impact of investments in health research, the Canadian Academy of Health Sciences (CAHS, 2009) payback model builds on the payback framework of Buxton and Hanney (1996). The Buxton and Hanney model combines an input-output-impact logic model with a balanced scorecard set of indicators, enabling tracing of investments in research through activities, outputs, and impacts; and categorizing research impact as a multidimensional phenomenon. This framework has been widely used to measure the impacts of health research in Canada (e.g., Canadian Institutes of Health Research, Alberta Innovates, and the Nova Scotia Department of Health and Wellness). The CAHS variant of the payback framework adopts a logic model to categorize outputs (primary and secondary) and impacts (adoption and outcomes) into five domains, with an associated 66 indicators: advancing knowledge, capacity building, informing decision-making, economic benefits, and social benefits. As with the Tekes (2012) framework, the indicators are comprehensive, the qualitative input-impact links are present, and the impacts are plural. However, similar to Tekes, the model does not fully capture the interactions of actors, time sensitivity of innovation investments, or behaviour in an innovation ecosystem.

3.3.4. European Innovation Scoreboard (EIS)

In the European Innovation Scoreboard (EIS) innovation performance is measured using data for 25 innovation indicators. These indicators are divided into 3 input dimensions covering 15 input indicators and 2 output dimensions covering 10 output indicators (cf. Table 1). Of the input dimensions, Innovation drivers measure the structural conditions required for innovation potential, Knowledge creation measures the investments in R&D activities and Innovation & entrepreneurship measures the efforts towards innovation at the firm level, Of the output dimensions, Applications measures the performance 5 expressed in terms of labour and business activities and their value added in innovative sectors, and Intellectual property measures the achieved results in terms of successful know-how.

Table 2: EIS 2007 Input and Output Indicators

Innovation inputs	Innovation outputs
• **Innovation drivers**	• **Applications**
o S&E graduates per 1000 population aged 20-29	o Employment in high-tech services (% of total workforce)
o Population with tertiary education per 100 population aged 25-64	o Exports of high technology products as a share of total exports
o Broadband penetration rate (number of broadband lines per 100 population)	o Sales of new-to-market products (% of total turnover)
o Participation in life-long learning per 100 population aged 25-64	o Sales of new-to-firm products (% of total turnover)
o Youth education attainment level (% of population aged 20-24 having completed at least upper secondary education)	o Employment in medium-high and high-tech manufacturing (% of total workforce)
• **Knowledge creation**	• **Intellectual property**
o Public R&D expenditures (% of GDP)	o EPO patents per million population
o Business R&D expenditures (% of GDP)	o USPTO patents per million population
o Share of medium-high-tech and high-tech R&D (% of manufacturing R&D expenditures)	o Triad patents per million population
o Share of enterprises receiving public funding for innovation	o Community trademarks per million population
• **Innovation & entrepreneurship**	o Community designs per million population
o SMEs innovating in-house (% of all SMEs)	
o Innovative SMEs co-operating with others (% of all SMEs)	

o Innovation expenditures (% of total turnover) o Early-stage venture capital (% of GDP) o ICT expenditures (% of GDP) o SMEs using organisational innovation (% of all SMEs)	

These four indicator-based frameworks all provide conceptually compelling frameworks to understand the nature of innovation and the relationship between innovation investments and a plurality of impacts. Examining impacts over time or between jurisdictions, however, requires sufficiently long time series data or internationally comparable data, respectively. This is often a significant challenge. Without a counterfactual, these frameworks do not establish causality between investments and impacts.

4. The Innovation Index framework for assessing Ranking of Islamic Countries

4.1. Innovation Index Framework for the Islamic countries

Measuring innovation outputs and impacts remains difficult; hence great emphasis is placed on measuring the climate and infrastructure for innovation and on assessing related outcomes. The rich metrics can be used by individual countries—either at the level of the index and sub-indices or at the level of individual variables, such as 'the number of patent applications by resident'—to monitor performance over time and to benchmark developments against other countries in the same region or of the same income group. The Innovation Index comprises two broad categories: **inputs** to innovation, which measure innovation capacity, and **outputs** of innovation, which measure the results. Innovation Index framework for assessing Innovation Index ranking of Islamic countries is given in Table 3.

Table 3 Innovation Index Framework for the Islamic countries

Innovation Input Sub-Index	**Innovation Output Sub-Index**
A. Human capital and research **1. Education** Current expenditure on education, % GNI Public expenditure/pupil, % GDP/cap **2. Tertiary education** Tertiary enrolment, % gross Graduates in science & engineering, % **3. Research & development** Researchers, headcounts/mn pop Gross expenditure on R&D, % GDP	**A. Knowledge and technology outputs** **1. Knowledge creation** Domestic resident patent ap/bn PPP$ GDP Scientific & technical articles/bn PPP$ GDP **2. Knowledge impact** Growth rate of PPP$ GDP/worker, % Hi-& medium-hi-tech manufactures, % **3. Knowledge diffusion** High-tech exports less re-exports, % FDI net outflows, % GDP
B. Business sophistication **1. Knowledge workers** Knowledge-intensive employment, % R&D performed by business, % **2. Innovation linkages** University/industry research collaboration R&D financed by abroad, % **3. Knowledge absorption** High-tech imports less re-imports, % FDI net inflows, % GDP	**B. Creative outputs** **1. Intangibles Assets** Domestic res trademark reg/bn PPP$ GDP ICT & business model creation **2. Creative goods and services** Paid-for dailies, circulation, % pop Creative goods exports, % **3. Online creativity** Generic top-level domains (TLDs)/th pop Country-code TLDs/th pop

4.1.1. Innovation Index

The Innovation Index relies on two sub-indices: the Innovation Input Sub-Index and the Innovation Output Sub-Index, each built around pillars. Each pillar is divided into three sub-pillars and each sub-pillar is composed two individual indicators for a total of 20.

4.1.1.1. Innovation Input Sub-Index

Two input pillars (Human capital and research and Business sophistication), each having three sub-pillars each consisting of two indicators have been selected to capture elements of the national economies of Islamic countries that enable innovative activities.

a) Human capital and research

The level and standard of education and research activity in a country are the prime determinants of the innovation capacity of a nation. This pillar tries to gauge the human capital of countries. The first sub-pillar includes two indicators. Education expenditure and Public expenditure per pupil which give a sense of the level of priority given to education by the state. The second sub-pillar on tertiary education aims at capturing coverage of tertiary enrolment and the percentage of tertiary graduates in science and engineering. The third sub-pillar, on Research and Development (R&D), measures the level and quality of R&D activities, with indicators on researchers (headcounts) and gross expenditure on research and development as a percentage of GDP.

b) Business sophistication

The second enabler pillar tries to capture the level of business sophistication to assess how conducive firms are to innovation activity. The Human capital and research pillar made the case that the accumulation of human capital through education, and particularly higher education and the prioritization of R&D activities, is an indispensable condition for innovation to take place. That logic is taken one step further here with the assertion that businesses foster their productivity, competitiveness, and innovation potential with the employment of highly qualified professionals and technicians. The first sub-pillar includes two quantitative indicators on knowledge workers: employment in knowledge-intensive services; and the percentage of total gross expenditure of R&D that is financed by business enterprise. Second sub-pillar Innovation linkages and public/private/academic partnerships are essential to innovation The sub-pillar draws on both qualitative and quantitative data regarding business/university collaboration on R&D and the level of gross R&D expenditure financed by abroad. The next sub-pillar is knowledge absorption. Sub-pillar three includes two statistics all linked to sectors with high-tech content or that are key to innovation: high-tech imports (net of re-imports) as a percentage of total imports; and net inflows of foreign direct investment (FDI) as a percentage of GDP.

4.1.1.2. Innovation Output Sub-Index

Innovation outputs are the results of innovative activities within the economy. Two output pillars: Knowledge and technology outputs and Creative outputs each having three sub-pillars each sub-pillar consisting of two indicators have been chosen to assess the performance of the Islamic countries.

a) Knowledge and technology outputs

This pillar covers all those variables that are traditionally thought to be the fruits of inventions and/or innovations. The first sub-pillar refers to the creation of knowledge. It includes two indicators that are the result of inventive and innovation activities: patent applications filed by residents at the national patent office and scientific and technical published articles in peer reviewed journals. Second sub-pillar on knowledge impact includes statistics representing the impact of innovation activities at the micro and macroeconomic level or related proxies, Growth rate of GDP per person engaged and high- and medium-high-tech industrial output over total manufactures output. The third sub-pillar, on knowledge diffusion, is the mirror image of the knowledge absorption. It includes two statistics all linked to sectors with high-tech content or that are key to innovation: high-tech exports (net of re-exports) as a percentage of total exports (net of re-exports); and net out flows of FDI as a percentage of GDP. High-tech exports.

b) Creative outputs

The last pillar, on creative outputs, has three sub-pillars. The first sub-pillar on creative intangibles includes statistics on trademark registrations by residents at the national office and the use of ICT in business model, new areas that are increasingly linked to process innovations in the literature. The second sub-pillar includes proxies to get at creativity and creative outputs in an economy: Daily newspaper circulation and Creative goods exports (% of total exports). Third sub-pillar on online creativity includes two internet indicators, Generic top-level domains (TLDs) and Country- code TLDs, scaled by population aged 15-69 years old.

4.1.2. Assessing Innovation Index Ranking of Islamic countries

The Global Innovation Index (GII) project was launched by INSEAD in 2007 with the goal of determining how to find metrics and approaches to better capture the richness of innovation in society. The Global Innovation Efficiency Index shows which countries are best in transforming given innovation inputs into outstanding outputs. Countries which are strong in producing innovation outputs despite a weaker innovation environment and innovation inputs are poised to rank high in this "efficiency" index. The ranking of top 15 Islamic countries in Innovation Efficiency Index is shown in Table 4 and 5. In the Global Innovation Index 2013, Kuwait is ranked 50th. It has a relative advantage in innovation outputs (36th) ranking 8th in efficiency Index. Its best showing is its 1st place in knowledge diffusion and 15th in knowledge technology and output. Turkey is ranked 68th. The strengths in areas are notably in Knowledge Impact (29th), Knowledge Creation (40th) and Research & Development (43rd). Turkey comes in at 53rd in the Output Sub-Index, reaching the efficiency ratios rank 29th. While Tunisia is ranked 36th in the Global Innovation Efficiency Index, it is ranked at 70th in the overall Global Innovation Index.

Table 4 Innovation Index Ranking of Islamic Countries

Global Innovation Index		**Innovation Input Sub -Index**	**Innovation Output Sub -Index**	**Innovation Efficiency Ratio**	**Innovation Input Pillar**	**Innovation Input Pillar**	**Innovation Output Pillar**	**Innovation Output Pillar**
Country					**Human capital & Research**	**Business Sophistication**	**Knowledge technology and output**	**Creative outputs**
Kuwait	50	74	36	8	72	114	15	73
Turkey	68	81	53	29	76	108	49	69
Tunisia	70	80	59	36	68	110	103	33
Guyana	78	94	55	15	120	17	77	46
Indonesia	85	115	62	6	99	112	81	57
Uganda	89	109	75	19	115	121	85	70
Senegal	96	116	80	18	119	113	97	62
Tajikistan	101	113	85	27	109	132	32	132
Mali	106	132	73	1	125	106	52	97
Nigeria	120	137	97	7	140	134	114	74
Gambia	122	127	107	44	134	63	112	103
Cameroon	125	131	110	47	113	125	117	110
Guinea	126	139	98	3	137	109	98	90
Bangladesh	130	135	119	46	138	138	80	131
Pakistan	137	142	113	16	141	131	105	120

Guyana is ranked 78th in Global Innovation Index, with relative advantage on outputs, where it is ranked 55th. In comparison it holds 94th position in inputs, coming in at 15th place in innovation efficiency. Indonesia also figures among the top 10 nations in the Global Innovation Efficiency Index at 6th position. Its best position is 16th in intangible Assets. Uganda is ranked 89th which has biggest change from 2012 (117th rank). Its strength is intangible assets (31st) with innovation Efficiency Ratio of 19th. While Senegal ranks 96th in the Global Innovation Index, it is at the 18th position in the Global Innovation Efficiency Index. It scores high on Intangible Assets (13th).

Tajikistan is ranked 101st in the Global Innovation Index. It has strength in Knowledge Diffusion (7th). Knowledge Technology and Output (32nd), Knowledge Creation (36th). Mali leads the 142 countries of the world in Innovation Efficiency Index with 106th rank in Global Innovation Index. It shows good scores on Innovation Linkage (38th) and Intangible Assets (20th). Nigeria is ranked 120th, showing a relative strength on the side of the innovation results, ranked 97th on the Output Sub-Index and 7th on the efficiency ratio. Its main strengths is in Creative outputs (74th). While Gambia ranks 122nd in the Global Innovation Index, it is at the 44th position in the Global Innovation Efficiency Index. It scores high on Knowledge Absorption (27th). Guinea is ranked 3rd in Innovation Efficiency Ratio with global Innovation Index rank of 126th. Some real strength in areas are notably in knowledge absorption (17th), knowledge diffusion (12th), creative goods and services (19th). Bangladesh, is ranked 130th. Its major strength lies in Knowledge and technology outputs, and yet it ranks 80th with Innovation Efficiency ratios of 46th. Cameroon is ranked 125th with Innovation Efficiency ratios of 47th. Pakistan is ranked 137th out of 142 countries on the 2013 global Innovation Index, which measured countries' innovation capabilities and how they drove economic growth and prosperity. Pakistan's scores in different criteria were dismal. With an Output Sub-Index ranking of 113th and an

Input Sub-Index of 142th, Pakistan is ranked 16th on efficiency Index (15th in 2012). Its strength is in Research & Development (61st) and Knowledge Creation (73th).

Table 5 Innovation Input sub- pillars and Innovation Output-sub pillars Ranking

	Innovation Input sub- pillars Ranking						**Innovation Output pillars Ranking**					
Pillar / Country	**Education**	**Tertiary Education**	**Research & Development**	**Knowledge workers**	**Innovation Linkage**	**Knowledge absorption**	**Knowledge creation**	**Knowledge impact**	**Knowledge diffusion**	**Assets Intangible**	**Creative goods and services**	**Online Creativity**
Kuwait	69	55	89	105	68	139	86	78	1	91	54	64
Turkey	102	78	43	81	111	115	40	29	109	87	50	56
Tunisia	60	93	48	104	86	117	62	116	184	10	23	98
Guyana	121	109	123	17	32	18	130	125	10	41	29	85
Indonesia	104	99	58	141	55	69	127	58	87	16	78	112
Uganda	116	112	90	139	66	86	80	84	77	31	68	128
Senegal	107	129	83	138	44	104	79	113	70	13	100	119
Tajikistan	100	105	109	125	132	90	36	103	7	129	124	101
Mali	114	134	98	135	38	98	106	54	35	20	132	140
Nigeria	132	135	100	119	120	128	101	106	116	17	106	138
Gambia	138	104	119	89	79	27	55	122	72	82	116	103
Cameroon	122	87	110	106	92	137	91	115	101	53	122	125
Guinea	133	117	123	132	128	17	138	142	12	100	19	130
Bangladesh	137	122	81	120	112	140	100	101	40	116	134	123
Pakistan	141	139	61	114	123	116	73	104	99	111	107	107

5. Measuring Innovation Input-output Indicators of Pakistan

According to (Freeman and Soete, 2004) the National Innovation system can be defined as the ‹interactions between various institutions dealing with science and technology as well as with higher education, innovation and technology diffusion (...) whether public or private‹ institutes. The innovation system is a complex system and in order to improve it, multiple fields should be considered. Nowadays the scientific and technical progresses are the main drivers for innovations. In order to explore the innovation system in any region it would be important to measure its main indicators and study the interaction among different institutes. The indicators can be classified as inputs and outputs indicators. The input indicators are: Researcher and Development ‹R&D‹ personnel, education and R&D expenditure, while the output indicators are: patents, scientific publications and technology trade (Lederman and Saenz, 2005; OECD, 2005; Nour, 2005; ESCWA,2003)

A nation’s ability to solve problems and initiate and sustain economic growth depends partly on its capabilities in science, technology, and innovation. Science and technology are linked to economic growth; scientific and technical capabilities determine the ability to provide clean water, good health care, adequate infrastructure and safe food. Development trends around the world need to be reviewed to evaluate the role that science, technology and innovation play in economic transformation in particular and sustainable development in general.

In the rapid changing world, neither the financial capital nor the human power are the only factors to the continuous progress in the economy, the innovation and the knowledge play nowadays major role in the economic growth. Innovation is of importance not only for increasing the wealth of nations in the narrow sense of increased prosperity, but also in the more fundamental sense of enabling people to do things which have never been done before. It enables the whole quality of life to be changed for better or for worse. (Freeman and Soete,2004).

Both Marx and Smith have considered Technology, Science and Inventions as elements in the economical growth. Empirical studies showed that before the industrial revolution, the difference between industrial and developing countries was small and after that the difference has increased dramatically (Freeman and Soete, 2004). It is important for the developing countries to catch-up with the Technological development to reach the economical growth. The catch-up can be achieved by imitation or innovation. An innovation is 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. There are many types of innovation such as product innovation, process innovation, marketing innovation and organizational innovation. The relationship between innovation and economic development is widely acknowledged. Hence, good measurement of innovation is essential for policymaking. There are enormous numbers of macro-indicators to measure and benchmark innovation capacity. Here we only could look at limited number of indicators to benchmark Pakistan's innovation capacity against other Islamic countries.

Innovation Input Indicators

Innovation is a multifaceted concept, so this tool allows the exploration of the different dimensions of innovation. The Innovation Index comprises two broad categories: inputs to innovation, which measure innovation capacity, and outputs of innovation, which measure the results. In order to explore the innovation system in Pakistan it would be important to measure its main indicators. The indicator can be classified as inputs and outputs indicators. The input indicators are: Researcher and Development R&D, personnel, education and R&D expenditure, while the output indicator are: patents, scientific publications and technology trade.

Human capital is a vital input to innovation. This tool includes state-level indicators—total R&D spending and science and technology graduates—that can help evaluate the strength of a state's investments to support innovation. Research and development (R&D) spending is generally viewed as a measure of an input to innovation. R&D expenditures are the most commonly used indicator of innovation capacity and competitive advantage. The allocation for R&D expenditure in most of the Islamic countries is less than 0.5 per cent of GDP. Gross Domestic Expenditure on R&D as a percentage of GDP in Pakistan (0.5%) is low when it is compared to Tunisia (1.1%) and Turkey (0.8%). The spending on research and development (R&D) in term of percentage of the Gross Domestic Product (GDP) in Pakistan as a proxy for inputs to innovation has actually fallen since 2008, from a peak of 0.67 percent of GDP in 2008 to 0.5 percent in 2010. The expenditure on education in Pakistan is too far away from the international standards. The Islamic countries have invested heavily in education as a central part of their economic future. In terms of the share of national wealth invested in education, the biggest spenders are Tunisia (5.9%), Senegal (5.2%), Mali (4.3%). The major weakness of Pakistan's innovation system is the shortage of technically skilled manpower to engage in R&D. The standard indicators of the government's commitment towards human capital efforts such as the proportion of total expenditure incurred on education (1.6%) compare unfavourable with all other Islamic countries. In terms of an indicator such as enrolment ratios at tertiary level, Pakistan's performance (8.3 with ranking of 114) is very poor compared to Turkey (55.4), Kuwait (21.9), Tajikistan (23.4), Tunisia (37.1) and Indonesia (23.1). Another proxy for inputs to innovations is researchers. Researchers are the central elements of the research and development system. The ratio of researcher (HC) per million population in Pakistan (320.8 with ranking of 74) are not comparable to Tunisia (3239.8), Turkey (1715.4) and Senegal (666.7). Increasing the number of R&D researchers is a big challenge and tougher than pumping more in R&D spending since developing research skills and capabilities takes much longer time. Increasing R&D expenditure with inadequate number of R&D research will lead to ineffective consumption of the spending and low value product development.

Table 6 Innovation Input Indicators Ranking

Indicator / Country	Exp on education	Exp/ pupil	Tertiary enrol	Gradu in S and E	Researcher/mn pop	GERD% GDP	know-intens emplo	R&D fin by business	Uni/industries collab	R&D from abroad	high-tech imorts	FDI net inflows
Kuwait	87	47	87	n/a	83	94	72	79	116	76	n/a	132
Turkey	101	94	43	45	41	38	76	31	69	80	67	90
Tunisia	21	36	68	n/a	27	34	n/a	64	57	24	58	122
Guyana	89	93	101	82	n/a	n/a	n/a	n/a	92	n/a	99	30
Indonesia	99	95	86	34	82	98	96	n/a	38	n/a	52	85
Uganda	95	103	111	95	105	67	102	73	67	11	43	47
Senegal	36	20	116	n/a	62	69	n/a	74	84	8	122	92
Tajikistan	78	85	85	n/a	75	96	n/a	82	81	81	n/a	133
Mali	59	29	121	n/a	100	74	n/a	70	108	4	116	98
Nigeria	n/a	n/a	109	n/a	90	80	n/a	86	71	77	106	64
Gambia	100	n/a	125	48	92	108	n/a	n/a	56	n/a	119	60
Cameroon	93	101	99	40	76	n/a	n/a	n/a	96	n/a	n/a	112
Guinea	85	91	104	n/a	n/a	n/a	n/a	n/a	128	n/a	n/a	6
Bangladesh	108	102	106	85	n/a	n/a	99	n/a	124	n/a	n/a	126
Pakistan	112	97	114	n/a	74	60	66	n/a	79	79	87	128

Table 7 Innovation Input Indicators

Indicator / Country	Exp on education	Exp/ pupil	Tertiary enrolment	Graduates in S and E	Researcher/bn GDP	GERD % GDP	Employment in knowledge intensive svc	GERD by business	Uni/industries collaboration	R&D finance by abroad	high-tech imorts	FDI net inflows
Kuwait	3.2	22.0	21.9	n/a	151.9	0.1	18.7	2.3	32.7	1.2	n/a	0.2
Turkey	2.6	12.2	55.4	20.7	1715.4	0.8	17.6	45.1	42.8	0.8	8.0	2.1
Tunisia	5.9	23.8	37.1	n/a	3239.8	1.1	n/a	20.0	45.8	14.9	9.3	0.9
Guyana	3.1	12.3	12.0	13.9	n/a	n/a	n/a	n/a	37.6	n/a	5.5	6.4
Indonesia	2.7	12.2	23.1	22.8	173.3	0.1	8.5	n/a	53.0	n/a	9.8	2.1
Uganda	2.9	10.6	9.1	9.5	52.6	0.4	4.3	8.2	43.0	26.1	10.5	4.7
Senegal	5.2	26.3	7.9	n/a	666.7	0.4	n/a	4.0	39.8	38.3	2.8	2.0
Tajikistan	3.7	14.0	23.4	n/a	253.9	0.1	n/a	1.1	40.4	0.7	n/a	0.2
Mali	4.3	24.7	6.1	n/a	62.5	0.2	n/a	10.1	35.1	49.0	4.2	1.7
Nigeria	n/a	n/a	10.3	n/a	119.9	0.2	n/a	0.2	41.8	1.0	5.0	3.6
Gambia	2.7	n/a	4.1	20.0	106.4	0.0	n/a	n/a	46.0	n/a	3.9	4.0
Cameroon	3.0	11.2	12.4	21.0	243.2	n/a	n/a	n/a	37.1	n/a	n/a	1.4
Guinea	3.3	12.9	11.3	n/a	n/a	n/a	n/a	n/a	23.7	n/a	n/a	17.6
Bangladesh	1.8	10.7	10.6	13.4	n/a	n/a	7.3	n/a	26.3	0.0	n/a	0.7
Pakistan	1.6	11.7	8.3	n/a	320.8	0.5	19.5	n/a	40.7	0.9	6.4	0.6

Innovation Output indicators

The weakness in the input indicators is reflected to the outputs. The patents and publications in Pakistan are too far away from the other Islamic countries. Scientific publications are widely utilized as performance indicators of national science and innovation systems. Science &Technology articles per billion GDP (10.8 with the ranking of 71) are low in Pakistan compared to Tunisia (26.5) Turkey (20.9), Gambia (27.2), Uganda (13.4), Senegal (14.0) and Cameroon (11.1). Patents reflect part of a country's inventive activity and how the country's capacity to exploit knowledge and translate it into potential economic gains. Considering the patents as one measure of the output of innovation, domestic resident applications per billion GDP in Pakistan (0.2) are comparable with Uganda (0.2) and Mali (0.2) and are relatively low compared to Turkey (4.0), Tunisia (0.8) and Indonesia (0.5). High Technology sectors are key drivers for economic growth, productivity and welfare, and are generally a source of high value added and well-paid employment. The High Technology exports are an important indicator for innovation. High-technology exports were 1.3% of the total manufactured exports in Pakistan. This figure is comparable with Turkey (1.5%) and lower than Tunisia (6.1%) and Indonesia (3.6%). High-& medium-high-tech manufactures % of total in Pakistan (23.7%) are low compared to Indonesia (32.0%) and Turkey (26.5%).

Table 8 Innovation output Indicators Ranking

Indicator / Country	Domestic residents patents ap/bn GDP	S&T articles/ bn GDP	Growth rate GDP/ worker	Hi-& med-hi-tech manufactured	Hi-tech exp, % GDP	FDI net infl, GDP	Domestic res trademark reg/ bnGDP	ICT&business model	Paid for daily	Creative goods expo,%	TDLs/ th pop	TDLs/ th pop
Kuwait	n/a	119	33	79	n/a	39	n/a	124	3	n/a	39	89
Turkey	34	46	6	37	69	66	30	59	59	59	37	63
Tunisia	72	36	110	68	34	100	n/a	58	84	18	84	107
Guyana	n/a	125	n/a	n/a	120	n/a	n/a	93	76	85	102	69
Indonesia	80	138	11	33	49	47	n/a	64	83	31	89	109

Uganda	98	62	47	n/a	87	113	n/a	73	123	72	122	120
Senegal	88	61	88	61	94	91	n/a	38	99	77	125	110
Tajikistan	89	120	35	94	n/a	n/a	67	107	n/a	n/a	142	94
Mali	93	74	49	n/a	106	80	n/a	72	126	109	138	140
Nigeria	n/a	114	25	88	117	64	n/a	50	125	112	112	126
Gambia	n/a	34	n/a	56	99	n/a	72	55	129	78	120	100
Cameroon	77	70	77	95	n/a	118	n/a	99	121	n/a	111	103
Guinea	105	130	n/a	n/a	n/a	104	n/a	127	127	n/a	134	134
Bangladesh	106	113	28	n/a	n/a	107	90	98	110	n/a	116	131
Pakistan	97	71	100	43	71	98	87	104	82	37	108	112

Table 9 Innovation Output Indicators

Indicator / Country	Domestic res patent app/bn GDP	S&T Articles per bn GDP	Growth rate of GDP per worker	Hi & Med-hi-tech manufactur %	High-tech exp %	FDI net outflows % GDP	Domes res trade reg per bn GDP	ICT& business model	Paid for daily	Creative goodsexp, %	TDLs per th pop	TDLs per th pop
Kuwait	n/a	3.4	3.5	7.0	n/a	1.7	n/a	42.1	50.6	n/a	14.6	13.2
Turkey	4.0	20.9	5.8	26.5	1.5	0.3	57.4	59.5	9.2	3.7	16.0	27.0
Tunisia	0.8	26.5	-1.1	11.8	6.1	0.0	n/a	59.7	5.4	3.8	2.4	7.5
Guyana	n/a	2.9	n/a	n/a	0.0	n/a	n/a	51.2	6.3	0.3	1.1	23.5
Indonesia	0.5	1.1	5.4	32.0	3.6	0.9	n/a	58.3	5.5	2.5	2.1	5.9
Uganda	0.2	13.4	2.3	n/a	0.6	-0.0	n/a	56.0	0.6	0.4	0.4	2.5
Senegal	0.4	14.0	0.9	15.1	0.3	0.1	n/a	65.3	3.0	0.4	0.3	5.6
Tajikistan	0.4	3.2	3.1	2.4	n/a	n/a	20.1	47.0	n/a	n/a	0.0	12.1
Mali	0.2	9.8	2.3	n/a	0.2	0.1	n/a	56.0	0.5	0.0	0.0	0.0
Nigeria	n/a	3.9	4.1	3.8	0.0	0.3	n/a	61.6	0.5	0.0	0.7	1.7
Gambia	n/a	27.2	n/a	16.8	0.3	n/a	15.9	60.6	0.4	0.3	0.4	10.4
Cameroon	0.6	11.1	1.4	1.9	n/a	-0.2	n/a	48.9	0.7	n/a	0.7	9.9
Guinea	0.1	2.5	n/a	n/a	n/a	0.0	n/a	38.0	0.5	n/a	0.1	0.3
Bangladesh	0.1	4.1	3.9	n/a	n/a	0.0	1.2	49.7	1.5	n/a	0.5	0.7
Pakistan	0.2	10.8	-0.2	23.7	1.3	0.0	5.1	47.7	5.5	1.9	0.8	4.3

Conclusion

The Global Innovation Index (GII) project was launched in 2007 by the French business school INSEAD and the World Intellectual Property Organization with the goal to find metrics and approaches to better capture the richness of innovation society. The Global Innovation Index (GII) 2013 compared 142 nations using 84 indicators, which were adjusted to population or GDP. Stretching from Indonesia to Morocco and from Uganda to Kazakhstan, the Islamic world encompasses remarkable diversity in political systems, geography, history, language and culture. But science in these nations is weak, with spending on research and development far lower than the global average. To get a more detailed picture of how Islamic countries measure up on science, technology and Innovation, and of what patterns exist within Islamic countries, the Innovation Index Ranking and Innovation input-output indicators of top 15 Islamic countries in Innovation Efficiency Index(a measure calculated as the ratio of the output sub-index over the input sub-index and that shows how innovation inputs are best translated into innovation outputs) were extracted from the Global Innovation Index Report 2013 and an overall picture of innovation indicators for Muslim countries was examined. The 5 out of top 10 countries with the highest Innovation Efficiency Ratios are Islamic countries: Mali (1st), Guinea (3rd), Indonesia (6th), Nigeria (7th), Kuwait (8th). Pakistan was ranked 16th in innovation efficiency ratio. 2 out of 8 countries which have biggest jumps in the Global Innovation Index ranking from 2012 to 2013 are Islamic countries. Uganda ranked 89th in 2013, up 28 position from 117th in 2012 and Indonesia ranked 85th, up 15 position from 100th in 2012. The group of innovation learners includes 18 countries out of which 6 are Islamic countries (Uganda, Malaysia, Jordan, Mali, Senegal and Tajikistan). Although many Islamic countries are among the world's poorest, with almost half being developing countries, their spending is consistently less compared with the national average across a range of income brackets. The exceptions are Tunisia and Turkey, whose spending is comparable to other moderately wealthy nations. The Islamic countries' low investment in science and technology is also reflected in a poor scientific output indicators, including low levels of scientific articles and numbers of researchers. Similarly, the ranking of Islamic countries in most of other innovation input-output indicators is low compared to other countries of the world.

In the rapid changing world, neither the financial capital nor the human power are the only factors to the continuous progress in the economy, the innovation and the knowledge play nowadays major role in the economic growth. In order to achieve such economic development, the investment in innovation and knowledge-based projects should be supported. Besides that, the education and research systems have focus on the applied researchers to improve the quality of investment outcome. The expenditure on education in Pakistan is too far away from the international standards. In Pakistan there is a need for investment in the education system improvements especially in the fields of science and technology and to increase the students enrollment in these fields. Moreover, the graduates from these fields to brain drain problem or because they will be working in fields other than their specialty. In order to minimize such problem, the R&D activities should be promoted in both the public and private sectors.

It is important to have FDI in capital accumulation and introduction of new machinery, the most effective approach for the economy that lead investment in knowledge (know-how) transfer. This would be achieved by more involvement of local researchers and engineers in the development process because the normal storage of the knowledge is the human brain and experience. The main factor in promoting the FDI is the proper policies and incentives structure planned by governments. Establishing business alliances and building cooperation and increased because the technologies are complex nowadays and depend on multidisciplinary knowledge. Through cooperation the R&D and knowledge acquisition costs can be minimized. The universities should seek industry contacts to ensure good job prospects for students, to keep curricula up to date and to obtain research support.

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