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The Knowledge Economy & the Knowledge Assessment Methodology
(The case study of Iran & Some other Countries)

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Abstract

This paper introduces a simple knowledge economy benchmarking tool, the Knowledge Assessment Methodology (KAM), which was designed by the World Bank Institute, to help countries identify problems and opportunities that they may face, and where it may need to focus policy attention or future investments, with respect to making the transition to the knowledge economy. The Knowledge Assessment Methodology based on the four pillars: education, innovation, information and communication technologies, and a conducive economic and institutional environment, which asserts that sustained investments on these pillars, will lead to sustained economic growth. Iran, on realization of the relative global position in terms of the knowledge economy, needs to develop coherent policies that place knowledge at the core of its development strategies, especially about the economic incentive regime and investment on education and innovation.

Keywords: The Knowledge Economy, The Knowledge Assessment Methodology, The Knowledge Index, The Knowledge Economy Index.

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1- Introduction

The World Bank Institute offers a formal definition of a knowledge economy[1] as one that creates, disseminates, and uses knowledge to enhance its growth and development. A knowledge economy uses data as it raw material and transforms it using technology, analysis tools, and human intelligence into useful applications for businesses that lead to economic (productivity) growth. Knowledge can be obtained and trained by experience, familiarity, science or learning. Often knowledge is taken together with innovation, the commercial exploitation of knowledge. Knowledge then is the adding up of abilities (capabilities, creativity and persistency) to recognize and solve problems, by collecting, selecting and interpreting information. The knowledge economy then is the use of knowledge in interactive relations between market actors and others, while producing and using goods and services, from the first idea to final products. This definition does not focus solely on technological renewal as the goal of a knowledge economy, but on productivity and employment growth of firms.

With the sustained use and creation of knowledge at the center of the economic development process, an economy essentially becomes a Knowledge Economy. A Knowledge Economy is one that utilizes knowledge as the key engine of economic growth. It has been found that the successful transition to the Knowledge Economy typically involves elements such as long-term investments in education, expanding innovation capability, modernizing the information infrastructure, and having an economic environment that is conducive to market transactions.

The paper introduces the knowledge economy framework, which holistically encompasses pillars such as education and training, innovation and technological adoption, the information infrastructure, and a conducive economic incentive and institutional regime. The framework asserts that sustained investments in these knowledge economy pillars will lead to the availability of knowledge and its effective use for economic production. This would tend to increase the growth rate of total factor productivity, and consequently result in sustained economic growth.

1- The Knowledge codification has brought in annex1 .

This paper also introduces a simple knowledge economy benchmarking tool, the Knowledge Assessment Methodology (KAM), which was developed by the World Bank Institute. The KAM is a benchmarking tool that is designed to help countries understand their strengths and weaknesses by comparing themselves with neighbors, competitors, or other countries that they may wish to emulate based on the four Knowledge Economy pillars. The knowledge assessment methodology is therefore useful for identifying problems and opportunities that a country may face, and where it may need to focus policy attention or future investments, with respect to making the transition to the knowledge economy.

This paper is organized as follows: Section1 includes literature review. Section 2 presents the 4 pillars of knowledge economy and provides a brief survey of the literature showing the importance of the knowledge economy pillars for economic growth and development. Section 3 introduces the data and the Knowledge Assessment Methodology. In section 4 we analyze the relative global position of Iran comparing to some other countries in terms of the knowledge economy. Section 5 presents the conclusion & policy implications.

2- Literature review

Knowledge has always been understood to contribute to economic growth. From Adam Smith and Karl Marx to Alfred Marshall and Joseph Schumpeter, economic thinkers have highlighted the importance of knowledge -dependent factors- such as skill, the organization of production, the development of technology and innovation- in the growth of productivity and economic development. But in recent times, the importance, scale, scope, and pace of change of knowledge in economic growth appears to have enlarged. Today, much attention is paid to a new global "knowledge economy" where information, skill and know- how is increasingly critical, if not paramount, to corporate, regional, and national economic success (Nonaka &Takeuchi, 1995; Stewart, 1997; Cooke,2002).

World economy has changed from an industrial into a knowledge economy (Drucker, 1993; Toffler, 1981), in which the competitive advantage of organizations is based on the ability to exploit knowledge resources. The increased importance of knowledge as an economic resource

has been reviewed from many perspectives, resulting in slightly different denotations, each usually emphasizing a different but related aspect of the same phenomenon. Some examples of this are the “knowledge society” (Toffler, 1981), “knowhow society” (Sveiby & Lloyd, 1988), “information society” (Giddens, 1994), “information economy” (Shapiro & Varian, 2003), “learning society”, “learning economy” (Harrison & Kessels, 2004), “network society” (Castells, 1996), “intangible economy” (Andriessen, 2004a) and the “creative economy” (Florida, 2002).

The knowledge economy, in which knowledge has become the main factor of competitive advantage, is a new phenomenon. The transition to the knowledge economy is about the increase in scale of knowledge as a production factor. Knowledge is not a new production factor, but the relative importance of knowledge, related to land, labor and capital, has substantially increased during the past few decades (Castells, 1996; Weggeman, 2000).

The central wealth-creating activities will be neither the allocation of capital to productive uses, nor "labor" - the two poles of nineteenth- and twentieth-century economic theory, whether classical, Marxist, Keynesian, or neoclassical. Value is now also created by "productivity" and "innovation", both application of knowledge to work. The economic challenge of the post-capitalist society will therefore be the productivity of knowledge work and the knowledgeable worker (Drucker, 1997).

While land, labor and capital were the main factors of production in the past, knowledge - broadly defined here to include data, information, images, symbols, culture, ideology, and values - is the central resource of the production in now. Intangible assets like information have become the key resources. Information increasingly substitutes for bulk raw of materials, labor, and other resources. Given the appropriate data, information, and/or knowledge, it is possible to reduce all of the other inputs used to create wealth. The right knowledge inputs can reduce labor requirements, cut inventory, save energy, save raw materials, and reduce the time, space, and money needed for production. Knowledge is the ultimate substitute for other resources (Alvin Toffler, 1993).

The new growth area currently and in the coming years, is based upon the manipulation of information on a very small scale, rather than the mass processing of raw materials. The eclipse of natural resources in the information age has been accompanied by an increase in the importance of

mental work and a decrease in the importance of physical labor (Davidson, 1993).

The new economy is dominated by information - generating it, processing it, storing it and transmitting it. It is this information aspect that is the most valuable part of every business. The information economy is much more stable and valuable than the conventional economy (Cohen, 1993).

The formal growth in accounting evidence, historical accounts, and everyday experience all suggest that something extra, such as innovation, invention, technological change, or the discovery of new ideas is needed to understand and explain growth (Paul Romer, 1992).

Whereas Adam Smith's Wealth of Nations depended on specialization and a division of labor within nations, the new wealth of nations depends on information, communication technology, and in-depth knowledge - on a global basis (Cordell 1994).

We do not fully understand how knowledge behaves as a resource. We have not enough experience to formulate a theory and to test it. We can only say so far that we need such a theory. We need an economic theory that puts knowledge into the center of the wealth-producing process. Such a theory alone can explain the present economy. It alone can explain innovation (Drucker, 1993).

The economy of the industrial society is initially and primarily a material economy and then changes gradually to a monetary economy. Keynes' economic theory, for example, reflects this transformation of the economy of the industrial society into an economy reflected to a considerable extent by monetary matters. However, as more recent evidence indicates, the economy that Keynes described, now becomes a (non-monetary) symbolic economy (Nicho Stehr, 1996). Stehr then continues that the change in the structure of the economy and its dynamics are increasingly a reflection of the fact that knowledge becomes the leading dimension in the productive process, that we need to focus on the peculiar nature and function of knowledge in economic relations. Knowledge is a most peculiar entity with properties generally unlike those of commodities. In principle, a consumer or purchaser of knowledge may use it repeatedly at diminishing or even zero cost. Knowledge need not be perishable.

This has never been an easy task, as ideas are not like goods. If one has an idea, and can use it and so can everyone else. In technical language,

goods are rivalries while ideas are not. However, ideas and human capital are also significantly different. Human capital is rivalries, while ideas are not (Paul Romer, 1990).

The increased importance of knowledge as a source of production, had to be followed by a revision of the concept of productivity (Drucker, 1981; 1993).

As the productivity of knowledge will be the determining factor in the knowledge economy, the main responsibility of today's management is to make knowledge productive. Not only the main source of production (knowledge), but also the tools of production (brains) are owned by the employees (Drucker, 1993).

The biggest challenge in the knowledge economy was the productivity of the knowledge worker. Therefore, knowledge-worker productivity to be the biggest of the 21st-century management challenges (Drucker, 1999).

The most valuable assets of a 20th-century company was its production equipment. The most valuable asset of a21st century institution (whether business or non- business) will be its knowledge workers and their productivity. (Drucker, 1999)

When reviewing the literature about knowledge productivity, we see two different interpretations of the concept of knowledge productivity, of which one uses knowledge as a starting point, whereas the other uses productivity as a starting point (Stam, 2007).

The different roles of the knowledge in the growth theories of the Neoclassics and the new theories

According to the neo-classical production function, returns diminish as more capital is added to the economy, an effect which may be offset, however, by the flow of new technology. Although technological progress is considered an engine of growth, there is no definition or explanation of technological processes. In new growth theory, knowledge can raise the returns on investment, which can in turn contribute to the accumulation of knowledge. It does this by stimulating more efficient methods of production organization as well as new and improved products and services. There is thus the possibility of sustained increases in investment which can lead to continuous rise in a country's growth rate. Knowledge can also spill over

from one firm or industry to another, with new ideas used repeatedly at little extra cost. Such spillovers can ease the constraints placed on growth by scarcity of capital.

Technological change raises the relative marginal productivity of capital through education and training of the labor force, investments in research and development and the creation of new managerial structures and work organization. Analytical work on long-term economic growth shows that in the 20th century the factor of production growing most rapidly has been human capital, but there are no signs that this has reduced the rate of return an investment in education and training. Investments in knowledge and capabilities are characterized by increasing (rather than decreasing) returns. These findings argue for modification of neo-classical equilibrium models – which were designed to deal with the production, exchange and use of commodities – in order to analyze the production, exchange and use of knowledge.

Incorporating knowledge into standard economic production function is not an easy task, as this factor defies some fundamental economic principles, such as that of scarcity. Knowledge and information tend to be abundant; what is scarce is the capacity to use them in meaningful ways. Nor is knowledge easily transformed into the object of standard economic transactions. To buy knowledge and information is difficult because by definition information about the characteristics of what is sold is asymmetrically distributed between the seller and the buyer. Some kinds of knowledge can be easily reproduced and distributed at low cost to a broad set of users, which tends to undermine private ownership. Other kinds of knowledge cannot be transferred from one organization to another or between individuals without establishing intricate linkages in terms of network and apprenticeship relationships or investing substantial resources in the codification and transformation into information (OECD,1996).

The four pillars of Knowledge Economy

The application of knowledge is one of the key sources of growth in the global economy. But many developing countries fail to tap the vast stock of global knowledge and apply it to their needs. They need not deny themselves this vital tool for growth. By building on their strengths and carefully planning appropriate investments in human capital, effective institutions,

relevant communications technologies, and innovative and competitive enterprises, developing countries can capitalize on the knowledge revolution. With the sustained use and creation of knowledge at the center of the economic development process, an economy essentially becomes a Knowledge Economy. It is an economy where knowledge is acquired, created, disseminated and used effectively to enhance economic development. The successful transition to the Knowledge Economy typically involves elements such as long-term investments in education, expanding innovation capability, modernizing the information infrastructure, and having an economic environment that is conducive to market transactions. The Knowledge Economy framework asserts that investments in the four knowledge economy pillars are necessary for sustained creation, adoption, adaptation and use of knowledge in domestic economic production, which will consequently result in higher value added goods and services. This would tend to increase the probability of economic success, and hence economic development, in the current highly competitive and globalized world economy.

The four pillars of the Knowledge Economy framework are:

- **An economic incentive and institutional regime**

The economic and institutional regime of an economy stimulate creativity and incentives for the efficient creation, dissemination, and use of existing knowledge, and provides good economic policies and institutions that permit efficient mobilization and allocation of resources. A "knowledge-conducive" economic regime should be open to international trade and be free from various protectionist policies in order to foster competition, which in turn will encourage entrepreneurship(Sachs and Warner, 1995; and Bosworth and Collins,2003). Government expenditures and budget deficits should be sustainable, and inflation should be stable and low(Barro,1991). Domestic prices should also be largely free from controls and the exchange rate should be stable and reflect the true value of the currency. The financial system should be one that is able to allocate resources to sound investment opportunities and redeploy assets from failed enterprises to more promising ones (Levine, Loayza, & Beck, 2000).

Intellectually property rights should be protected and strongly enforced. If intellectual property rights are not adequately protected and enforced, then

researchers/scientists will have less incentive to create new technological knowledge and even in the event that knowledge is created, the lack of intellectual property rights protection will greatly hamper dissemination of such new knowledge (Knack & Keefer 1995; and Kaufmann, 2002, 2003).

- **Educated and skilled workers**

The global knowledge economy is placing new demands on labour, who need more skills and knowledge to be able to function in their lifelong. These demands requires a new model of education and training. Lifelong learning improve people's ability to function as members of their communities, education and training increase social cohesion, reduce crime, and improve income distribution. A lifelong learning encompasses formal learning (schools, training institutions, universities), non formal learning (on-the-job and household training), and informal learning (skills learned from family members or people in the community). It allows people to access learning opportunities as they need them rather than because they have reached a certain age (TechKnowLogia org.2003).

Most empirical studies have focused on the role of human capital in economic development (Mankiw, 1992; Benhabib & Spiegel,1994; Hall & Jones,1999). Barro (1991), using cross-section data for 98 countries for the period 1960 to 1985, found that both school enrollment rates had statistically significant positive effects on growth of per capita real GDP. Cohen and Soto (2001), using cross-country time-series data on educational attainment or average years of school, find statistically significant positive effects of education on economic growth. Hanushek and Kimko (2000), using international test scores as a proxy for the quality of educational systems, find that educational quality does exert positive effects on economic growth. Jorgenson & Stiroh (2000) point out that high-skilled workers are likely complementary to ICT, while low-skilled workers are substitutable. Higher-skilled workers are more likely to be hired than low-skilled workers (The World Bank, 2006).

- **An effective innovation system**

An innovation system of firms, research centers, universities, consultants, and other organizations that influence the way by which a country acquires,

creates, disseminates and uses knowledge is the one which provides an environment that nurtures research and development (R&D), which results in new goods, new processes, new knowledge, and hence is a major source of technical progress.

There are many studies that show innovation has substantial positive effects on economic growth or productivity growth. Lederman and Maloney (2003), using regressions with data panels of five-year averages between 1975 to 2000 over 53 countries, find that a one-percentage point increase in the ratio of total R&D expenditure to GDP increases the growth rate of GDP by 0.78 percentage points. Guellec and van Pottelsberghe (2001) investigated the long-term effects of various types of R&D on multifactor productivity growth using panel data for the OECD over the period 1980-98. They find that business, public and foreign R&D all have statistically significant positive effects on productivity growth. Adams (1990), using the number count of academic scientific papers of various scientific fields to proxy for the stock of knowledge, finds that technical knowledge contributed significantly to the total factor productivity growth of U.S. manufacturing industries for the period 1953-1980. M.Squicciarini–T.Loikkanen (2008) believe that four main elements have important roles to sustain inovation: businesses, governments, academia and the labour market:

Businesses, by investing in research, provide private capital that helps creating new and innovative products and services. Businesses also develop new business models that allow regions to thrive in the global economy. Innovation can also be improved through the development of innovation clusters that would enable small and medium sized companies to be more productive and innovative than they could be in isolation.

Governments must have robust systems for recognizing and protecting patents and intellectual property. Besides, increasing the interaction between business, government and academia can strengthen innovation by sharing ideas, knowledge and expertise and improve the commercialization of research. Governments should provide R&D fiscal incentives and coordinate R&D Funding to focus on key sectors that are sources of competitive advantage in the region considered.

Universities are incubators for entrepreneurs. This must be enhanced even further to support faculty and students interested in taking ideas to the marketplace and to help produce graduates who can lead this type of activity.

Academia tends to reward people comparatively more for their academic achievements and tends to ignore those achievements that have a commercial impact.

As innovation obviously depends on good ideas and talented people, the

Labor market should be structured in such a way as to encourage and support life-long learning. The supply of a deep and wide talent pool is critical to success. The labor market certainly plays a fundamental role in ensuring opportunities for talent growth.

• A modern and adequate information infrastructure

The impact of ICTs on the economic growth can be observed by looking at the multifactor productivity factor (MPF) measurement. The productivity growth by ICTs is usually through two main channels: First, greater investment in ICT, which boosts labour productivity growth by raising the stock of capital available to each worker, and secondly, rapid productivity growth occurring in the production of ICT goods. Irene Bertschek, Fryges, & Kaiser (2004) found that MPF coefficients In OECD countries, higher in economies and more specifically in sectors with higher investments in ICTs. A series of studies show that both ICT production and ICT usage have contributed to economic growth(Pilat and Lee, 2001; Jorgenson and Stiroh ,2000; Oliner and Sichel ,2000; Whelan ,2000; and Schreyer ,2000) .Various studies have produced empirical evidence suggesting that substantial productivity gains have been experienced from ICT usage(Oliner and Sichel ,2000; and Jorgenson and Stiroh, 2000; Whelan,2000).

ICT usage can facilitate the effective communication, dissemination, and processing of information and knowledge. ICTs allow information to be transmitted relatively inexpensively and efficiently. ICT usage tends to reduce uncertainty and transactions costs of participating in economic transactions. This tends to lead to an increase in the volume of transactions leading to a higher level of output and productivity. ICTs allow the reduction of hierarchical structures within firms and greater empowerment and

capabilities for work teams and individual workers. ICTs also allow more lean and timely inventory management.Moreover, with the increased flow of information, technologies can be acquired and adapted more easily again leading to increased innovation and productivity. Sheng, Nah, & Siau, (2005) categorize these benefits from ICTs to productivity as tangible and intangible. The tangible benefits include: Reduced cost , Improved productivity (i.e., amount of output produced per unit of input), Increased market share, Savings in labor , Increased consumer surplus (i.e., the accumulated difference between consumer demand and market price), Improved customer service quality, Improved organizational efficiency, Quicker response to customers, Deeper knowledge and understanding of customers.

The intangible benefits include: Improved decision-making ability,Superior product quality, Knowledge/information management and sharing, Improved coordination/relationships with partners, Other forms of competitive advantages.

In some developing countries is a considerable time lag before ICT benefits growth and productivity. The lag represents the time it takes organisations to assimilate and adjust to new technology. Also, ICTs enablers are crucial for technology to work. For example, quality of country's business environment, as well as its attention to specific ICT enablers significantly affect its ability to harness full benefit of technology. Chandra (2007) argue that the ICTs enablers include appropriate education, skills training, research and development (R&D), access to venture capital, affordability of Internet access, security of Internet infrastructure, government support for ICT development, and quality of ICT supporting services. Thus, for ICTs to effectively enhance labor productivity, nations ought to not only invest in ICT infrastructure but also in ICT enablers if benefits from ICT are to translate into higher human resource productivity on sustainable basis.

3- The Data and the Knowledge Assessment Methodology

The Knowledge Assessment Methodology (KAM) is a benchmarking tool that is designed to facilitate the transition to becoming a knowledge economy،and to help countries understand their strengths and weaknesses by

comparing themselves with neighbors, competitors, or other countries that they may wish to emulate based on the four Knowledge Economy pillars. The knowledge assessment methodology is therefore useful for identifying problems and opportunities that a country may face, and where it may need to focus policy attention or future investments, with respect to making the transition to the knowledge economy.

Comparisons in the knowledge assessment methodology are made on the four knowledge economy pillars. Because of the variables that are contained in the knowledge assessment methodology span over different ranges of values, all variables are normalized from 0 (weakest) to 10 (strongest).

The Knowledge Assessment Methodology and normalization procedure is as follows:

1- The raw data (u) is collected from World Bank datasets (KAM 2009)

2- The 0-10 scale describes the performance of each country on each variable, relatively to the performance of the rest of the country sample. 10 is the top score for the top performers and 0 the worst for the laggards. The top 10% of performers gets a normalized score between 9 and 10 the second best 10% gets allocated normalized scores between 8 and 9 and so on.

3- The following formula is used to normalize the scores for every country relation to the total number of countries in the sample (Nc) For each specific country, the number of countries that ranks lower or below it (Nw) is calculated:

$$\text{Normalized (u)} = 10\ \left(\frac{Nw}{Nc}\right)$$

4- We choose six countries to compare with Iran. Some of them such as Turkey and Pakistan with Iran are in ECO group (regional group). Nigeria and Iran are members of OPEC. Japan has trade relative with Iran. Malaysia has cultural similarities with Iran. Singapore as an Asia country, one of the

best performance in terms of the knowledge economy, among the world countries.

5- The Knowledge Economy Index (KEI) is an aggregate index that is calculated based on the average of the normalized performance scores of a country on all 4 pillars related to the knowledge economy - economic incentive and institutional regime, education and human resources, the innovation system and ICT. For the purposes of calculating KEI, each pillar is represented by three key variables: **The Economic Incentive and Institutional Regime include:** Tariff & Nontariff Barriers; Regulatory Quality; Rule of Law. **Education and Human Resources include:** Adult Literacy Rate; Secondary Enrollment Tertiary Enrollment. **The Innovation System include:** Royalty and License Fees Payments and Receipts; Patent Applications Granted by the US Patent and Trademark Office; Scientific and Technical Journal Article. **Information and Communication Technology (ICT) include:** Telephones per 1,000 people; Computers per 1,000 people; Internet Users per 10,000 people.

6-The comparisons among seven countries on the knowledge economy Indexs are presented in Table 1 that show similarities and differences across countries.

Variable	Japan		Singapore		Malaysia		Turkey		Iran, Islamic Rep		Pakistan		Nigeria	
	actual	normalized	actual	normalized	actual	normalized	actual	normalized	actual	normalized	actual	normalized	actual	normalized
Annual GDP Growth (%)	2	1.1	7.2	8	6	6.69	6.6	7.38	6.2	7.22	6.60	7.38	7.60	8.34
Human Development Index	0.95	9.51	0.922	8.32	0.811	6.15	0.775	5.03	0.759	3.89	0.55	2.17	0.47	0.98
Tariff & Nontariff Barriers	82	6.71	90	9.93	78.2	4.83	86.6	9.3	57.4	2.22	65.60	1.68	61.80	0.98
Regulatory Quality	1.05	8.08	1.87	9.79	0.53	6.64	0.23	5.82	-1.61	0.56	-0.56	2.26	-0.89	1.37
Rule of Law	1.39	8.63	1.79	9.32	0.53	6.85	0	5.82	-0.84	1.11	-0.93	1.78	-1.20	0.62
Royalty Payments and receipts (US$/pop)	312.33	9.24	2.544.63	9.92	46.38	7.31	4.96	4.79	n/a	n/a	0.89	2.44	0.32	1.85
S&E Journal Articles / Mil. People	434.36	8.54	846.34	9.58	23.96	5.14	108.46	7.43	38.14	4.44	3.17	2.85	2.58	2.29
Patents Granted by USPTO / Mil. People	284.08	9.86	104.28	9.25	4.32	8.01	0.31	5.27	0.02	2.78	0.02	3.36	0.01	2.74
Adult Literacy Rate (% age 15 and above)	100	10	94.43	5.62	91.9	4.73	88.73	3.77	84.71	5	54.89	0.75	72.01	1.92
Gross Secondary Enrollment rate	101.41	8.33	63.18	2.71	69.07	3.13	78.64	3.75	72.65	2.78	32.54	1.32	32.44	1.18
Gross Tertiary Enrollment rate	58.06	7.68	55.9	7.54	30.24	4.78	36.3	5.87	31.39	6.47	5.12	1.45	10.15	2.39
Total Telephones per 1000 People	1.240.00	6.58	1.700.00	9.25	1.040.00	5.62	1.090.00	6.03	760	3.89	420.00	2.95	280.00	2.12
Computers per 1000 People	410	8.24	740	9.51	230	7.32	60	4.15	110	6.47	n/a	n/a	10.00	1.69
Internet Users per 1000 People	690	9.18	660	8.9	560	8.49	160	4.59	320	6.67	110.00	3.84	70.00	2.88

SOURCE: The Knowledge Assessment Methodology (KAM 2009) website (www.worldbank.org/kam).

The performance of Iran on the four knowledge economy pillars, relatively to the performance of the rest of the countries in sample

We use the spider charts to compare among countries. Figure 1 illustrates the basic scorecard spider chart with Iran as an example.

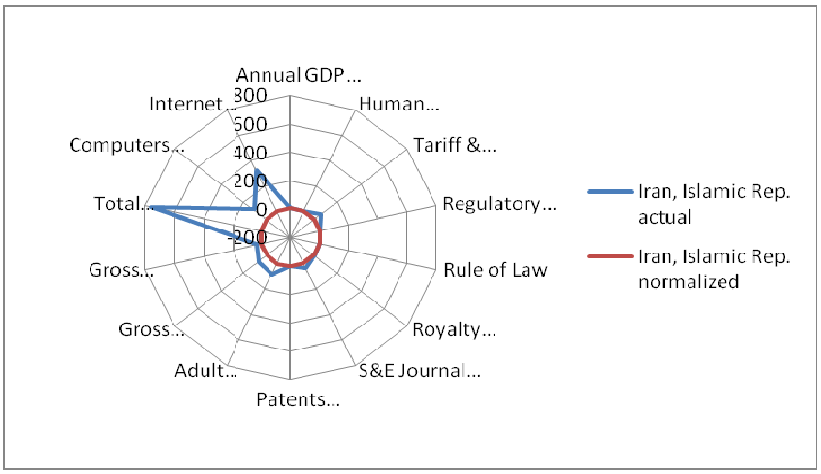

Figure 1: The Basic Scorecard (Spider Chart) –Iran

Source: The results of this study

It can be seen, the position of Iran in terms of the knowledge economy, is very weekend in many of the knowledge indicators. For example, it is very weekend in terms of regulatory quality with a normalized value of 0.56, which implies that Iran ranks in the 5th percentile in terms of regulatory quality. Iran also is very weekend in rule of law with a normalized value of 1.11. On the other hand, it is relatively strong in terms of computers and internet users per 1000 people with a normalized value of 6.47 and 6.67, implying that it ranks only in the 65th percentile. The ICT pillar is probably the strongest pillar for Iran, with rankings above the 56th percentile in all three ICT indicators. In terms of changes over time, Iran has made improvements in ICT pillar but has lost some ground for the Economic Incentive Regime and Education and Human Resources pillars.

Table 2 and Figure 2 present the Knowledge Assessment Methodology basic scorecard for Iran and some other countries to comparing them. Here only aggregate performance in each of the four Knowledge Economy pillars

is shown. The value for each pillar is constructed as the simple average of the normalized values of the 3 knowledge indicators that proxy for each pillar in the basic scorecard.

Table 2: T KEI Indexes (seven countries)

Countries	Economic Incentive Regime	Innovation	education	ICT
Japan	7.81	9.22	8.67	8
Singapore	9.68	9.58	5.29	9.22
Malaysia	6.11	6.82	4.21	7.14
Turkey	6.98	5.83	4.46	4.92
Iran, Islamic Rep.	0.99	4.56	3.8	5.65
Pakistan	1.91	2.88	1.17	3.39
Nigeria	0.99	2.29	1.83	2.23

SOURCE: The Knowledge Assessment Methodology (KAM 2009) website (www.worldbank.org/kam

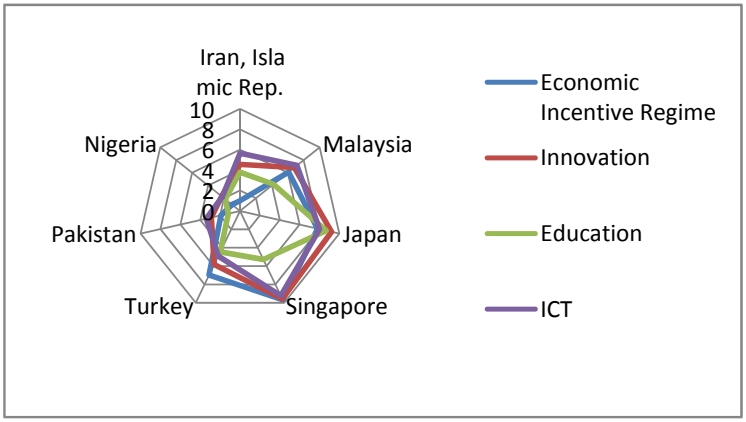

Figure 2: KEI Indexes (KAM 2009) (Spider Chart) – seven countries

Source: The results of this study

As it can be seen, Singapore's performance in terms of the knowledge economy is very strong, with all of pillars, except Education, ranking well above the 90th percentile. Singapore's strongest pillar is the Economic Incentive Regime pillar with its performance ranking above the 96th percentile, while its weakest is the Education with a ranking around the 52th percentile. It also can be said that Singapore has made significant progress towards the knowledge economy since 1995, especially in terms of the Economic Incentive Regime, Innovation and ICT pillars. Nigeria's performance in terms of the knowledge economy is very weekend, with all of pillars, ranking worse below the 22th percentile.

Another mode of the Knowledge Assessment Methodology enables the basic scorecards of up to three countries to be plotted on one chart. Figures 3 to 9 illustrate this mode using the most recent data. We use the spider charts to illustrate the Knowledge Assessment Methodology basic scorecard to compare among countries, Japan, Malaysia and Iran as example.

As can be seen, Japan is the most developed in terms of the knowledge economy among the countries, with all of its knowledge indicators being ranked in the 80th percentile or higher, except for those in the economic incentive regime pillar. Malaysia comes in next with its indicators coming in between the 40th and 80th percentiles. The ICT pillar appears to be Malaysia's strong point with all of the indicators being in the 71th percentile. Iran is the weakest in terms of the knowledge economy, with all of its indicators ranking below the 56th percentile.

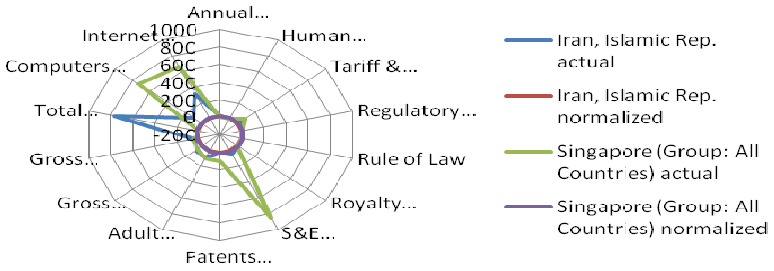

Figure 3: The Basic Scorecard (Spider Chart) –Iran & Singapore

Source: The results of this study

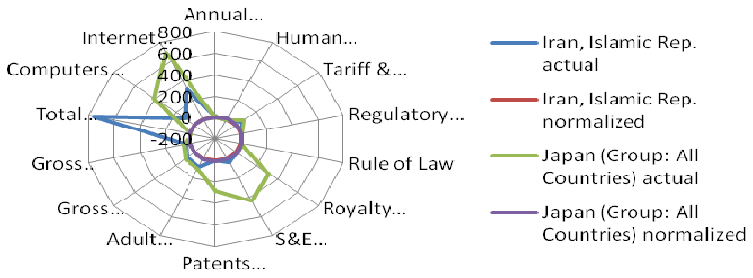

Figure 4: The Basic Scorecard (Spider Chart) –Iran & Japan

Source: The results of this study

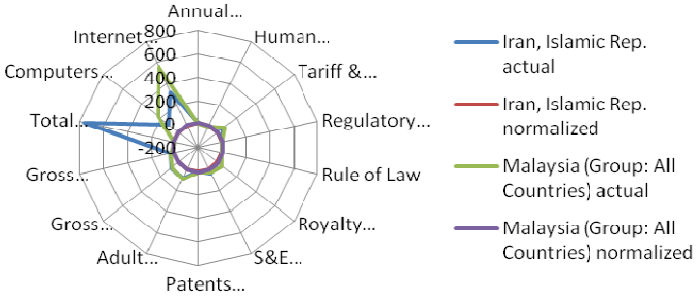

Figure 5: The Basic Scorecard (Spider Chart) –Iran & Malaysia

Source: The results of this study

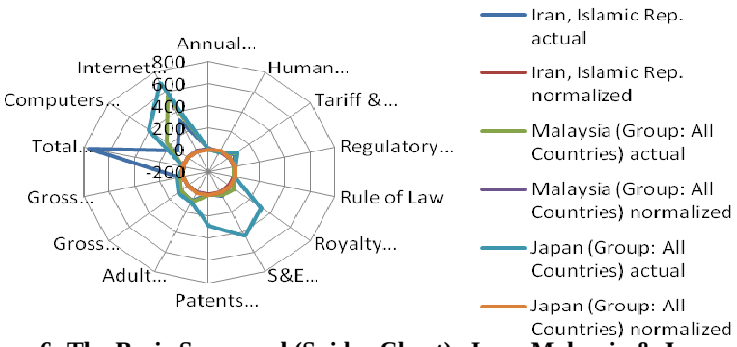

Figure 6: The Basic Scorecard (Spider Chart) –Iran, Malaysia & Japan

Source: The results of this study

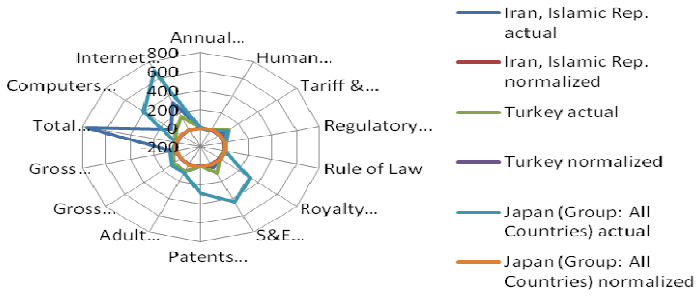

Figure 7: The Basic Scorecard (Spider Chart) – Iran, Turkey & Japan

Source: The results of this study

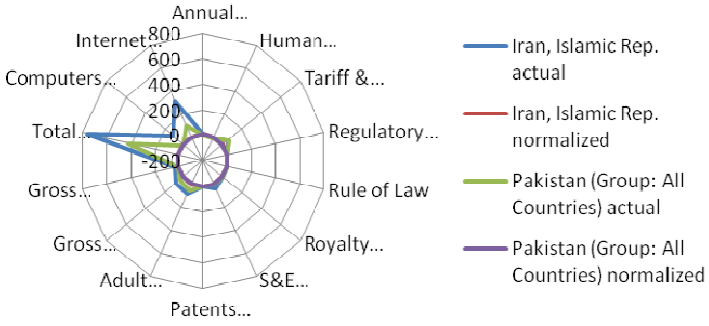

Figure 8: The Basic Scorecard (Spider Chart) –Iran & Pakistan

Source: The results of this study

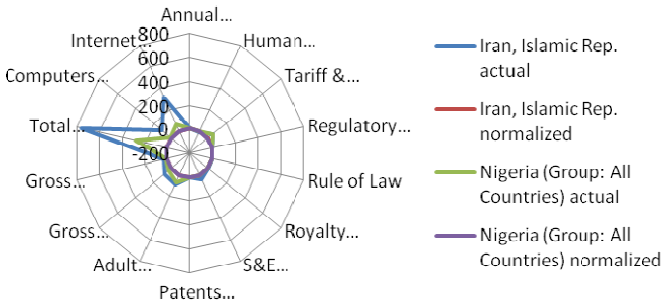

Figure 9: The Basic Scorecard (Spider Chart) –Iran & Nigeria

Source: The results of this study

4- Conclusion

This paper presents the concept of the knowledge economy, an economy where knowledge is the main engine of economic growth. The paper also introduces the knowledge economy framework, which asserts that sustained investments in education, innovation, information and communication technologies, and a conducive economic and institutional environment will lead to increases in the use and creation of knowledge in economic production, and consequently result in sustained economic growth. The Knowledge Assessment Methodology was designed by World Bank, to provide a basic assessment of countries' readiness for the knowledge economy, and identifies sectors or specific areas where policy makers may need to focus more attention for future investments. The Basic Scorecard mode allows me to compare up to two or three countries in terms of all 4 pillars of the knowledge economy.

The comparisons are presented in spider charts that highlight similarities and differences across countries. Table 2 and Figure 2 illustrate that Singapore's performance in terms of the knowledge economy is the best among countries, with all of pillars except education, ranking well above the 90th percentile, and Nigeria's performance is the worst, with all of pillars, ranking below the 22th percentile. Table 2 and Figure 1 present the development of Iran in terms of the knowledge economy using the basic

scorecard plotted with the spider chart. As it can be seen, Iran performance in terms of the knowledge economy is relatively week, with all of pillars except ICT, ranking worse below the 45th percentile. Iran's strongest pillar is the ICT pillar with its performance ranking the 56th percentile, while its weakest pillar is the Economic Incentive Regime with a ranking around the 9th percentile. It also can be said that Iran has not made progress towards the knowledge economy since 1995 (Table3 & Figure10).

Table3: KEI and KI Indexes -Iran

	Iran, Islamic Rep.(most recent)	Iran, Islamic Rep. (1995)
1. Knowledge Economy Index (Average of 3,4,5,6)	3.75	3.78
2. Knowledge Index (Average of 4,5,6)	4.67	4.59
3. Economic Incentive and Institutional Regime	0.99	1.35
4. Education	3.80	4.51
5. Innovation	4.56	2.86
6. ICT	5.65	6.41

SOURCE: The Knowledge Assessment Methodology (KAM 2009) website (www.worldbank.org/kam)

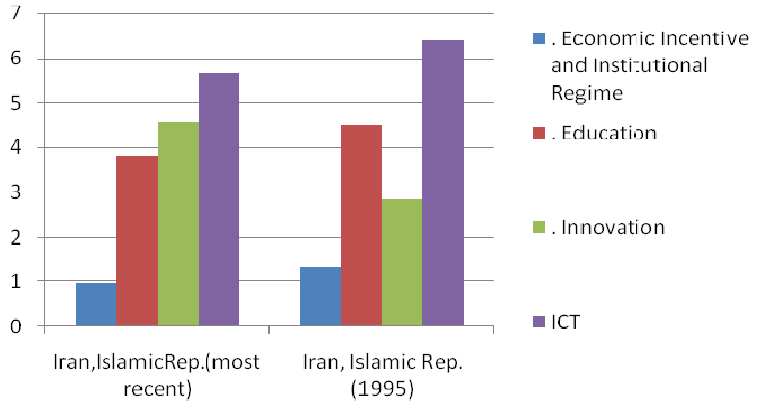

Figure10: KEI Indexes -Iran

Source: The results of this study

5- Policy implications

Iran, on realization of the relative global position in terms of the knowledge economy, needs to develop coherent policies that place knowledge at the core of its development strategies as follow:

Although Iran has successfully embarked on ICT Infrastructure as an integral part of its development goals, implementation still remains a major challenge. Concerted efforts are still required to enable Iran to build efficient innovation systems, through investment in R&D, education and ICT infrastructure. Investments in capacity building and science and technology(S&T), particularly in strong innovation systems and in R&D, are necessary in a competitive environment. These investments are inevitably based on a long-term vision for the development of a country.

Human resource development is the main factor for economic prosperity and it is important that priority is accorded to investing in human capacity development. Educated and skilled human resources form human capital, that is, the skills embodied in workers. These become the most valuable assets and a central pillar in development and growth. A well-trained workforce is essential to the efficient acquisition, utilization, creation and dissemination of the relevant knowledge and skills that tend to increase productivity and economic growth.

For the knowledge economy in Iran to be successful, strengthening alliances for investment in training (formal, informal, vocational, lifelong learning, etc.) and human resource development are essential in the building of societies that are increasingly knowledge-based. The private sector is now recognized as the primary global force in S&T research and development. Funding is needed to encourage public-private partnerships and promote joint research. It is recognized that the core of research ability will be developed in higher education institutions such as universities. Thus, it is crucial for government to achieve quality S&T higher education and appropriate training mechanisms.

Developing an innovation-driven economy is crucial for competitiveness. A key concept linking innovation and technology with growth and development is productivity. Transformation in the capabilities of business enterprises is the key to achieving innovation and consequent productivity and performance gains. Technological change is one of the major forces resulting in improved productivity and growth of income per capita. It

implies enhanced productive capabilities, which can potentially be used to fulfill a variety of human needs and realize social goals in the context of economic development. Innovation in products, processes and organizational structures is a major source of growth and is a result of numerous interactions by a community of actors and institutions.

It is also well recognized that information and knowledge economies are characterized by targeted investment in R&D. Higher levels of R&D are correlated with higher levels of economic performance and thus, the importance of R&D cannot be overlooked as economies become more knowledge-based. Countries that have taken the lead are reaping the benefits of R&D potential and accelerated innovation and taking advantage of emerging global markets.

Iran's weakest pillar is the economic and institutional regime pillar, with all of indicators such as reduction in tariff and non tariff barriers performance, regulatory quality and rule of law. Therefore Iran needs to sustained economic and institutional regime pillar that provides incentives for the efficient use of existing knowledge, creation of new knowledge and the flourishing of entrepreneurship.

Intellectual Property Rights (IPR) regimes affect the diffusion of scientific knowledge, the innovation process and ultimately, economic performance. Patents play an increasingly important role in business strategies and the commercialization of technology. Thus, it is important for government to sustained IPR regimes.

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Annex 1

Knowledge codification

It can be made distinctions between different kinds of knowledge which are important in the knowledge economy: know-what, know-why, knowhow and know-who. Knowledge is a much broader concept than information, which is generally the know-what" and "know-why" components of knowledge. These are also the types of knowledge which come closest to being market commodities or economic resources to be fitted into economic production functions. Other types of knowledge – particularly know-how and know- who – are more tacit knowledge and are more difficult to codify and measure (Lundvall and Johnson, 1994).

In some complex areas, experts **Know-what** refers to knowledge about facts. must have a lot of this kind of knowledge in order to fulfill their jobs. Practitioners of law and medicine belong to this category.

Know-why refers to scientific knowledge of the principles and laws of nature. This kind of knowledge underlies technological development and product and process advances in most industries. The production and reproduction of know-why is often organized in specialized organizations, such as research laboratories and universities.

Know-how refers to skills or the capability to do something. Businessmen judging market prospects for a new product or a personnel manager selecting and training staff have to use their know-how. The same is true for the skilled worker operating complicated machine tools.

Know-who involves information about who knows what and who knows how to do what. It involves the formation of special social relationships which make it possible to get access to experts and use their knowledge efficiently. It is significant in economies where skills are widely dispersed because of a highly. Developed division of labor among organizations and experts

Learning to master the four kinds of knowledge takes place through different channels. While know-what and know-why can be obtained through reading books, attending lectures and accessing databases, the other two kinds of knowledge are rooted primarily in practical experience. One reason why firms engage in basic research is to acquire access to networks of academic experts crucial for their innovative capability. Know-who is socially embedded knowledge which cannot easily be transferred through formal channels of information.