CHAPTER TWO

THEORETICAL FRAMEWORK

2.1 Knowledge: Definition:

The new industrial revolution 'the knowledge revolution' characterized by the technological change. Knowledge is the engine of the social, economic and cultural development in today's world. It is key source of growth in the global economy. Entrepreneurship and innovation, research and development, software and product design, and how people use their education and skills, are factors of Knowledge. Technology and knowledge are the key factors of production.

The major goal of this chapter is to give an overall theoretical explanation for the terms knowledge and knowledge economy and the different methodologies to measure knowledge and to assess the countries' readiness to be knowledge-based economies.

Knowledge can be defined as:

1. "Facts, information, and skills acquired through experience or education; the theoretical or practical understanding of a subject" (Oxford Dictionary)
2. "Knowledge is a familiarity with someone or something, which can include facts, information, descriptions, or skills acquired through experience or education. It can refer to the theoretical or practical understanding of a subject. It can be implicit (as with practical skill or expertise) or explicit (as with the theoretical understanding of a subject);

it can be more or less formal or systematic. Knowledge acquisition involves complex cognitive processes: perception, communication, association and reasoning; while knowledge is also said to be related to the capacity of *acknowledgment* in human beings. (Wikipedia, the free encyclopedia)

3. Knowledge in an economic context can be thought of as a type of instruction or recipe that sets out how a good or service can be produced. Innovation, on the other hand, is "the successful development and application of new knowledge" (OECD, 2005).

2.2 Knowledge and Islam:

Knowledge accompanied Man since the time when Allah created Adam, the father of mankind and taught him all the names (i.e. all sorts of knowledge he needed). However, when Adam and Eve forgot, ate from the forbidden tree and were sent down to earth, they forgot most of the things they learnt and had to try with their children and grandchildren to rediscover things as they go along and as the need requires.

The importance and priority of knowledge, learning comes before acting and praying. Islam came with the first order to man to read. Allah says:

أقرأ باسم ربك الذى خلق " خلق الانسان من علق " أقرأ وربك الأكرم " الذى علم بالقلم " علم الانسان مالم يعلم" سورة الفلق

"Read in the Name of your God, Who created, created Man from a clot. Read and your God is Most Generous, Who taught by the pen, taught man what he did not know" (Q96:1-5)

A number of other Qur'an verses were revealed later, to emphasize the importance of knowledge and to strike a contrast between knowledge and ignorance and between those who know and those who do not know.

The Hadith literature is full of references to the importance of knowledge. Such sayings of the Prophet as "Seek knowledge even in China", "Seek knowledge from the cradle to the grave", and "Verily the men of knowledge are the inheritors of the prophets", have echoed throughout the history and literature of Islam.

2.3 Knowledge and the Economy:

The founders of Economics: Adam Smith, Ricardo, Malthus, Marx and Mill. Smith had in 1776 observed that the most fundamental aspect of the division of labor is the division of knowledge:

1. "Smith applies the division of labor to the growth of knowledge, pointing to the role of those specialized philosophers and men of speculation, whose trade is not to do anything, but to observe everything; and who upon that account are often capable of combining together the powers of the most distant and dissimilar objects" (Ramlogan and Metcalfe 2005, pp.658).
2. In the early nineteenth century Hegel had argued that the spirit (geist) of each age is integral to its social organization and in particular to the political constitution of each state (Ramlogan and Metcalfe 2005, pp.658).
3. In mid-nineteenth century Marx argued that the spirit of the current age is capital, which is embodied in particular in the mode of production, and (contra those who see Marx as an economic determinist) that ideologies both shape and are shaped by the latter (Ramlogan and Metcalfe 2005, pp.658).

4. But the emergence of micro economics in the late nineteenth century, with its assumption that the knowledge of market conditions is always perfect, dampened the interest in subjectivity, and meant that it was within sociology that the investigation of knowledge was taken forward.
5. The work of Max Weber, Karl Mannheim and Talcott Parsons have been particularly important to the development of the sociology of knowledge as a sub-discipline, although this was only really formalized as such with the writings of Schűtz, Berger and Luckman, Goffman and Garfinkel during the 1960s.
6. It was not until the 1980s that economics, building upon the work of Schumpeter and Hayek, Solow, Swan and Arrow began gradually to incorporate knowledge into its equilibrium models, a process that was advanced especially in the writings of Romer and Lucas.
7. Before the emergence of a knowledge-based economy, the economic exchange of knowledge was first developed and stabilized as distinct from the exchange of commodities within the context of the market economy. For example, the patent system can be considered as a typical product of industrial competition in the late nineteenth century (Van den Belt and Rip, 1987).
8. The production and control of organized knowledge has existed as a sub-dynamic of the socio-economic system in advanced capitalist societies since approximately 1870 (Braverman, 1974; Noble, 1977).

2.4 The Key Characteristics of Knowledge:

The economies have developed from an agricultural economy in which land is the key resource, then to an industrial economy in which natural resources

and labour are the main resources, and now to a knowledge-based economy (KBE) in which knowledge is the key resource.

Knowledge is a strange good, with remarkable properties that differ from those characterizing conventional tangible goods. The key characteristics of knowledge are:

1. ***Non-rivalry*** which means that one person's use of an idea does not preclude another person using it at the same time. A good is non-rivalrous when it's undiminished by consumption. . As Jones (2004) puts it: "Once the design of the latest computer chip has been invented, it can be applied in one factory or two factories or ten factories. The design does not have to be reinvented every time a new computer chip gets produced." Instead of the term "non-rivalry", some authors prefer "infinite expansibility" (David, 1993; Keely & Quah, 1998).
2. ***Fixed and marginal costs:*** Coming up with a good new idea typically costs resources (often significant resources) but subsequent uses of the idea are possible at zero marginal cost, since it can be simultaneously used by many people or firms. We can say that the new piece of knowledge has an initial high fixed cost but zero marginal costs with respect to repeated uses of the idea. *But still Transmission* of the idea is not costless. For example, think of a design for a computer chip, which is transmitted via a blueprint. Additional copies of the blueprint might be required, and these have a cost.
3. ***Non-excludability*:** once a good has been created, it is impossible to prevent other people from gaining access to it (or more realistically, is extremely costly to do so). It is continuum, with the degree of excludability varying depending on a range of factors:

i. the observability of the knowledge (for example, the process for manufacturing a product may be more excludable than the design);
ii. the legal and regulatory environment;
iii. the state of technology; and
iv. The characteristics of both imitators and knowledge creators.

4. ***Knowledge is a cumulative and progressive good:*** Existing knowledge is the prime factor in the production of new knowledge and new ideas. Jefferson, a particularly insightful thinker, wrote: "The fact is, that one new idea leads to another, that to a third, and so on through a course of time until someone, with whom no one of these ideas was original, combines all together, and produces what is justly called an new invention" (quoted by David, 1993).

2.5 Knowledge Measurement:

Efforts to measure knowledge have been undertaken at one of two levels:

A. ***At The Individual Firm Level;*** arises out of business initiatives to manage knowledge and measure intangible assets. These efforts are operationalized at *the micro* or individual firm level and use a combination of accounting and nonfinancial indicators to measure stocks of intellectual or knowledge capital and flows of changes in knowledge stocks (OECD, 2002). The knowledge capacity of firms is proxied by means of instruments like balanced scorecards, intangible assets monitor, intellectual capital accounts, and stylized models of knowledge spillovers. (Sveiby, 1997; Lev, 2001; Boudreau, 2002). In addition to knowledge stocks and flows, knowledge enablers are measured as a way of identifying practices with the potential to change or maintain

knowledge stocks and flows. These may include leadership, strategy, organizational partnerships, or talent. (Kermally, 2002).

B. *At the national systems level:* Economic models capture the generation of ideas and their association with wealth in the production function. Conceptually, the generic production function relates total product to labor, capital, and other inputs that combine to produce it. The deficiency of the basic Cobb-Douglas function in handling new innovations and endogenous technical change has since resulted in many refinements, dating back to the seminal work of Robert Solow (1957) and Moses Abramowitz (1956).

2.6 Economic Researches on Knowledge:

Economic researches on knowledge come in various forms:

1. There has been much research into the importance of human capital to economic growth (Barro, 1991; Hanushek and Kimko, 2000; Cohen and Soto, 2006) in the sense of education or achieved skills.
2. Some research has also been conducted on innovations and R&D that lead to new technologies, ultimately resulting in increases in output per capita (Adams, 1990; Lederman and Maloney, 2003).
3. Other research (Lee and Pilat, 2001; Stiroh, 2002) has focused on the effects of Information and Communication Technologies (ICT) on economic growth.
4. The application of knowledge in areas such as entrepreneurship and innovation, R&D, software and product design, and in people's education and skill levels, is now being recognized as one of the key sources of growth in the global economy (Chen and Dahlman, 2005).

2.7 Knowledge Economy and Knowledge-Based Economy: *Definitions*:

Knowledge economy according to Oxford Dictionary is defined as: "An economy in which growth is dependent on the quantity, quality, and accessibility of the information available, rather than on the means of production". Or in short: the economic systems rely on knowledge.

OECD also defined Knowledge economy as "the economies which are directly based on the production, distribution and use of knowledge and information" (OECD, 1996: 3).

The knowledge economy and knowledge based economy are defined differently in the literature; in knowledge economy knowledge is a product while in knowledge based economy knowledge is a tool.

Knowledge-based economy exit when knowledge can do more than increase economic growth; when there is an economic transition due to a structural change in an economy and therefore society when there is a profound change in the way we live and work.

Knowledge based economies are defined according to OCED (2002) : as: advanced economies heading towards greater dependence on knowledge, information and high skill levels, and the increasing need for ready access to all these by the business and public sectors.

2.8 Historical Development of Knowledge Economy:

The initial foundation for the Knowledge Economy was first introduced in 1966 in the book *The Effective Executive* by Peter Drucker. In this book, Drucker described the difference between the manual worker and the knowledge worker. The manual worker, according to him, works with his hands and produces goods or services. In contrast, a knowledge worker) works with his or her mind not hands, and produces ideas, knowledge, and information.

Smith (2002) claimed that to define an adequate theory of knowledge economy, it is necessary for economists to carefully examine the question of what knowledge in the knowledge economy is. On the practical side, although many international economic organizations such as OECD, World Bank, and APEC have provided practical directions to build the knowledge economy in developed and developing countries (WB, 1999; OECD, 2001; APEC, 2001), no viable action framework to develop the knowledge economy exists. This paper aims to address both of the above problems of the knowledge economy.

The knowledge economy is also seen as the latest stage of development in global economic restructuring. Thus far, the developed world has transitioned from an agricultural economy (pre-Industrial Age, largely the agrarian sector) to industrial economy (with the Industrial Age, largely the manufacturing sector) to post-industrial/mass production economy (mid-1900s, largely the service sector) to knowledge economy (late 1900s – 2000s, largely the technology/human capital sector). This latest stage has been marked by the upheavals in technological innovations and the globally

competitive need for innovation with new products and processes that develop from the research community (i.e., R&D factors, universities, labs, educational institutes).

A large number of studies and research papers were published in the last 20-25 years on the role and importance of knowledge, education and information technology in economics or what is known as: "Knowledge Economy". This was as a result of the huge developments in the fields of information technology and communications by the end of the 20th and beginning of the 21st centuries.

New economic keywords appeared such as: Electronic Economy; Electronic trade or E-Trade; Electronic Government; Knowledge Value-Added; Information Society and Knowledge Economy. These keywords emphasize the role and importance of information technology and human resource development.

2.9 Driving Forces of Knowledge Based Economy:

There are two driving forces of knowledge based economy:

1. ***Globalization:*** markets and products are more global.
2. ***Information technology,*** which is related to next three:

- Information/Knowledge Intensity: efficient production relies on information and know-how; over 70 per cent of workers in developed economies are information workers, most factory workers use their minds more than their hands.

- New Media : New media increases the production and distribution of knowledge which in turn, results in collective intelligence. Existing knowledge becomes much easier to access as a result of network data-bases which promote online interaction between users and producers.
- Computer networking and Connectivity: developments such as the Internet bring the "global village" ever nearer. As a result, goods and services can be developed, bought, sold, and in many cases even delivered over electronic networks. It can remain dormant or make a commercial breakthrough.

2.10 Kinds of Knowledge in Knowledge-Based Economy:

1. ***Codified Knowledge:*** Codification of knowledge refers to a process whereby knowledge is transformed into information through a process of reduction and conversion. It consists of:
   a. "*Know-what*" a type of codified refers to knowledge about "*facts*". Examples: How many people live in Khartoum? What are the ingredients in pancakes? And when was the battle of Waterloo? What is the temperature of water at boiling point? What is the capital city of Sudan?
   b. "*Know-why*" refers to scientific knowledge of the principles and laws of nature. For example, Newton's Law of Gravity explains (to a very high degree of accuracy) the nature of the observed orbits of the planets around the sun.
2. ***Tacit knowledge*** describes types of knowledge which tend to remain embodied within an individual or implicit within a knowledge network and which are more difficult to identify and measure. Includes types of knowledge – particularly know-how and know-who – "*tacit knowledge*"

is more difficult to codify and measure (Lundvall and Johnson, 1994). Consists of:

a. 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-how is typically a kind of knowledge developed and kept within the border of an individual firm. One of the most important reasons for the formation of industrial networks is the need for firms to be able to share and combine elements of know-how.

b. 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 labour among organizations and experts. 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. Know-who is learned in social practice and sometimes in specialized educational environments.

2.11 The Scope of the Literature on the Knowledge Economy:

The scope of the literature on the knowledge economy can be broadly placed into three categories (Powell & Snellman, 2004) (Brint, 2001):

1. The first focuses on the development of science-based industries and how they facilitate social and economic change. Machlup (1962) used

information-centered industries as the central theme of his work. In this approach, researchers studied the role of knowledge as a factor in facilitating production (Basalla, 1988; Lane, 1966; Machlup, 1962; Porat, 1977; Gotzfried, 2004).

2. Research in the second approach resides within the realm of urban economics and the degrees of knowledge intensity (Brint, 2001). They involve the application of theoretical concepts from the first approach to practical implications. Research in this vein focuses on industries that make particular use of scientific and professional knowledge (Brint, 2001). Studies related to the semi-conductor industry, as well as analyses to anticipate and create new market opportunities, develop products ahead of the competition, and to reconfigure production processes rapidly in response to changing production requirements, determine the sustainability of these firms and industries (Angel, 1994).
3. The third approach in the knowledge economy focuses on the role of learning and continuous innovation and the less tangible aspects of human capital such as learning and adaptability (Drucker, 1993; Drucker, 2004). The concentration is to study the social conditions that facilitate or impede knowledge creation and transference (Cowan, David, & Foray, 2000).

Table 2.1 maps the reviewed theories of knowledge economy to the above three views. The accuracy of the allocation is just relative, because there are many theories that can be located in more than one view. However, this figure provides a good overview of the literature on the knowledge economy, according to their assumptions of what knowledge is. This assumption is suggested the most important one to assess the degree of persuasiveness of a theory of knowledge economy (Smith, 2002).

Table 2.1: Theories of Knowledge Economy

Views of Knowledge Economy	**Theories of Knowledge Economy**	
Knowledge as Asset	New Growth Theory	Technology Gap, Knowledge Gap Theory
Knowledge as Capability	Evolutionary Theory of Economic Change	National Innovation System Theory
Knowledge as Relation	Triple Helix Theory of Knowledge Economy	

Source: the researcher based on the above discussion

2.12 Comparison between Traditional Economy and Knowledge Economy:

There are five main differences between traditional economy and knowledge economy; these differences are presented in Table 2.2

Table 2.2 A Comparison Between Traditional Economy and Knowledge Economy:

Traditional Economy	***Knowledge Economy***
The economics is about scarcity *(Resources become depleted when used)*	The economics is about abundance *(Resources grow through application and sharing (*information and knowledge*)*
The effect of geographical displacement is large.	The effect of geographical displacement is diminished. Using appropriate

	technology and methods, virtual marketplaces and virtual organizations can be created, that offer benefits of speed and agility, round the clock operation and of global reach.
Laws, barriers and taxes can be applied solely on a national basis	Laws, barriers and taxes are difficult to apply on solely a national basis. Knowledge and information 'leak' to where demand is highest and the barriers are lowest.
Quality of the products (features) is very important	Knowledge enhanced products or services can command price premiums over comparable products with low embedded knowledge or knowledge intensity.
Prices are determined by market forces or government interventions	Pricing and value depends heavily on context. Thus the same information or knowledge can have vastly different value to different people at different times

Source: the researcher

2.13 Knowledge Economy and Sustainable Economic Growth:

In the context of growing knowledge-based economies there is the recognition that country's growth needs to be centered around and driven by knowledge. This recognition of knowledge as a critical element of economic

growth is not new; the issue is long acknowledged as a factor behind the economic success of the developed world (OECD, 1996). The dynamics embedded in knowledge-based economies have been articulated by studies such as Romer and Gross (1994), with propositions that are now leading to new growth theories to explain the forces behind long-term economic growth.

2.14 Knowledge Economy and Territory Education:

In a knowledge economy, tertiary education can help economies keep up or catch up with more technologically advanced societies. Higher education graduates are likely to be more aware of and better able to use technologies. They are also more likely to develop new tools and skills themselves. Their knowledge can also improve skills and understanding of non graduate co-workers, while the greater confidence and know-how inculcated by advanced schooling may generate entrepreneurship, with positive effects on job creation.

2.15 Knowledge Economy and Labourforce:

In the knowledge economy, the specialized labor force is characterized as computer literate and well-trained in handling data, developing algorithms and simulated models, and innovating on processes and systems. Harvard Business School Professor, Michael Porter (2002) asserts that today's economy is far more dynamic and that comparative advantage is less relevant than competitive advantage which rests on "making more productive use of inputs, which requires continual innovation." Consequently, the technical, STEM careers including computer scientists, engineers, chemists, biologists, mathematicians, and scientific inventors will see continuous demand in years to come. Additionally, well-situated

clusters, which Michael Porter argues is vital in global economies, connect locally with linked industries, manufacturers, and other entities that are related by skills, technologies, and other common inputs. Hence, knowledge is the catalyst and connective tissue in modern economies.

2.16 Knowledge Economy :Next Evolutionary Step:

It has been suggested that the next evolutionary step after knowledge economy is the network economy, where the relatively localized knowledge is now being shared among and across various networks for the benefit of the network members as a whole, to gain economies of scale in a wider, more open scale.

2.17 The Indicators of the Knowledge Economy:

The Knowledge Economy indicators are classified into four main drivers, two main outputs, and a number of horizontal indicators of globalization:

- the first indicators on the drivers and characteristics of a Knowledge Economy are further divided into four main sub-groups:
  a. Production and diffusion of ICTs
  b. Human resources, skills and creativity
  c. Knowledge production and diffusion; this group includes many of the traditional indicators of R&D and knowledge production. They provide us with sound trend data and with indicators to develop composite measures of globalization and competitiveness.
  d. Innovation, entrepreneurship and creative destructions. They cover firm behavior and aspects of innovation including demand for innovative products, financing and market innovation. The share of

the population in specific age cohorts can provide insights into the demand for innovative products

- The output indicators, from economic outputs to measures of social performance:
  a. Economic output: such as GDP, value added and employment that can be used to develop indicators of economic outputs including income measures, productivity measures and employment trends.
  b. Social performance: policy issues in the KBE that can be used to develop composite indicators on the environment and sustainable growth, economic welfare and quality of life.
- The horizontal indicators related to globalization. These indicators include measures of economic and work life in the KBE. There are indicators of trade, knowledge production and diffusion, economic structure (change) and human resources (especially international flows of HR) emerging in and/or driving the KBE.

Table 2.3: Proxy Indicators of Knowledge Based Economy.

Proxy Indicator	**Aspect Measured by Indicator**
Knowledge Creation	
Percentage of GDP spent on R&D	Intensity of R&D conducted in the economy
Researchers per capita	Availability of human resources needed for R&D
patents per capita	Overall quality of the national innovation system by the scientific output it creates
Knowledge Acquisition	
Percentage of total imports that goes to technology balance of payments	Intellectual content embedded in imports from other countries
Number of head and regional offices in Sudan	Amount of firm-specific knowledge brought in by regional firms
Size of the knowledge intensive	Provides intermediate products and services to firms,

business services sector	thereby perpetuating innovative practices and services from global sources
Knowledge Dissemination	
Info-communication technology (ICT) spending as a percentage of GDP	Intensity of resources put into developing information infrastructure
Internet access cost as a percentage of per capita GDP	Affordability of ICT services, which will determine the usage of a country's ICT network
Percentage of workforce with at least secondary school education	Basic IT and linguistic skills to tap onto ICT network
Knowledge Application	
Percentage of workforce with university education	Ability of workforce to seek out, process and use relevant information
Percentage of "knowledge workers" in workforce	Jobs that demand and allow workers to apply knowledge extensively
World Competitiveness Yearbook rating of entrepreneurship	Ability of the economy to create new business models for generating, acquiring, diffusing and applying new ideas and processes

Source: *Leydesdorff & Scharnhorst, 2003*

2.18 Measuring Knowledge Economy:

2.18.1 World Bank Institute's Knowledge for Development:

(K4D): Program has developed the *Knowledge Assessment Methodology* (KAM) in 1999 with the object of measuring and analyzing the knowledge economy. This methodology is based on the supposition that the knowledge economy comprises four pillars: Economic Incentive and Institutional Regime, Education and Human Resources, Innovation System and Information and Communication Technology (World Bank Institute, 2007). KAM is based on 83 structural and qualitative variables that serve as proxies for the four knowledge economy pillars (see Table 2.4). There are two

frequently used modes of the KAM: The Basic Scorecard and Knowledge-based Economy Index.

Table 2.4: World Bank Knowledge Economy Indicators (Basic Scorecards):

1. Performance
1.1 Average annual GDP growth (%)
1.2 Human Development Index
2. Economic Incentive and Institutional Regime
2.1 Tariff and non-tariff barriers
2.2 Regulatory Quality
2.3 Rule of Law
3. Education and Human Resources
3.1 Adult Literacy rate (%age 15 and above)
3.2 Secondary Enrolment
3.3 Tertiary Enrolment
4. Innovation System
4.1 Researchers in R-D, per million populations
4.2 Patent Applications granted by the USPTO, per million populations
4.3 Scientific and technical journal articles, per million populations
5. Information Infrastructure
5.1 Telephones per 1000 persons, (telephone mainlines + mobile phones)
5.2 Computers per 1000 persons
5.3 Internet Users per 10000 persons

***Source**: World Bank Database, the Knowledge Assessment Methodology (KAM),*

2.18.2 Organization for Economic Co-operation and Developmen:t

(OECD): The concept of knowledge-based economy was firstly used in a document written for the meeting of the Committee on Science and Technology Policy in 1995. This paper discussed two themes: new growth theory and innovation performance in the framework of knowledge-based economy (OECD, 1995). In 1996, after defining the knowledge economy as "economies which are directly based on the production, distribution and use of knowledge and information", it was suggested that improved indicators for the KBE are needed for the following tasks (OECD, 1996); Measuring knowledge inputs, Measuring knowledge stocks and flows, Measuring knowledge outputs, Measuring knowledge networks, Measuring knowledge and learning.

Industry and Technology Scoreboard of Indicators are published by OECD every 2 year and includes a series of economic and science and technology indicators. OECD STI Scoreboard consists of 76 indicators under the 5 sub-titles: R&D and Innovation, Human Resources in Science and Technology, Patents, ICT, Knowledge Flows and the Global Enterprise, and The Impact of Knowledge on Productive (see Table 2.5)

Table 2.5: OECD Knowledge Economy Indicators

1. Knowledge-Based Economy
1.1 Knowledge Investment (education, R&D and software) as % of GDP
1.2 Education of the adult population as % of the population aged 25-64
1.3 R&D expenditure as a percentage of GDP
1.4 Basic research expenditure as a percentage of GDP
1.5 Expenditure of Business R&D in domestic product of industry

1.6 Expenditure of Business R&D in manufacturing
1.7 Share of services in R&D expenditure
1.8 Expenditure on innovation as a share of total sales
1.9 Investment in venture capital as a percentage of GDP
2. Information and Communication Technology
2.1 ICT spending as % of GDP
2.2 PC penetration in households
2.3 Number of internet host per 1000 inhabitants
2.4 Percentage share of ICT industries in GDP
2.5 Share of ICT in patents granted by USPTO
3. Science and Technology Policies
3.1 Publicly funded R&D as % of GDP
3.2 Government R&D expenditure on health-defense-environment
3.3 Government R&D expenditure in total R&D expenditure
3.4 Business R&D expenditure in total R&D expenditure
3.5 Share of Government-Business R&D expenditure financed together
3.6 Tax subsidies rate for R&D
4. Globalization
4.1 Share of foreign affiliates in R&D
4.2 Share of foreign and domestic ownership in total inventions
4.3 Number of international technological alliances
4.4 Percentage of scientific publications with a foreign co-author
4.5 Percentage of patents with a foreign co-investor

5. Output and Impact
5.1 Scientific publications per 100 000 population
5.2 Share of countries in total EPO patent application
5.3 Share of firm creating any innovative output
5.4 GDP per employed person
5.5 Share of knowledge-based industries in total value added
5.6 Share medium-high technology industries in manufacturing export
5.7 Technology balance of payments as a percentage of GDP

Source: *OECD, (1999), the Knowledge-Based Economy: A Set of Facts and Figures.*

2.18.3 European Innovation Scoreboard developed by the European Commission. It includes a set of indicators which together give an assessment of Europe's innovation performance. European Innovation Scoreboard indicators are distributed among five categories under two sub-titles such as Innovation Input and Innovation Outputs. Dimensions under Innovation Output consist of Innovation Drivers), Knowledge Creation, and Entrepreneurship) while Innovation Inputs covers two dimensions like Application) and Intellectual Property Rights. This Scoreboard issues for a cross- country comparison of the innovation indicators to help identify national strength of member countries rather than determining the indicators of knowledge-based economy exactly. European Innovation Scoreboard has been published every year since 2001. Besides this scoreboard European Union publish Global Innovation Scoreboard in order to give possibility to member's country for compare their innovation capabilities with other countries in the world. Global Innovation Scoreboard includes only 12 indicators as summary version of European Innovation Scoreboard. See (Table 2.6).

Table 2.6: European Union Knowledge Economy Indicators (European Innovation Scoreboard)

1. Innovation Drivers (5)
1.1 New S&E graduates per 1000 population aged 20-29
1.2 Population with tertiary education per 100 population aged 25-64
1.3 Number of broadband lines per 100 population
1.4 Participation in life-long learning per 100 population aged 25-64
1.5 Percentage population age 20-24 completed secondary education
2. Knowledge Creation (5)
2.1 Public R&D expenditures (% of GDP)
2.2 Business R&D expenditures (% of GDP)
2.3 Share of medium high-tech and high-tech R&D
2.4 Share of enterprises receiving public funding for innovation
2.5 Share of University R&D expenditures financed by business sector
3. Innovation and Entrepreneurship (6)
3.1 SMEs innovating in-house (% of SME)
3.2 Innovative SMEs co-operating with others (% of SMEs)
3.2 Innovative expenditures (% of turnover)
3.4 Early-stage venture capital (% of GDP)
3.5 ICT expenditure (% of GDP)
3.6 SMEs using non-technological change (% of SMEs)
4. Application (5)
4.1 Employment in high-tech services (% of total workforce)
4.2 Exports of high technology products as share of total exports
4.3 Sales of new-to-market products (% of turnover)

4.4 Sales of new-to-firm not new-to-market products (% of turnover)
4.5 Employment in medium-high tech manufacturing (% of total)
5. Intellectual Property (5)
5.1 New European Patent Office patents per million
5.2 New United States Patent and Trademark Office per million
5.3 New Triad patents per million population
5.4 New community trademarks per million population
5.5 New community industrial designs per million population

***Source**: European Innovation Scoreboard, 2010, European Commission*

2.18.4 Asia Pacific Economic Cooperation (APEC). The aim of the Project was to provide the analytical basis useful for promoting the effective use of knowledge, and the creation and dissemination of knowledge among APEC economies. APEC KBE framework consists of 26 indicators under the four dimensions: Pervasive innovation and technological change, Pervasive human resource development efficient infrastructure and a business environment (see Table 2.7).

Table 2.7: APEC Knowledge Economy Indicators:

1. Business Environment
1.1 Knowledge based Industries as % of GDP
1.2 Services Exports as of GDP
1.3 High-Tech Exports as of GDP
1.4 Foreign Direct Investment inward flow as % of GDP
1.5 Government transparency rating by World Competitiveness Yearbook
1.6 Financial transparency rating by World Competitiveness Yearbook
1.7 Competition policy rating by World Competitiveness Yearbook
1.8 Openness rating by World Competitiveness Yearbook

2. ICT Infrastructure
2.1 Number of mobile telephones in use per 1000 inhabitants
2.2 Number of telephone mainlines in use per 1000 inhabitants
2.3 Number of computers per 1000 inhabitants
2.4 Number of internet users as % of population
2.5 Internet hosts per 10000
2.6 Expected e-commerce Revenues, M$US
3. Innovation System
3.1 Scientists Engineers in R&D per million of the population
3.2 Full-time researchers per million of the population
3.3 Gross Expenditure on R&D (% of GDP)
3.4 Business Expenditure on R&D (% of GDP)
3.5 US Patents per annum
3.6 The number of technological cooperation among companies
3.7 The number of technological cooperation between company-university
4. Human Resource Development
4.1 Secondary enrolment (% of age group)
4.2 Natural Sciences Graduates per annum
4.3 Knowledge Workers (% of labor force)
4.4 Newspaper (per 1000 inhabitants)
4.5 Human Development Index

Source: *APEC, (2000),*

2.19 Limits of Knowledge Economy:

Knowledge economy does not lead necessarily or automatically to sustainable development just by acquiring latest information and communication technologies.

This is because, unlike traditional technology, new information and communication technologies get abandoned as soon as new technologies are discovered. It enters not only in the production of goods but in all fields of knowledge especially education.

Thus, investing in information technology might help in the development of human resources and in integrating the economy in worlds markets but only if it is seen as a complementary policy to other policies. This means that the economic policy which understands the role of knowledge should not restrict itself to transfer of latest information technology but depends before that on the change of basic structures especially in the investment in human resources and organized innovation.

2.20 Dangers of Knowledge Economy:

Knowledge economy activities may lead to undesirable results if not undertaken within a framework of religious or legal values. For example Bahauddin (2003) points out to a new triangle of terror: genetic engineering, nanotechnology and robotics. He argued these are considerable means of progress and development, but at the same time, they may constitute tools and weapons of mass destruction. As pointed out by Abdul Aziz (2005), the explosion of knowledge and information technology, has affected some peoples and cultures differently. It cost some to lose their identity, and in some cases, moral decay, disintegration of family, rebellion, violence, crime, etc. emerged. Besides, the impact of globalization on people of least developed countries is very dangerous, as it add to the risks faced by the peoples of other advanced effects in all kinds of interference in their affairs and control over its decisions away from the truth and justice.

2.21 Sustainable Development:

Sustainable development has been defined as being "development that meets the needs of the present without compromising our ability to meet the needs of the future" [*Our Common Future* 1987*)*. In response to the challenge of sustainable development in a rapidly changing world – characterized by the lack of resources – will require deep structural changes in economics, society and resource management.

2.21.1 The Knowledge-based Economy and Sustainable Development:

The knowledge-based economy provides significant opportunities for sustainable development. Effective application of knowledge has the potential to enable new products to be developed in an environmentally sound manner. As well, knowledge can be applied to ensure that other inputs, such as energy and resources, are used in ways that minimize negative environmental impacts. Knowledge-based industries can free up natural resources and contribute to sustainable development. In addition, increased use of knowledge in resource-based industries can raise productivity of these industries, leading to conservation of natural resources for use by future generations and to an improved environment.

Many of the sectors which have been experiencing rapid growth in both output and employment are knowledge-intensive. The majority of these sectors, (as information and environmental technologies, aerospace, pharmaceuticals, and education) offer important enabling effects that can contribute to sustainable development. Satellite technology produced in the

aerospace sector, for example, promotes our understanding of the natural environment by tracking and collecting information on environmental degradation. Information technology can then be used to process and analyze the data, while environmental technologies can be applied to the source of the problem.

2.21.2 Building a Sustainable knowledge Economy:

A sustainable economy is one that gives its people - both now and in the future - a high quality of life as measured by objectives such as secure and improving incomes, job opportunities, social and political stability, education, health and a clean environment. It promotes human welfare through the integration of economic, environmental and social objectives and the balanced consideration of the needs of present and future generations. *But to build a sustainable knowledge economy the following factors must be fulfilled:*

a. **Marketplace climate** - A healthy marketplace climate is one which is stable, predictable, efficient, fair and responsive. A marketplace that creates information and makes it widely available is crucial to building a knowledge-based, sustainable economy. Consumers and businesses need continuous improvements in market-related information, such as prices, in order to improve the allocation of resources.
b. **Innovation** - Knowledge- and technology-based innovation is critical to a sustainable economy. Through the development, diffusion and application of new products, services and processes, innovation can lead to improved productivity, enhanced market opportunities, more jobs and reduced stress on the environment.

c. **Trade and investment** - The world's economies are becoming increasingly interdependent, with the liberalization of trade and investment a key force driving global economic development**.**

In this chapter, we have reviewed the literature of knowledge economy, we have found that modern economies – whether called the knowledge economy, the information society, the digital era, the learning economy, the intangible economy, or the network economy, do not differ qualitatively from earlier economic systems, but they do differ in terms of intensity. Perhaps the deepening of the importance of learning, knowledge, and creativity – combined with ICT and globalization, has produced a fundamentally different type of world.