Digital Communication and Knowledge Society

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Abstract - Knowledge is awareness at higher level of abstraction [5, 6, 7]. It has tacit and explicit components. Concern lies in conversion of tacit knowledge to explicit form and its scientific management since it is identified presently as an economic entity without diminishing return. Advancement in knowledge exercise contributes immensely towards socio-economic development of a community. This induces to explore ways to generate new scientific knowledge with evolving technologies. Communication is one approach of many alternatives to evolve new scientific knowledge through inter and intra entity data & information exchange. Data communication using digital technology in recent years has attained ubiquitous dimension and its affect on knowledge generation has grown enormously [3, 19], resulting in need for enhanced attention. Present text is an attempt in similar stratum.

Index Terms - Information Society, Knowledge, KAM-Knowledge Assessment Methodology, K4D-Knowledge For Development, KI-Knowledge Index, Knowledge Society, ICT-Information Communication Technology, IDI -ICT Development Index, Hyper Text, HTTP, TCP/IP.

1. INTRODUCTION

Civilization has surfed through agrarian, semi-industrialization, industrialization and advanced industrialization phases and arrived at information age where power has shifted from industrial to information and knowledge production and management leading to 'Information Society' concept wherein creation, distribution, and manipulation of information and knowledge has become the most significant economic and cultural activity [6,7].

Ahmad, Mazida [02] el al conveys, Nonaka and Takeuchi opines analyzing data from top Japanese industries that knowledge creation involves the processes of interaction and transaction of tacit and explicit knowledge between experts and novices that employ the processes of Socialization, Externalization, Combination, and Internalization (SECI).

There are different interpretations of knowledge. To have knowledge one needs to add value to data or information. This brings in the role of management in the entire process. As knowledge is awareness at higher level of abstraction, to acquire it institutionally collective business goal is to be on focus, which in turn calls for a mechanism to facilitate intra and inter entity fluent flow of data communication [6, 7, 8].

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The knowledge abstraction as depicted in figure1 is a process of awakening. The efficiency, with which it is attained, in terms of content and speed, varies amongst entities. In the figure, arrowed lines indicate flow of communication. Digital communication has become an important mode of knowledge exchange today. Comparatively, more knowledgeable institution or entity needs relatively lesser time and effort to traverse across information hierarchy, as depicted below in Fig-1 [6]. This requires skills for detailing, consolidation and communication. The speed and accuracy, with which an individual or an institution consolidates details to evolve knowledge, or traverse in reverse order from consolidation to detailing, reflects on its intelligence. The involved processes herein are both tangible and intangible in form.

Knowledge has both tacit and explicit components to deal with, making its management very fiddly. Exchange of thoughts, views and opinions through affective communication has always enhanced knowledge. The process of knowledge abstraction and its ramification at times is intangible and varies amongst entities or institutions. This makes tacit knowledge component bit inconceivable and its conversion to explicit form a challenge [4, 6].

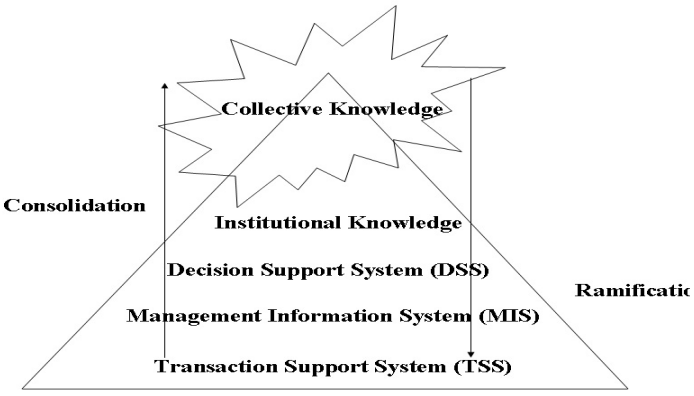

Figure1: "Institutional Intelligence System"

To avoid knowledge loss or distortion its tacit part needs to be communicated widely for better storage and editing on cognitive space through discourse, debates, discussion, and deliberation. Alternatively, its conversion to explicit form, in black and white or digital structure and communication over wide domain offers opportunity for future editing, up-gradation, retrieval and reuse. One may use either of the two techniques or both, in tandem. From time immemoriall, tools are being searched, used and improved upon to make it happen. Today ICT, amongst other available tools, with its power, agility and ubiquity provides one of the best options.

The issues on hand are to process data, information and knowledge and then share it on fast track. ICT works as a catalyst in this process, which has gone through evolution involving first, second, third, fourth and fifth generations of computing [1, 3]. This has made knowledge-generating practices to arrive on web1 to web2 and then on to web3 platform from standalone mode [21]. Exchange of thoughts and views over Internet worked as guiding force, framing public opinion in recent years, leading to notable changes in the social and socio-economic system. Recent upheaval in Middle East countries can be considered as case in point. Facebook, Twitter, Wiki etc are the platforms on Internet and World Wide Web where views and opinions are exchanged, edited and given shape by stake holders to evolve a collective perspective [26].
Discussions and deliberations on digital social network like ReseachGate are immensely popular amongst serious thinkers with strong research orientation. On ResearchGate, with over million members onboard and publications, covering various subjects from 'Mathematics' to 'Literature', knowledge gets generateds reviewed and updated online. This makes instant conversion of tacit knowledge to its explicit form possible. However, to be able to use these platforms effectively one needs to possess necessary ICT tools like a computer system and means to hook it on to a strong digital network [12].

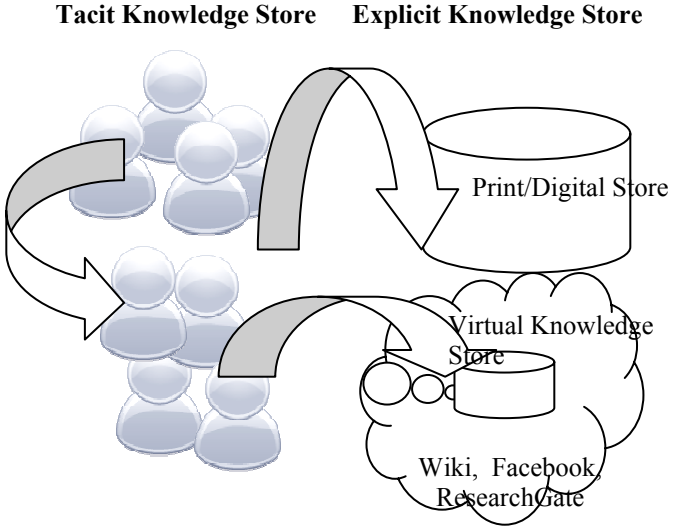

Figure2

2. KNOWLEDGE OBJECT WITH ICT AS AN ENABLER

From an abstract entity "Knowledge" in this era has evolved as an object with material and economic value, a fact recognized by international institutions. World Bank derived Knowledge and Knowledge Economic Index (KI & KEI) of counties considering 83 factors affecting their respective socio-economic conditions and ranked them according to the order during 2008 and 2009 [11]. According to these reports ICT is increasingly affecting socio-economic and cultural exercises leading to advanced knowledge.
IBM and Economic Intelligence Unit (EIU) are regularly publishing data on ICT preparedness of countries in the world and related ranking since year 2001 to 2009 [10].
In the year 2010, in keeping with changing scenario, it published digital economy raking of member countries [10, 15]. Recent report of International Telecommunication Union (ITU) [16, 17] of 2010 and 2011 on measuring information society concedes the role of ICT in enhancing socio-economic growth. It observes that if applied appropriately, ICT can be development enabler, critical to countries attempting to transform itself as a knowledge society.
Evolving computing and communicating techniques have affected Human-Computer relationship at various stages, which opened new avenues for knowledge generation. In the following section these aspects are briefly touched upon.

3. COMPUTING

The first generation computers of 1940-56 era used vacuum tubes for circuitry and magnetic drum for memory. Programming was done using machine language. Transistors replaced vacuum tubes in second-generation computers during 1956-63. For programming, Assembly Language was used on such computers. High-level languages like FORTRAN and COBOL were developed during this time to make usages easier. Miniaturized transistors, called semiconductors, which were placed on silicon chips ushered era of third generation computers during 1964-71. Use of semiconductors helped in radical enhancement of computing speed. Forth generation computers came into existence from 1971 with the arrival of microprocessors and are still in use, which also brought in GUI features, mouse and handheld devices [24]. Evolvement of various technical standards of computing enabled collaboration between technologies, pushing the growth faster. Fifth generation computers involving quantum computing and nanotechnology are in course of evolution. These efforts stepped up speed, efficiency and volume of information processing and at the same time elevated the quality of the process involved in information dispensation [19, 24].

4. COMMUNICATING

Evolution of Internet started in the 1950s and 1960s along with the development of computers. Initially this was to facilitate point-to-point communication between mainframe computers and their access points or nodes or terminals. Later it expanded to aid connections between computers leading to early research into packet switching. During 1970 Donald Davies developed a packet switched network called Mark I to support NPL (National Physical Laboratory). This was later, improved to Mark II in 1973 and it remained in operation till 1983. 'Larry Roberts' of 'Advanced Research Project Agency' in the United States took ahead the technology to ARPANET, which later evolved to INTERNET. In 1982 Internet Protocol Suite TCP/IP was standardized and concept of World Wide Network over TCP/IP came into existence. Berners Lee evolved world

information medium during 1990. He built all necessary tools for working on web, like Hyper Text Transfer Protocol (HTTP), Hyper Text Mark-up Language (HTML) and the first web browser (World Wide Web). At this instance during 1980-1990 commercial Internet Service Providers (ISPs) emerged [22, 23].

Efforts on standardization of computing and communicating practices increasingly become momentous from this occasion allowing diffusion of computer and communication technology in to all aspects of human life ranging from culture to commerce through fast exchange of data, information and message [15, 19 22].

Mark Weiser conceived the phenomena of existence of computing in every aspect of human life without any conscious reference and coined the word 'ubiquitous computing '. In one of his articles in "Scientific American" during 1991 he expressed that all profound technologies will be very much in common place and be taken for granted so much so that all will get oblivion to their existence. Later, ubiquitous computing and related fields like wearable computing and augmented reality, have become one of the major emerging areas of HCI research [28, 29].

5. PARADIGM SHIFT IN HUMAN VS COMPUTER RELATIONS

Electronic computing with Mainframe System had multiple users sharing centralized computing facility giving 'one computer to many user' relationship. Developments of microprocessors enabled creation of personnel computers leading to 'one computer to one user' relationship where each user possessed one computer to execute specific personal tasks. Evolution of TCP/IP protocol standard enabled to connect personal computers over digital network helping real time information sharing. The paradigm shifted further at the advent of Internet and World Wide Web, which allowed interconnection of computers across the world over Internet leading to 'one user many computer' environment. Evolution of standards and protocols contributed immensely in these efforts.

Miniaturization of microprocessors enabled embedded computing ability on various devices of day-to-day use leading to ubiquitous computing paradigm [03, 28, 29]. This made computers to have invaded in every aspect of life. To take things further ahead, virtualization and cloud computing emerged with offerings like Software (SaaS), Infrastructure (IaaS) and Platform (PaaS) as service to shape paradigm shift of computing to forth generation and beyond [8,12]. These facts encouraged computer and Internet usages reducing individual resource liability.

6. KNOWLEDGE GENERATION ON VIRTUAL PLANE

'Data communication' and 'Text Transfer' protocols like (TCP/IP) and (HTTP) paved path for INTERNET and World Wide Web (www) leading to Web1, Web2 and Web3 paradigm on which knowledge generation and exchange has become faster and simpler [21]. Standards and Protocols combined with advanced computing and networking features extended human reach and capability to express over virtual plane beyond defined spatial boundaries and media restrictions [01, 18, 26]. Web1 paradigm allowed us to create simple black and white static pages while Web2 allowed to be colorful with dynamic content. Web3 environment provides interactive web pages on which a piece of text can be created, edited or commented on instantly to have tacit knowledge converted in explicit form [21]. Computing capability and techniques over Web 2.0 & 3.0 are emerging as a very effective tool to process data and retain information to create Knowledge instantly online [08, 18, 19, 21]. This comes handy in registering tacit knowledge in explicit form too.

To take things further ahead, virtualization and cloud computing techniques are attempting to make advanced computing resources ubiquitously available without involving end users in the complexities of information storage and retrieval process. Leading ICT institutions and service providers like Oracle, IBM, Microsoft, Goggle etc. are coming up with virtualization and cloud computing options. Wikis, Blogs, Social Networking over digital platform etc. are modern day's podium for knowledge collaboration, tacit knowledge registration and up-gradation [12,18].

7. VIRTUAL ENTERPRISING

To remain competitive we need to identify what helps us best to traverse on the path of wisdom as shown in fig -1. Hendricks [14] opines that Information and Communication Technology (ICT) with Hardware equipments and software solutions can enhance knowledge sharing by lowering temporal and spatial barriers between knowledge workers, thus improving access to information on knowledge. He throws light on differential effects of ICT on the motivation for knowledge sharing in different settings. It is also observed that most successful companies are those who use their intangible assets faster and better.

Christian Kreutz [27] the founder of Crisscrossed indicated that Tagging (Marking), Social Book Marking (Networking), Blogging (Story Telling), Wikis the white board and RSS Feed are five tools for present day's knowledge sharing. For which one simply need to possess computing systems and access to Internet. This leads to the conviction that the overall structure for handling data and information presently is capable of accommodating more abstract inputs in business decision making process to enhance cognitive level at one end and its quick ramification leading to detail functional directions for effective business process execution on the other. This leads to the assurance that ICT facilitates 'knowledge production' with reasonable ease and effect can be seen in enterprise level conceptualization. '

'Enterprise 2' is the new buzzword where concept of social business is being consolidated. Enterprise 2.0 uses web 2.0 within organization to enhance collaboration leading to streamlining of business processes. "Enterprise 2.0" concept

was coined by Harvard Business School professor Andrew McAfee in 2006 to portray how the Web 2.0 "technologies could be used in organization's intranet and extranets. It is obvious now that in this era of collaboration, connectivity over data communication network holds the key [19, 21, 25, 26].
This necessitates assessing ICT strength in general and communication network in terms of broad band connectivity in particular to comprehend state of knowledge society. Today E-Readiness ranks and Broad band connectivity statistics indicates accessibility to ICT, one of the modern platforms of knowledge exercise.

8. ANALYSIS

At this instance assessment of Knowledge and Communication capability appears imperative. Country wise measures to assess Knowledge and Communication strength are brought in focus to analyze and comment on the context in the following section.

8.1 Connectivity

The report of International Telecommunication Union (ITU) [16, 17] of 2010 and 2011 on measuring information society, the concept as discussed in section 3 of present text, finds the touchable role of ICT in enhancing economic growth and socio-economic development
It observes that if applied appropriately, ICT can be development enabler, critical to attempting to transform countries as a knowledge society and the concept is pivotal to the measure IDI (ICT Development Index). According to the report, apart from productivity, ICT impacts other economic and socio-economic factors like digital inclusion, access to knowledge and information, acquisition of skills increasingly in demanded in a range of occupations and even in school performance. It considers availability of infrastructure, access and effective use, with skill and intensity forms the core context, which has an impact on knowledge society. ITU member states are considering ICT demand data as an essential input to gauge ICT impact. According to the report ICT is assisting in creating knowledge on many sectors like Agriculture, health, educations, socioeconomic growth etc. In digital communication context it has observed significant increase in use of both fixed and mobile broadband services in both developing and developed world in international scenario. It underlines growth in developed nation has been at a higher rate than developed nations though its usage remains non-measurable. The introduction of high-speed mobile Internet access in an increasing number of countries could further boost the number of Internet users, especially in the developing world. It finds the number of mobile broadband subscriptions surpassed the number of fixed broadband subscribers in 2008 indicating shift in usage pattern. The number of mobile broadband subscriptions refers to subscriptions that have access to a high-speed mobile network. The report finds fixed broadband access is still largely confined to Internet users in developed countries. In the year 2009 broadband penetration stands at 23.3 per cent in developed countries compared to only 3.5 per cent in developing countries. The gap between developed and developing countries appears even wider for mobile broadband penetration, with 38.7 and 3.0 per cent penetration, respectively. The report observes the mobile broadband market in developed countries is dominated by Europe, accounting for 220 million mobile broadband subscriptions (over one third of world's total) [17].
Encouragingly the report observed ICT services have become more affordable worldwide and its usage has increased even in the era of economic downturn. Of the ICT services, fixed broadband service showed the largest price fall. This is followed by mobile cellular and fixed telephone services. The report observed that countries with the highest broadband prices are all ranked relatively low in the ICT development index (IDI) [16, 17] putting forward the view that the services affordability is essential to build an inclusive information society.
It further highlights the fact that Internet plays at home improve educational achievements and accesses role of positive catalyst in socio-economic developments. However, the broadband price gap between developing and developed nations remains enormous and least affordable service in developing world. The gap continues incase of mobile cellular and Internet use though its usages is in increase in developing world. Since these are the platforms used for accessing knowledge generating tools of the day, a look into the related statistics may be revealing [16,17].

8.2 Knowledge Assessment

Knowledge Assessment Methodology (KAM) evolved by World Bank and its indexes are identified to realize inherent benefit in Knowledge Exercise. The KAM was designed by the **Knowledge for Development (K4D)** program to assess a country's preparedness to compete in the knowledge economy using 83 (eighty-three) structural and qualitative variables.
The KAM Knowledge Indexes comprise of **Knowledge Economy Index (KEI) and Knowledge Index (KI)**. The Knowledge Economy Index (KEI) considers whether or not the environment is conducive for knowledge to be used effectively for economic development. (KI) measures a country's ability to generate, adopt and diffuse knowledge. This helps planners of a country to have an opportunity to look into the state of national knowledge exercise, responsible for defining future growth framework and align planning process to reap best benefits out of it [9, 10, 11]. Methodologically, the KI is the simple average of the normalized performance scores of a country or region on the key variables in three Knowledge Economy pillars – education and human resources, the innovation system and Information and communication technology (ICT). ICT score, as registered by World Bank reflects on its preparedness of a country. Of the two knowledge indices in the present context, KI is taken into consideration, which is an indication of overall potential of knowledge development in a given country.

8.3 ITU References

The **IDI (ICT Development Index)** scores registered by ITU (International Telecommunication Union) is culmination of ICT preparedness of a country in terms of infrastructure, ICT use (intensity) and ICT Capability (Skill). IDI reflects on nation's preparedness towards evolving as Information Society.

8.4 Collective Perspective

To allow better comprehension in the following table Knowledge Index scores of top ten KEI ranked countries recorded by World Bank for the year 2009 are charted along with corresponding ICT score. IDI scores of 2008 and 2010, as indicated by ITU of the related countries are also reflected to depict trend of IDI. Scores of India along with other countries with neighboring scores are tabled to present a window view of the scenario. This is likely to present a wider perspective.

KEI Rank 2009	Country	KEI Year 2009	KI Year 2009	ICT Year 2009	IDI Year 2008	IDI Year 2010
1	**Denmark**	9.52	9.49	9.21	7.46	7.97
2	**Sweden**	9.51	9.57	9.66	7.53	8.23
3	**Finland**	9.37	9.39	8.73	6.92	7.87
4	**Netherlands**	9.35	9.39	9.52	7.30	7.61
5	**Norway**	9.31	9.25	9.1	7.03	7.60
6	**Canada**	9.17	9.08	8.54	6.42	6.69
7	**United Kingdom**	9.10	9.06	9.45	7.03	7.60
8	**Ireland**	9.05	8.98	8.71	6.43	6.78
9	**United States**	9.02	9.02	8.83	6.48	7.09
10	**Switzerland**	9.01	9.09	9.68	7.06	7.67
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107	**Honduras**	3.21	3.09	3.13	2.72	2.42
108	**Syrian Arab Republic**	3.09	3.57	4.43	3.05	2.66
109	**India**	3.09	2.95	2.49	1.72	2.01
110	**Guatemala**	2.89	2.69	3.31	2.65	2.39
111	**Nicaragua**	2.81	2.60	2.61	2.31	2.09

Table1
***KI, ICT, IDI Scores on 0-10 scale;**
****KI, KEI, ICT Data Source - World Bank; IDI Data Source-ITU**

It has been discussed earlier that World Bank evolved Knowledge Assessment Methodology (KAM) by the Knowledge for Development (K4D) program and indexes therein are identified to realize inherent benefit in Knowledge Exercise. It was designed to assess a country's preparedness to compete in the knowledge economy, using 83 (eighty-three) structural and qualitative variables. It is important to note that according to the study the Knowledge Index (KI) measures a country's ability to generate, adopt and diffuse knowledge; and benchmarks one country's position compared to others in the global knowledge economy whereas the Knowledge Economy Index (KEI) considers whether or not the environment is conducive for knowledge to be used effectively for economic development in the concerned country.

According to the studies in **K4D** program the Knowledge Index (KI) is the average of the rankings of the performance of a country or region in three areas of the so-called Knowledge Economy, namely, education, innovation and information and communications technology (ICT). Thus KI of a country reflects on state of education, new knowledge creation in terms of research and development R&D, patent registration etc and state of ICT exercise therein. ICT in terms of preparedness, use intensity and capability also figures in ITU studies and shapes IDI scores. This makes study of ICT and IDI scores quite interesting.

In the table-1, countries are ranked according to KEI of the year 2009. In that context position of 'Denmark' comes forth at the top vis-à-vis other countries in the world as far as effectiveness of its environment for knowledge usages is concerned though it's KI score is less than Sweden. This indicates that Sweden was more capable than Denmark to generate, adopt and diffuse knowledge though its environment was not as conducive in its usage in the year 2009.

It appears IDI scores are on increase for advanced knowledge generating countries, which indicates infrastructure, skill and intensity is on increase in these countries. Juxtaposing ICT and IDI score gives a window view of two different class of assessment on ICT preparedness of a country. Placing KI next to it helps to reflect on effect of these scores on Knowledge Index. As found in the study, India needs to cover more ground to figure in elite segment. According to the study India figures at 109th position followed by Guatemala, Nicaragua etc. In the same year the ranking continued up to the rank 146, which is held by Haiti. In the following in Table-2, attempt has been made to present perspective of Indian subcontinent and China for the same year i.e. year 2009.

KEI Rank 2009	Country	KEI Year 2009	KI Year 2009	ICT Year 2009	IDI Year 2008	IDI Year 2010
81	**China**	4.47	4.66	4.33	3.23	3.55
88	**Sri Lanka**	4.17	4.04	2.98	2.51	2.79
109	**India**	3.09	2.95	2.49	1.75	2.01
118	**Pakistan**	2.34	2.48	3.39	1.54	1.83
131	**Nepal**	1.74	1.62	0.8	1.34	1.56
138	**Bangladesh**	1.48	1.55	1.53	1.41	1.52
140	**Myanmar**	1.34	1.69	0.7	1.74	NA

Table2
***KI, ICT, IDI Scores on 0-10 scale;**
****KI, KEI, ICT Data Source - World Bank; IDI Data Source-ITU**

According the World Bank study knowledge exercise in Indian Subcontinent has spaces to cover up in terms of education, innovation and information and communications technology (ICT) along with infrastructure development.

Recently World Bank has made data related to KI & KEI for the year 2012 available and it is presented in Table-3. It is evident that there is sharp competitiveness amongst countries in moving ahead to make distinguishable in knowledge society. In the knowledge society first three positions are being held between Denmark, Sweden and Finland with relatively high ICT score. However it appears that capability to generate, adopt and diffuse knowledge, does not always enhance the capability to use it. In Table-3 it is evident that though Netherlands possess same KI score of Finland, in KEI, it scores much less, which finally affects its KEI rank.

KEI Rank	Country	KEI Year 2012	KI Year 2012	ICT Year 2012
1	Sweden	9.43	9.38	9.49
2	Finland	9.33	9.22	9.22
3	Denmark	9.16	9.00	8.88
4	Netherlands	9.11	9.22	9.45
5	Norway	9.11	8.99	8.53
6	New Zealand	8.97	8.93	8.30
7	Canada	8.92	8.72	8.23
8	Germany	8.90	8.83	9.17
9	Australia	8.88	8.98	8.32
10	Switzerland	8.87	8.65	9.20
****	**********	****	****	****
108	Indonesia	3.11	2.99	2.52
109	Honduras	3.08	3.00	3.24
110	India	3.06	2.89	1.90
111	Kenya	2.88	2.91	2.91
112	Syrian Arab Republic	2.77	3.01	3.55

Table-3
***KI, ICT Scores on 0-10 scale;**
****KI, KEI, ICT Data Source - World Bank;**

In this spirited segment Australia, New Zealand and Germany are new entrants, pushing USA, United Kingdom and Ireland out of top ten slots. Slide of countries like USA and UK out of top ten slots, indicate, the state of competitiveness in efforts to improve on state of education, new knowledge creation in terms of research and development (R&D), patent registration etc and state of ICT exercise in it along with efforts in conversion of the same in economic term with the improvement of overall environment. Micro and Macro planners at national level are required to note Indian slide by one more rank with reference to KI & KEI issues, in order to advance efforts to be part of knowledge society.

9. CONCLUSION

Human civilization has gone through various stages like Agrarian, Industrialization, Advanced Industrialization etc. and finally arrived at Information age where knowledge has been identified as an economic entity [5,6,7] as discussed before. An advanced Knowledge Society expected to provide opportunities for knowledge creation and its application for better economic edge. KI and KEI are the measures identified by World Bank, which help in accessing success of a country in efficient production and effective use of knowledge. These measures help to present a perspective, which need not be taken as absolute term, though it is irrefutable that the process helps in taking necessary steps towards knowledge advancement in society. In the present context looking at the table 1, 2, 3 it gets clear that countries with higher ICT and IDI have higher KI, which also vindicate observation made by ITU studies and leads to the conclusion that ICT preparedness affects Knowledge exercise positively leading to a knowledge society. Collectively these studies indicate that to realize higher ICT and knowledge generating capability academic environment, cost of connectivity and other ICT resources needs due attention along with improvement of infrastructure in a country.

FUTURE SCOPE

Technology changes at a fast pace and so does overall scenario, accordingly measures are also adjusted. Thus assessment of Knowledge Society needs to be a continuous process and needs to be realigned with changing scenario.

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