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Knowledge management and safeguarding Indian traditional knowledge

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Traditional knowledge (TK) is the knowledge base of a particular society or community which has been generated over a period of time through the process of learning and sharing by its members. TK is time tested and has been playing a vital role in sustainable development of the indigenous communities. Commercialization of biodiversity and traditional knowledge has increased the threat of misappropriation. Indian cultural and scientific heritage is discussed in this paper. Proper KM practices are required to tap that knowledge. This paper highlights the need to develop an Indigenous Knowledge Management System (IKMS) for indigenous communities which should document the knowledge heritage (without jeopardizing local culture, societal practices, IPRs, etc.) and it should also improve the process of adaptation, adoption and experimentation of the traditional knowledge. To develop an IKMS, various types of knowledge management tools and platforms are discussed. This paper also highlights the major issues/challenges in management of traditional knowledge.

Keywords: Traditional Knowledge; Knowledge Management; Indigenous Knowledge Management System (IKMS); Indian Scientific Heritage

Introduction

Globally, many countries have exploited their knowledge base for economic growth and transformed themselves into knowledge economies. Knowledge-based economy has the potential to bridge the gap of class-based divisions of the society. Traditional knowledge (TK) is community-based which has been generated over a period of time through the process of learning and sharing by the members of a particular society or community. It takes several generations and iterations to refine or improve the knowledge base with expertise gained through experience and is passed on from generation to generation. Ultimately, it becomes the integral part of the cultural identity of a community. TK is time tested and has been playing a vital role in the livelihood of the vast majority of people especially in developing countries, many of which are using the advancements in information and communication technologies (ICTs) for proper utilization of knowledge capital. If documented properly and used, TK would provide food and health security to millions of people in the developing world. Local communities have developed various plant/crop varieties according to their local needs which strengthen their agricultural system. Traditional medicines, based on various ecological products are the alternative to the modern medicine system; even in some cases the only way to provide the affordable treatment to the poor people. The role of traditional medicines for healthcare can be determined by the fact that 80 percent of the population of some Asian and African countries is dependent on traditional medicine for their primary health care needs.[1] People of developed countries also use alternative or complementary medicines for curing some ailments. In recent times, the merits of traditional medicine system are increasingly felt and recognized the world over. However, Commercialization of biodiversity and traditional knowledge has increased the threat of misappropriation.

India is one of the oldest civilizations with more than 5000 years old history and has a rich cultural and scientific heritage. Indian traditional knowledge is based on oral culture, i.e., transmission of knowledge through word of mouth from generation to generation. It emphasized on transmission by word and learning by doing; very less amount of that knowledge is available in written form, making it vulnerable for exploitation by the technology rich countries. Proper

KM practices are required to tap that knowledge, as it would be very effective for the sustainable development of the society.

Knowledge and its management

Knowledge is the systematized form of the meaningful information used for strategic decision making in which contextual information is framed to evaluate the given problem and to reach at particular decision based on one's experience, values and expertise. Knowledge is acquired over a period of time and involves various complex cognitive processes of perception, communication, association and reasoning through study, investigation, observation, individual or group understanding and experience. Knowledge that is held by the human brain is known as tacit knowledge. When tacit knowledge is documented or transformed in to a tangible form, it is called as explicit knowledge.

Explicit knowledge is objective and consists of "know-what" described in a formal language. It is well documented, codified and can be archived for future use. It is based on facts and logical thinking. It is document oriented knowledge and uses "people to document" approach. Various documents such as monographs, standard operating procedures, manuals, best practices, product specifications, universal principles, trademarks, patents, research papers, etc are the sources of explicit knowledge.

Tacit knowledge is available in intangible form and cannot be expressible easily. It is hard to formalize and communicate due to its unstructured nature. Tacit knowledge is subjective and can be acquired through cognitive and experiential learning. It is practical and action oriented knowledge and describes the "know-how". It is highly personal as it resides in the mind of the individuals. It is the product of creative and flexible thinking of the individuals which includes gut feelings based on thoughts, intuition, insights, instincts, experiences and expertise of people.[2]

Knowledge management enables organizations or institutions—R&D, academia, public, private or corporate—know what they have and share the knowledge for keeping themselves ahead of competitors. It has become an inseparable activity of institutions, especially after 1990's. In India too, in recent times, many have used KM for organizational/institutional development and to have competitive edge over others. Many institutions have been practicing KM in one way or other. Some, especially in corporate world, have established institutional repositories by digitizing internal documents[3]. Many corporate giants like TCS, Godrej-Boyce, ONGC; institutions like DRDO, CSIR; academia like IITs, IISc, etc have been involved in digitizing and creating knowledge repositories for safeguarding and long term preservation of knowledge DESIDOC, one of the constituent establishments of DRDO, took several initiatives in knowledge management, in DRDO. The aim was to tap the tacit knowledge available with senior scientists and converting it into explicit knowledge in the form of monographs and special publications. Explicit knowledge available in the form of technical reports, research papers in journals and conference papers are also managed through knowledge Repository (for Technical Reports of DRDO) and *Gyansrota* (Institutional Repository of Research papers and conference papers of scientific and technical staff of DRDO). Besides, digital repository of DRDO publications, multimedia collection of DRDO's scientific and cultural heritage and group collaboration tools (DRDO Wiki and Blog) for knowledge sharing are being maintained by the DESIDOC in its efforts towards knowledge management in DRDO.[4] KM is equally applicable to educational and research institutions which produce large volumes of knowledge and are amenable for implementing KM to facilitate knowledge sharing across the institutions.[5]

Traditional knowledge

Traditional knowledge consists of both codified knowledge which is documented and non-codified knowledge which is not documented and is communicated orally; this knowledge is known to certain societies and is in use over a period of time providing for food or healthcare besides helping the families economically. It covers all fields of human endeavour ranging from agricultural, medicinal, and science to socio-cultural knowledge. TK is a cooperative effort of the members of a particular society and is a part of social process of learning and sharing from generation to generation mostly through word of mouth and enhancing their knowledge domain with their personal experience and expertise. It is unique to each culture as influenced by various factors such as economical, socio-cultural and ecological. TK is well tested by repeated use and becomes part of the society as a dynamic process (ever evolving and flexible according to the situational needs). The traditional communities lack

proper documentations and do not know how to safeguard their intellectual capital. In modern times, TK is kept in public domain and is easily accessible and so is more susceptible to misappropriation. At the same time, it would be difficult to do justice to the traditional communities by providing financial gains to them.

The World Intellectual Property Organisation (WIPO) has described the TK under three broader areas: traditional knowledge (in the strict sense), traditional cultural expressions, expressions of folklore, and genetic resources. Traditional knowledge (in the strict sense) includes technical know-how, practices, skills, and innovations such as those related to biodiversity, agriculture or health. Traditional cultural expressions/expressions of folklore include cultural manifestations such as music, art, designs, symbols and performances. Genetic resources include genetic material of actual or potential value found in plants, animals and micro-organisms.[6]

Developed countries with advances in various technologies are in an advantageous position to exploit the TK base of the communities of developing countries just on the basis of latter's lack of proper documentation and the so called digital divide. Traditional medicines due to their time-tested effectiveness in curing many ailments and being in use for generations and even centuries are prone to bio-piracy. Not only the traditional medicines, but geographical indicators, artistic manifestations, agricultural products, classical music (*ragas*) and folk dance are also under threat of misappropriation; these are being used for centuries by the indigenous communities. Another major impediment with safeguarding TK is the fact that documented TK is available in languages other than English (mostly in regional languages); so, it is almost impossible for Patent Offices to recognize the non-patentable knowledge on the basis of prior art.

Ancient Indian contributions to education, science, and technology

India has a well-established, rich science and cultural history of over 5000 years. According to archaeologists, the Indus Valley civilization, also called the Harappan culture, was one of the three earliest civilizations of the world. It flourished for more than 8 centuries during 2750-1900 BC. The script of Harappan culture which was found on nearly 3000 seals, sealings and other inscribed objects is yet to be deciphered. Due to this fact, there is little or no information about their scientific ideas relating to astronomy, mathematics, medicine and the like.[7] But findings of Harappan and Mohen-jo-Daro show that they were a scientifically advanced civilization. Indian scholars have showed their prowess and excelled in almost all fields of scientific and cultural knowledge in those days. Takshila, Nalanda, Vikramsila, Nagarjuna and Varanasi were the knowledge hubs of ancient India. Sanskrit, the native language of ancient India, is the most scientific language. A whole plethora of subjects ranging from philosophy, law, mathematics, medicine, astronomy and other branches of sciences, grammar, phonetics and literature were written in Sanskrit by ancient Indian scholars which accounts about 95% of Sanskrit literature and remaining 5% is of religious nature.[8]

The pioneering works of Sanskrit literature, the four Vedas (Rig, Yajur, Sam, and Atharva Vedas), hold a vast amount of scientific knowledge. Rig Veda has a description about physics (motion of earth, speed of light, gravitational force, etc.), mathematics, chemistry, astronomy (eclipses, telegraphy, etc.) and aeronautics. Yajur Veda has a description about human psychology, military science, etc. Sam Veda deals with classical music, poetry, dance and drama. Natya Shastra is the Upveda of Sam Veda. Atharva Veda is known to be the origin of Ayurveda, i.e., treatment of ills via medicinal plants. Political science, economics and agriculture are other branches of knowledge which are described in Atharva Veda.[9]

Indian philosophy has six classical systems and three non-classical systems. Classical systems include Nyaya, Vaisheshik, Sankya, Yoga, Purva Mimansa and Uttara Mimansa, while non-classical systems are Buddhist, Jainist and Charvaka. Out of these nine systems, except Uttara Mimansa, eight are atheistic as there is no description of God in them. Nyaya Vaisheshik philosophy, which emphasized on reasoning and experience before accepting any theory, gave the scientific approach to our ancient scholars and due to which they were able to propound scientific theories.[8]

The manufacturing sector of ancient India was well developed with advanced technologies. The Ashoka's Iron Pillar at Delhi is one of the great examples of high quality metallurgy of ancient India, which, although in the open, is rust free for the past 1500 years. Findings of Mohen-jo-Daro and Harappa remains showed that at that time (around 3000 BC) copperware was in use and Harappan bronze figurines

are still preserved. Greek historians documented smelting of metals in India as early as in the 4th century BC. According to the Gemological Institute of America, India was the only source for diamonds to the world till 1896. Ancient Indians knew the technique to make camphor (important to produce naphtha), tin (cassiterite, the technical name of tin in English was derived from Sanskrit word *kasthira*) and cane sugar (the word sugar is derived from the Sanskrit term *sharkara).*[10] The earliest reservoir and dam for irrigation was built in Saurashtra.[11] Indian mathematics emerged in the Indian subcontinent from 1200 BC until the end of the 18th century. The *Sulba Sutras* contain geometry related to fire-altar construction. They are *sutra* texts belonging to the *Śrauta Sutra* which are the source of Vedic mathematics. The four major *Shulba Sutras* of mathematical significance were composed by Baudhayana, Manava, Apastamba and Katyayana. Baudhāyana (800 BC) was the author of *Baudhāyana Śulbasûtra* (earliest *Sulba Sutra*) which contains several important mathematical results. He had calculated the value of pi (π) to some degree of precision and also the Pythagorean Theorem.

In astronomy, the calculations which were made 2,000 years ago by the Indian scholars are still the basis of predicting the day and time of a solar eclipse or a lunar eclipse with great accuracy by just reading a '*patra'*. The calculations of those days compare well with the current parameters calculated using sophisticated instruments. Pingala (circa 5th-2nd century BC) used binary numbers in the form of short and long syllables (the latter equal in length to two short syllables), making it similar to Morse code. He and his contemporary Indian scholars used the Sanskrit word *śūnya* to refer to zero or *void*. Today's software and computing technology is based on these binary numbers one (1) and zero (0). Aryabhata-I (476–550 AD), collected and expanded the results of *Siddhantas* (theorems) in an important work called the *Aryabhatiya*. In this work, he propounded the Heliocentric theory (that the Earth revolves around the Sun, now attributed to Nicholas Copernicus), motions of solar system and about eclipses. The words *jya* for sine, *kojya* for cosine, *utkrama-jya* for versine, and *otkram jya* for inverse sine were used at that time. In his work *Aryabhatiya*, Aryabhata-I described the important fundamental principles of mathematics in 332 *shlokas* and described the quadratic equations, trigonometry, the value of pi (π) correct to 4 decimal places. In 498 AD, he stated that *Sthanam sthanam dasa gunam* or place value system with each place ten times in value to the previous, which is the origin of the modern decimal-based place value notation. Aryabhata-I also wrote the *Arya Siddhanta*, which is now lost. The significant developments in trigonometry (4th–5th century) was known as the *Siddhantas* (there were five, but only Surya *Siddhanta is* completely available); sine, cosine, versine, and inverse sine were defined in it.

Bhāskaraacharya (Bhāskara-I, 600–680AD) expanded the work of Aryabhata-I in his books titled *Mahabhaskariya*, *Aryabhatiya-bhashya* and *Laghu-bhaskariya*. He calculated the time taken by the earth to orbit the sun (365.258756484 days) hundreds of years before the western astronomers. Varahamihira (505–587AD) produced the *Pancha Siddhanta* (the five astronomical canons). In his work *Mahasiddanta* (consisting of 18 chapters), Aryabhata II (920-1000 AD) described mathematical astronomy (in 12 chapters) geometry, geography and algebra (6 chapters). Bhāskara-II (1114–1185 AD), mathematician-astronomer, wrote *Siddhanta Shiromani, Leelavati, bijaganita, gola addhaya, griha ganitam* and *karan kautoohal*. He in his work *Leelavathi* discussed mathematical astronomy, circumference of earth, distance to moon, etc. His major contributions include arithmetic (interest computation, arithmetical and geometrical progressions, proof for division of anything by zero being infinity), algebra (quadratic equations, cubic equations, equations with more than one unknown, etc.), geometry (proof of the Pythagorean theorem), calculus (differential calculus and derivatives, etc.), computed pi (π) correct to 5 decimal places, calculated the length of the Earth's revolution around the Sun to 9 decimal places, and trigonometry. All these calculations were made at a time when scientific and precision instruments were not available. Other significant contributors to Indian Mathematics are made by Brahmagupta. Jaina Mathematics (400BC-200AD) also made significant contributions.[12]

Ancient Indians were pioneers in the field of medicine as well. Sushruta (800 BC) was a pioneer in surgery and a surgeon par excellence. In his work *Sushruta-samhitha* he wrote about *Ayurveda, kayatantra, salyatantra, salakyatantra, salyachikitsa, kayachikitsa*. *Sushruta-samhitha* describes more than 300 different operations and 121 surgical instruments (20 Sharp and 101 accessories) such as tongs, forceps, scalpels, catheters, syringes, speculums, needles, saws, probes, scissors and the like. Nearly 2600 years

ago, Sushruta and his contemporaries conducted complicated surgeries like cesareans, cataract, artificial limbs, fractures, urinary stones, brain and even plastic surgery which westerners invented only about 200 years back.[13] Usage of anesthesia was well known to ancient Indians and they had the deep knowledge of anatomy, physiology, etiology, embryology, digestion, metabolism, genetics and immunity as found in many ancient texts. *Charakasamhita* of Charaka (300 BC), a famous physician who knew pathology, anatomy, pharmacology, diagnostics, is a valuable text of Ayurveda. Charaka is treated as the father of medicine who consolidated Ayurveda 2500 years ago. Today, India is the only country with three different medicinal systems viz. Ayurveda, Unani and Sidha Systems of Medicine. Ayurveda is very old; Allopathy and Homoeopathy are just 200 years old.

There are several other prominent contributions by ancient Indian scholars in other fields also. The art of navigation was born in the river Sindh 6000 years ago; even the word navigation was derived from the Sanskrit word *Navgatih* (meaning new direction) and the word Navy was derived from Sanskrit word *Nou*. Chess (*Shataranj* or *Ashta Pada*) was played by Indian kings and emperors[11]. Yoga, known as the best way to be physically and mentally fit, was also given by Indians (Patanjali (150 BC), Yoga Sutras) Kung Fu and its various forms are also the derivative of Yoga which was taught to the Chinese by the Indian Buddhist monk Bodhidharma (which was validated by the recent studies carried out at Shaolin Temple, China).

Most of the ancient Indian scientific heritage was lost as the knowledge was not documented or managed properly. In those days the knowledge used to be transferred orally through *Guru-shishya parampara* or parents (father) to children (sons only, as daughters will move to other families after marriage and so forbidden). Some of these have been obliterated as no documentation was done while a few survived the vagaries of time in the form of ancient scripts including Vedas. The problem got aggravated with foreign invasions and the subsequent British rule.[14]

Protection of traditional knowledge

Traditional knowledge, especially traditional medicinal systems, is found effective in current global context due to its wider application in healthcare industry. It emerged as an alternative to modern allopathy, which has many side effects. Developed countries due to their advancement in technology have started exploiting the TK which mostly belongs to developing countries where it is the part of the society since time immemorial. Protection of TK is a sensitive issue as it is available in public domain. TK mostly is not documented or available in regional languages, which makes it hard to justify at the legal platform leading to granting patents to non-original innovations. Traditional communities who are the sole knowledge holders of that knowledge remain financially deprived. In India alone, many ailments are cured by using ecological products. Medicinal properties of neem (leaves, bark, seeds and branches), turmeric, *tulsi, methi* (fenugreek leaves), *dhania*, garlic, onion, bitter gourd (*karela*), *bel phal* (*bilva*) pepper, ginger (fresh and dry), clove oil, cardamom, cinnamon, *Terminalia arjuna* (Arjuna tree), Aswagandha, Aloe vera, grass root (*vatti veru*), brahmi, etc. are well known and used to cure many ailments like fever, jaundice, diabetes, normal and dry coughs, asthma, headache, cold, eczema, burns, mumps, infertility, bone fractures, diarrhea, itches, coronary artery disease, controlling cholesterol, gastric disorders, arthritis, inflammations, hypertension, anemia, memory enhancer, etc. Even in traditional medicine system, derivatives of snake venom have various therapeutic properties and used to cure arthritis, acute fever, coma, etc. "Cow therapy" known as *Panchgavya*, found wider application in Ayurveda.

The rhizomes of turmeric (*Curcuma longa Linn*.) have been used traditionally by Indians for centuries as a spice for cooking and medicine for healing wounds and rashes. It has also been used traditionally as an ingredient of cosmetics and dyes. Various medicinal properties of turmeric are traditionally known to Indian communities and their manifestations are available in ancient Sanskrit literature. But in 1995, two emigrant Indians Suman K Das and Harihar P Cohly at the University of Mississippi Medical Centre were granted a US Patent for the use of turmeric in healing wounds. The Council of Scientific and Industrial Research (CSIR), India challenged this patent with US Patent and Trademark Office, arguing that it was prior art and not novel invention as turmeric has been used traditionally by the Indians for its medicinal properties in healing wounds and rashes for centuries and provided documentary evidence for its support. Finally in 1997, US PTO revoked the patent on the basis of prior art.

Neem (*Azadirachta indica*) has such exceptional medicinal properties that almost every part of the plant, be leaves, bark, roots or seeds, has been traditionally used by Indians to cure many ailments such as cold, flu, malaria, skin diseases, fever, infections and also been used in agriculture for its fungicidal effects. It is also known to boost the immune system by enhancing the production of lymphocytes and T-cells. European Patent Office (EPO) in 1994 granted a patent (No. 436257) to W.R. Grace Company, USA and the US Department of Agriculture for a method developed using extracted neem oil for anti-fungal use on plants. In 1995, a group of international NGOs and representatives of Indian farmers filed a petition against this patent with EPO supported by documentary evidence for fungicidal use of Neem oil in traditional farming. In 2000, EPO revoked the patent on neem considering that it didn't contain any invention and known to public for centuries.

Basmati is a variety of rice grown in the Terai area of Shivalik hills and is a Geographical Indicator. Rice Tec. Inc of Texas, USA applied in the UK Trademark Registry for registration of a mark Texmati to a rice plant variety based on US patent granted in 1997 to that rice variety with the geographical delimitation covering American and Latin American region which has characteristics similar to Indian Basmati rice. In 2000, Agricultural and Processed Food Exports Authority (APEDA) challenged this application by providing several evidences in support of Basmati as a Geographical Indicator. Soon after to this petition Rice Tec. Inc. withdrew its application on April 2000. A majority of the 20 odd claims made for Texmati were deleted.[15]

Some 36 yoga postures were copyrighted by an expatriate Indian in USA. Patent authorities of US alone have granted more than 130 patents related to yoga.[16] The misappropriation of TK is not limited to unethical patents granted; it extends to cultural heritage of the traditional communities such as folk dances, music ragas and even yoga postures which are vulnerable to unethical exploitation. In 2003, UNESCO International Convention for safeguarding of the intangible cultural heritage focused on the social values of TK.

These classic examples and many more such exploitations make it clear that there is a need to protect the TK through suitable means including *sui generis* system as provided under Article 39(2) and 39(3) of TRIPS. United Nation's Convention on Biological Diversity (CBD) was held at Rio de Janeiro on June 1992 which came into effect from 1993 with 168 signatories. The objectives of the Convention are conservation, sustainable use and equitable sharing of benefits. Issues related to these objectives are mentioned in its 42 Articles. Article 8(1)(j) emphasized on equitable sharing of benefits arising from the use of TK, innovations and practices thereof. Article 15(5) provides signatory state parties to obtain prior informed consent from contracting parties before accessing genetic resources.[17]

In recent times, WIPO Intergovernmental Committee on Intellectual Property and Genetic Resources, Traditional Knowledge and Folklore (IGC) has discussed the various issues related to TK. In the discussions it comes out that TK doesn't fit in the scope of current intellectual property regime. TK is knowledge developed over a period of time with continuous up-dation and refinement to achieve the stolidity and in the livelihood of the indigenous communities. The "know-how" of the TK is more mental and culturally defined in comparison to technologically derived industrialized innovations and products. For the developed countries, the derivative of TK may be innovative, but for the indigenous community of developing countries the TK is the part of their livelihood. So, there is a need to make a balance between innovation and stability.

There is a common consensus to protect the TK and to develop a mechanism to regulate the use and access of TK as well as mechanism to ensure benefit sharing. But the point of disagreement is about whether the scope of such mechanism should be measure-based or rights-based. In measure-based approach the emphasis is on developing general guidelines for managing the TK. It emphasizes on defensive protection and includes goals of preservation, preparation of database or documentation of TK. The development of Traditional Knowledge Digital Library (TKDL) by Govt agencies, Biodiversity registers, etc. is according to measure-based approach. The rights-based approach provides the rights to the TK holders to regulate the uses of TK for either commercial purpose or non-commercial purposes. It requires Prior Information Consent (PIC) of the indigenous communities to which the TK belongs before it can be utilized for any purpose. Disagreements are also there for determining the duration of TK and its beneficiaries. In the draft article it is provided that duration of TK would be perpetual as long as it comes

under the definition of TK, but some member states insisted that while deciding the duration of TK, value should be the determining factor. Another major issue of disagreement is about the provisions for fair use/ fair dealing or experimental use.[18]

The twenty-first session of the WIPO's IGC was held on Geneva from 16 to 20 April 2012. Participants from 95 countries and 55 observers have attended the Committee. Revisions were made to "The Protection of Traditional Knowledge: Draft Articles". The draft articles identify areas of convergence and issues which need to be further clarified and discussed. Some of the issues include: definition of traditional knowledge (Article 1), identification of the beneficiaries of protection (Article 2), defining the scope of protection (Article 3, Article 3BIS) and identification of exceptions and limitations (Article 6). General guiding principles for the protection of traditional knowledge, part of draft articles, were also discussed.[19]

Countries having common interests, such as India, Columbia, Peru, and New Zealand have decided to meet in Bali to sort out their differences on some issues. They have tried to agree on a common definition of "traditional knowledge" but till now no success is achieved. Besides, the issue of deciding the beneficiary for sharing the royalty or fee that will be collected from a company for using the TK, genetic resources or traditional cultural expressions is yet to be resolved. Peru and Columbia have the opinion that the monetary benefits should be given to the local communities, i.e., holders of TK. Some other countries like India are insisting that sovereign governments should get the funds as in many of the cases there is no evidence about the actual TK holders.[20]

In India, Council for Scientific and Industrial Research (CSIR), Non-Governmental Organisations (NGOs), Indian Government, Indian Agricultural Research Institute, and the Directorate of Rice Research have played a crucial role in revoking the patents granted to the turmeric, neem and Basmati rice. Educating communities and societies in preservation, documentation and dissemination of traditional knowledge is required.

Traditional knowledge digital library

Traditional knowledge of India, especially the traditional medicinal systems has been exploited by the developed countries in the past two decades in the form of patents granted to developed countries. There is a continuous threat of misappropriation of Indian traditional knowledge. Indian agencies had to fight at international platform for revocation of the granted patents based on TK or a minor variation thereof. But it is not an easy task as it involves huge costs, time and even sometimes it may not be feasible to prove the TK as a prior art and thus non-patentable knowledge. As most of the TK is available in regional languages or in ancient scripts, it is difficult for patent offices to examine the patentability of any claim which is subjective to available non-patent literature sources. In view of this, the need for a digital database of 5000 years old Indian TK was felt and a collaborative project between CSIR, Ministry of S&T and Department of AYUSH, Ministry of Health and Family Welfare was started and named as Traditional Knowledge Digital Library. This project was started in 2001-02 with NISCAIR as the implementing agency. The objective of TKDL is to protect the Traditional Indian Systems of Medicine, viz. Ayurveda, Unani, Siddha and yoga available in public domain, from exploitation in the form of unethical patents granted leading to bio-piracy.[21] Scientists working under the TKDL project have consulted 16 ancient texts related to yoga, including Patanjali Yoga *Sutra*. They have provided the description of 1,300 yoga *asanas* or postures and videography of 200 popular yoga postures through the TKDL. It will help in preventing granting of unethical patents to yoga postures. For phase II, it is planned to refer 20 more ancient texts to describe more yoga postures.[22] The aim is to digitize TK, which is available in Indian languages, by sifting, collating and converting the information into a structured language using Traditional Knowledge Resource Classification (TKRC) made available in 5 international languages, viz. English, German, French, Spanish and Japanese. TKRC is an innovative structured classification system developed for systematic arrangement, retrieval and dissemination of information which is organised under section, class, subclass, group and subgroup as per International Patent Classification so that it will be convenient to International Patent Examiners to retrieve information.

Traditional Knowledge Digital Library comprises an inter-disciplinary team having experts from Ayurveda, Unani, Siddha, and Yoga, patent examiners, IT experts, scientists and technical officers. Each *sloka* from ancient literature is converted into structured language using TKRC with the help of TKDL software and the meta-data is converted into different languages using Unicode

technology with knowledge-based conversion. Even, traditional terminology is converted into modern terminology. It contains millions of pages of ancient scriptures and about 1200 formulations of Ayurveda (500), Unani (500) and Siddha (200) having application of 291 plants for the treatment of 186 diseases. Besides, as on August 2011, transcriptions of 2,44,860 medicinal formulations from about 150 old manuscripts/books are made available to Patent Offices only under TKDL Access Agreements.[21]

Knowledge management practices for safeguarding traditional knowledge

As discussed in earlier sections, India's traditional knowledge is prone to misappropriation due to its high market value (commercial application) and at the same time, India has lost a considerable amount of its scientific heritage over the period of time due to the lack of proper documentation. Facilitated with current ICT advancements, latest knowledge management practices can be used for managing the traditional knowledge heritage of the country. It involves identifying, capturing, managing, storing and disseminating the indigenous knowledge besides protecting the rights of the original traditional knowledge holders. There is a need to develop an Indigenous Knowledge Management System (IKMS) for indigenous communities through which they themselves take necessary steps to document and preserve their knowledge heritage whether it is traditional medicinal practices, plant varieties, genetic resources, geographical indicators, or folk and cultural aspects of that community in a cost-effective way. However, there are ample benefits of current digital technologies in managing the knowledge heritage (by preserving and sharing the knowledge base). At the same time it is also required to understand that digital technologies may accompany the opportunities for knowledge misuse and misappropriation by paving the way for illicit access to the knowledge base. This requires understanding of the capacities and contexts in which the proposed system has to work, i.e., proper understanding of the needs of local innovators and those who benefit from indigenous knowledge. IKMS should not only document the knowledge heritage (without jeopardizing local culture, societal practices, IPRs, etc.) but beyond that it should improve the process of adaptation, adoption and experimentation of the traditional knowledge. It should work as a mechanism to support claims of original ownership so that the indigenous communities can receive proper compensation for their cultural heritage and associated intellectual property.

To develop an IKMS, various types of knowledge management tools and platforms can be considered ranging from content management systems, database management systems, Geographic Information Systems to group collaboration tools (such as wikis, etc.). Different software tools such as text to speech (screen readers), character recognition tools, audio and video editing tools may also be helpful in proper capturing, management and dissemination of indigenous knowledge. Maps and GIS technology should be used to correlate the knowledge available in database with the ecosystem. The software tools, used for developing IKMS should have the provision to describe, contextualize and annotate resources in the languages of traditional knowledge holders from their own perspectives. For that purpose it should support Unicode for multi-lingual input and efforts should be made to automatically translate into English for access by others. Besides having the provision for textual annotations it should have the ability to incorporate spoken (voice) annotations which would reinforce the oral tradition of indigenous communities and also help to preserve the threatened languages. There should be proper security provisions in the software tools to enable authorized members of the indigenous communities to define and control the rights and accessibility of their digital resources to check the misappropriation. Provision for different levels of access for different people based on security needs of knowledge itself will help to ensure the appropriate use of knowledge such as knowledge to be used by government agencies for proper natural resource management, traditional medicinal knowledge to be shared with pharmaceutical companies to ensure the recognition of prior use by indigenous communities and its compensation accordingly.[23,24] Community-based resource centres should be established to enhance the flow of indigenous knowledge primarily through oral interaction such as audio-visual technologies, text to speech, etc. (as most of the indigenous community members are not enough competent in ICT and sometimes even not literate).[23]

While applying the latest knowledge management practices based on information and communication technologies, it should be kept in view that managing the indigenous knowledge has some other concerns

also. Documenting the traditional knowledge and setting up databases alone will not solve the purpose. It is not always possible to document and capture the indigenous knowledge as 'artefacts' using digital technology. Medicinal practices, plant varieties, genetic resources, geographical indicators, folk and cultural aspects of a particular community need not only be documented digitally for knowledge sharing but also required to be protected as such in real life practice for future generations. Furthermore, collecting the indigenous knowledge from diverse sources for its proper management is not an easy task as indigenous communities especially tribals are not always willing to share their knowledge with outside world.[23] The process of traditional/ indigenous knowledge management involves manpower, time and investment of huge money.

Managing indigenous knowledge would be beneficial only if the retrieval of that knowledge is based on the local knowledge system of a particular indigenous community. Based on the search strategy of indigenous communities various search options should be incorporated in the database. The standard thesauri and classification systems have been developed on the basis of present day standard form of a language and subject related to that knowledge. Particular indigenous languages and cultures have their own system of concepts and words which creates complexity. Thus to manage the indigenous knowledge base special consideration should be made to develop alternative thesauri and classification systems which will suit the needs of indigenous communities.[24]

Knowledge management practices will be treated successful only if they protect the intellectual property rights of the individuals and indigenous communities, provide indigenous knowledge in usable form to the people who need it but don't have access to ICTs. They should also generate benefits for these communities for commercialization of their knowledge base.

Besides TKDL, other successful indigenous knowledge management practices in India which are worth to be mentioned are the Honey Bee Network in Gujarat which created the world's largest database on innovations to help protect intellectual property rights (IPRs) of grass root level workers to ensure benefit sharing. It is run by Society for Research and Initiatives for Sustainable Technologies & Institutions(SRISTI) of Ahmedabad. The NGO *Kalpavriksh* initiated the *Beej Bachao Andolan* of Garhwal (save the 10,000 seeds campaign). Village-wise Community Biodiversity Registers (CBRs), People's Biodiversity Registers in Kerala, Karnataka and Maharashtra; Plant Biodiversity Registers in more than 10 states, are some of the efforts towards safeguarding the traditional knowledge of the country. Research Foundation of Science, Technology & Ecology (RFSTE) in 1999 initiated *Jaiv Panchayat* (living democracy) register at 292 sites/villages in the country.[14]

Conclusion

Traditional knowledge, which is the integral part of traditional communities, especially those related to developing countries, is highly prone to misappropriation by the technologically rich developed countries. Traditional knowledge is treated as knowledge available in public domain which results in unethical exploitation without taking care of the indigenous communities. Traditional knowledge doesn't fit in the purview of current IP regimes. It requires some sort of innovation and change to provide IPR protection as TK is developed over a period of time to provide stability for the development of the society. WTO and TRIPS have provided the benefits to the industrialized world; they failed in protecting the traditional knowledge base of the indigenous communities under the current IP regime. Traditional Medicinal Systems need protection against exploitation as several unethical patents have been granted in past. The biggest challenge for protecting is that most of the TK is not documented as it is based on oral culture, transmitted from generation to generation. Even when documented, it is available in regional languages or ancient scripts which make it difficult to defend at legal platforms. Various efforts should be made at national as well as international level to protect the TK related to various communities. In this regard, provisions under TRIPS, Convention on Biodiversity (CBD), etc. are well noted and need to be implemented effectively. Equitable sharing of benefits with traditional communities need to be enforced. Educating the traditional communities in preservation and dissemination of TK by increasing their involvement in documentation of the TK, bringing together Govt. organizations as well as NGOs working in this field, preparing the digital database of inventory/registry of biodiversity and protecting the TK through strong and

effective IPR laws are some of the efforts which have to be taken to safeguard indigenous traditional knowledge. In India, various Govt. departments/ institutions and NGOs have taken initiative to protect the TK base of various communities of the country and this must continue. More and more such initiatives need to be taken and collaboration among such initiatives is required to join hands in this endeavour to create a knowledge grid and to strengthen the knowledge base of the country.

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