Chapter 7

Using ICT to protect and promote IK

7.1. Introduction

The previous chapter identified some limitations in the use of intellectual property (IP) laws and some measures currently implemented to protect indigenous knowledge (IK). It also suggested that there is a need to implement another system in addition to existing measures to protect and promote access to IK. Such a system must be appropriate for the information age in which globalisation is a growing trend. The additional system should also be able to protect any form of IP, in other words, it should not be limited to IK only but should also be applicable to other forms of knowledge. In an attempt to address the main problem statement, this chapter answers the following research sub-question:

What information and communication technologies (ICT) solutions exist to promote and protect IK?

In an attempt to answer this research sub-question, this chapter aims to explore the possibilities for the protection and increased access to IK. This will be done through a consideration of the following proposals:

- Briefly determine the existence of IK on the Internet.
- Establish IK Resource Centres (IKRCs).
- Implement the repositories to store and preserve digitised IK resources.
- Employ cryptography and digital watermarking techniques to protect IK resources.
- Use the Dublin Core (DC) Metadata Element Set, the World Wide Web and multimedia standards derived from DC to organise IK resources into repositories

- Use the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH) as an interoperable transport protocol to harvest the metadata from the repositories.

7.2. Background

Documented IK must be protected and preserved digitally. Digital preservation can be defined as managed activities to ensure continued access to electronic resources. Access is the key factor here because it does not help to preserve digitised IK information that cannot be easily accessed. If an IK resource cannot be used effectively anymore, it is pointless to preserve it. It is thus very important to protect and promote digitised IK. This section does not, however, address the protection of IK in printed books. Contrary to digital material, it is relatively easy to preserve printed material for decades or even centuries. First, paper is usually very durable material. Second, humans can extract information from a book by a simple process of reading. Third, understanding the information is possible since written languages have not changed entirely and there are human experts who can translate the documents into a commonly understood language. Electronic resources differ in a fundamental way from printed resources. Every electronic resource has to be interpreted by an application before it can be displayed to and understood by humans (Hakala 2001a). Before investigating the actual promotion and protection of digitised IK, it is thus important to investigate the Internet as an important tool to communicate digital IP. In addition, the existence of digitised IK on the Internet must be explored.

7.2.1 Internet as an important tool of communicating digital IP

The most prominent phenomenon of the information age is the Internet. The Internet began in 1969 when the US Department of Defense created a computer-based failsafe communication system for the US President. This system was called the Arpanet. It was intended to give the signal for war in the event of nuclear attack, and to conduct such a war safely should traditional means of communication be knocked out. It was later extended to form links between the Pentagon and university researchers conducting military research. Gradually the Internet expanded to communicate non-

classified research and personal messages. The Internet has become the most open, uncontrolled and heavily trafficked communication system the world has ever seen. Modern-day IW is conducted via the Internet because organisations and individuals are dependent on it for communication (Graham 1999:484; Harris 1998:135-6; Hofman et al. 1999:11-12).

Technology is advancing too fast for the law in the area of IP. The main problem is that the Internet is an international tool and that IP regulations are nationally based. As chapter three pointed out, each country has its own laws regulating copyright, trademarks, patents, designs and trade names. The revolution in information technology is making information easier to access and move around. Should national patent offices allow access to their collection via the Internet, this would be a major breakthrough for the efforts of information transfer. Such endeavours would be driven by the need to reduce registration costs at the patent offices, to please governments and industrial applicants who want lower fees. This would likely be driven mainly by the developed world due to their stronger bargaining power. The availability of patents via the Internet would entail less use of expert help for patent searches (Bettcher et al. 2000:526; De Villiers 2000:37; Van Dulken 2000:273).

Society can increasingly be defined in terms of information-poor and information-rich communities, but boundaries may shift as technology becomes available and it is difficult to predict whether those who are currently disadvantaged will continue to be so in the future. The unequal distribution of resources such as IP, telecommunications and technical skills, causes concern about the ability of developing countries to participate in the emerging world economy. There are fears that globalisation trends may result in a further marginalisation of poor countries within the world economy and may lead to disruption of their social fabric (Avgerou 1998:15; Elman 2001:896; Pye 1999:307). Challenging intellectual property must involve the development of methods to support small intellectual producers. An obvious way to challenge IP is simply to defy it by reproducing protected works, which is punishable according to the stipulations of the international conventions (Martin 1995:19; Shiva 1996:27-8).

The nature of the Internet may force international governments to standardise law, not only in the intellectual property field, but elsewhere also. Currently international relationships in the area of IP, in South Africa for instance, are governed by several international conventions and agreements, most notably the Berne Convention (see table 3.1 in chapter three), and the Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS). These conventions dealt with copyright, trademarks and patents. The TRIPS agreement and the other Conventions make some provision for the enforcement of IPRs across borders and oblige signatories to grant protection to foreign works through amending their domestic legislation. These Conventions were aimed at harmonising IPRs across the world. Because these agreements were signed before the Internet became the force it is today, they do not address the problems associated with it (Bettcher et al. 2000:525; De Villiers 2000:37; Wallis et al. 1999:9; WIPO 2000:27).

By making IP work available on the Internet, the copyright holder must implicitly grants a non-exclusive licence to all Internet users who have access to the material to make transient copies of such works on their computers. Where a user gains access to material without proper authorisation, it could be argued that authorised access resulted in copyright infringement. This might be applicable to material on a website available to the general public. When determining copyright infringement, the courts evaluate the substantial similarity between works (Beutler 1997:254; De Villiers 2000:39-40; Goodchild 2000:352; Harris 1998:9; Hofman et al. 1999:85; Lloyd 1997:299; Search 1999:191).

Exposing works via the Internet holds an inherent threat of the illegal use of such works. There is a totally new reuse capacity of electronic works; original work can be copied over time without loss of quality. Stealing IP has become easier with digital technology. Electronically copying someone else's work takes very little time and almost no effort, often costs very little, and the reproductions are as perfect as originals (De Castell 2000:369; Granstrand 2000:340; Hart 1995:128; Hofman et al. 1999:85; Lloyd 1997:279; Search 1999:191).

Referring to the current Internet, Clifford Lynch (in Hakala 2001a) states that:

> The Internet – and particularly its collection of multimedia resources known as the World Wide Web – was not designed to support the organized publication and retrieval of information, as libraries are. It has evolved into what might be thought of as a chaotic repository for the collective output of the world's digital "printing presses." This storehouse of information contains not only books and papers but raw scientific data, menus, meeting minutes, advertisements, video and audio recordings, and transcripts of interactive conversations. The ephemeral mixes everywhere with works of lasting importance. In short, the Net is not a digital library. But if it is to continue to grow and thrive as a new means of communication, something very much like traditional library services will be needed to organize, access and preserve networked information.

The presence of IK on the Internet is a recent phenomenon because IK has recently started to intrigue many people. Many of the IK-related websites support and encourage research on the subject of IK. They also solicit financial and student support for their academic and postgraduate research programmes. The main reason for making IK available on the Internet was to coordinate the work that was being done internationally on IK. ICTs became the most feasible mode of communication and this was accelerated by technological advances, improved availability of computers and increased Internet access. Indigenous people themselves have limited or no access to the Internet. Even if they obtain access to the Web, they may lack training and familiarity with the technology (Le Roux 2003:107-108). The Internet can be regarded as a tool for communicating IK. However, the information on IK resources available on the Internet is not always controlled or verified with the indigenous communities.

7.2.2 IK on the Internet

There are various organisations that fund IK-related research and projects across the globe. These organisations include governments and multinational companies, especially pharmaceutical companies, that contribute funds to IK-related research. The World Bank, for instance, funds various development projects around the world, including IK-related projects. As discussed in chapter five, some of the information on IK resources available on the Internet could easily originate from appropriated IK resources. Although such IK is protected by various IP regimes, it is not possible for the poor indigenous communities to contest the appropriation thereof. The World Bank in particular has an IK Internet database available (see http://www4.worldbank.org/afr/ikdb/search.cfm) to which anyone can contribute. There is no form of control and verification of the information included in the database. The fact that anyone can contribute anything to the database means that serious inaccuracies and falsifications may be included. Thus, the quality of the information contributed to the database cannot be trusted.

Several other databases on the Internet contain information based on IK resources collected across the developing world. These databases are not always constructed in conjunction with the indigenous communities whose IK is sought after. Most of these databases are not related to each other but they, to some extent, contain similar information on IK resources from various geographic regions of the developing world. Duplication of information cannot be easily identified. The cataloguing of the information in most of these repositories does not conform to any standard. The following URL is a reference to UNESCO's IK database which contains information from various areas of the developing world: http://www.unesco.org/most/bpikreg.htm.

Academic institutions within the developed world also possess catalogues of IK resources, which are integrated with their main academic collection. Such IK resources are kept for research purposes. A number of institutions are already promoting IK as a popular research topics. This is not yet a reality in some academic institutions of the developing world. The Antioch New England School Library's Indigenous Knowledge Gateway Page is an example of such a catalogue (see

http://library.antiochne.edu/LIBPAGE/Envstudies/indigenous).

It is now very clear that digitised IK has been available via the Internet for some time. In most instances, the indigenous communities are not consulted prior to making information about their IK resources available on the Internet. Information on IK resources available on the Internet should be promoted through its indigenous owners and protected from appropriation. The next section illustrates various ICT-based mechanisms that could be implemented to protect and promote digitised IK.

7.3. Management structures to protect and promote IK

Based on the Information Science perspective, this section will focus on the management structure required to protect and promote IK on the Internet. Electronic organisation and retrieval of information are measures that may improve access to information and eliminate problems that are usually experienced with the communication between end-users and indirect information sources (see figure 2.4 in chapter two). The Dublin Core (DC) Metadata Element Set and the Open Archives Initiatives (OAI) are the *de facto* standards used for information organisation and retrieval. The purpose of implementing DC and OAI is that they support detailed analysis and retrieval of the intellectual content of an information resource. DC and OAI should be implemented to strengthen the existing IP laws that protect IK. The importance of having a national body in each country, particularly the developing IK-rich countries, to oversee the exploitation of domestic IK must be emphasised. The overall aim of this section is to explore the establishment of appropriate management structures to promote, protect and improve access to IK.

7.3.1 Repositories

Repositories are required for the storage of digitised IK. Modern-day repositories are electronic databases supported by specific application software. Copyright on databases is enforceable and the arrangement of their contents constitutes the author's own intellectual creation. IK databases are to be protected by copyright. The authors

of a database are defined as a natural person or group of natural persons who create the database. The rationale behind the introduction of databases is purely economical, but it protects the author's creativity in the selection and arrangement of the content of databases. In this instance, the official author of an IK database will always be the relevant Indigenous Knowledge Resource Centre (IKRC). The *sui generis* rights take a different approach when it comes to databases. They protect the investment made by database makers (Beutler 1997:257). The main purpose for the use of repositories is to promote the use of IK because all the IK resources will now be organised into one union catalogue, namely, international repository. The format or structure of all repositories should be consistent.

There are usually costs involved in the protection of the intellectual content of documented IK. Protection of the intellectual content of IK is cheaper than costs incurred for the protection through the law. This is the main reason for having chosen the use of repositories. Legal costs include transaction costs of transferring the rights, the costs of protection and enforcement, and the cost of filing. These high transaction costs may delay or even impair filing, exposing ideas that have been discovered over time to appropriation (Drahos 1997:207).

The advent of digital technology is an important element of modern-day IP. Digital technology permits the storage, production and transmission of material in the form of digits in binary codes consisting of zeros and ones. Digital information is only machine-readable and must be converted by a machine into some other form before it can be understood by a human being. Hart (1995:128) posits that the boundaries between different types of works must break down to allow text, pictures, audiovisual and musical works to be viewed and heard through the same medium, namely, a computer screen. This is imperative for digitised IK because it is available in different forms and multimedia would be the most appropriate way to portray it. Works would be transmitted anywhere when combined with telecommunications systems. Enormous volumes of material can be stored in relatively small spaces, allowing for increased portability (Goodchild 2000:344; Hart 1995:128; Oddie 1999:239; Shiozaki et al. 1999:100).

It should be decided at a later date if it is feasible to translate the documented information into any foreign language. On-demand or on-request translation services would be used. However, the original language version should always be kept because the meaning and implications are not always precisely reflected whenever the information is translated into a foreign language, especially in terms of cultural mores and norms. Various organisations are already involved in maintaining IK collections. These organisations would be required to contribute to the national IK repositories. The intellectual content of the recorded IK resources in all the repositories would be catalogued according to the DC Metadata Elements Set, in other words, it would be OAI compliant (see table 7.3). It would be mandatory for each IK resource to have an abstract in the English language.

Three repositories including local, national and international information, would be constructed. All of these repositories would be accessible via the Internet. A downloadable copy of the digitised resources must be stored in the local or national repository in a compressed format. The format of the IK resources would be determined by each IKRC and must be as popular as possible. Limited cross language information retrieval (CLIR) would be used where available. CLIR is still under research and would not be fully employed in the repositories until a universal standard has been adopted.

7.3.1.1 Local repositories

Various organisations involved and interested in IK research already have their own IK databases. These organisations serve as IK Resource Centres (IKRCs). Such organisation must contribute their collection to the national repository in the national interest. Should the organisation not be interested in contributing their IK resources to the national repository, they would have to contribute their metadata (which would always include an English abstract).

Local repositories with complete IK resources would contain various information resources such as still pictures, graphics, 3D models, audio, speech, video, documents, images, datasets, and so on (Richardson & Powell 2003). A dataset is information encoded in a defined structure (e.g., lists, tables, and databases), intended to be useful for direct machine processing. Multimedia would be catered for in the local repository. An abstract and any documented information regarding the relevant IK resource would be available over the Internet

A keyword search, based on the DC Metadata, would be allowed. Due to the fact that IK resources would be documented in the indigenous language, full-text searches would only be available in the indigenous language and can be used if known to the user. Should the organisation conducting the research decide to document their research only in English or any language other than the indigenous language, full-text searches would be allowed in that language. This means that for every full-text IK resource in the local repository, a full-text search should be possible in the documenting language. Local repositories would mainly serve as data providers during harvesting (for more details, see the section of OAI-PMH). Thus, local databases would allow both keywords and full-text searches. All the local repositories must be consolidated into national IK repositories. The local repositories would also be directly accessed via the Internet, without having to be harvested via the national or international repository.

7.3.1.2 National repositories

Indigenous communities must benefit from increased recognition of their own intellectual contributions to the national IK databases. All the local repositories must be consolidated into national repositories. Copies of IK resources in the local repositories would also be kept in the national repositories for redundancy purposes. The national repository would thus function as both a data provider and as a harvester. This means that searchers must be pointed to the relevant repository, and if no full-text IK resource is available, they should be directed to the local repository. This

would curb the free exploitation of resources for commercial purposes by companies who feel no obligation to compensate indigenous communities for their IK resources.

National IK Resource Centres (NIKRCs) would be responsible for overseeing the creation of the national repositories. The NIKRCs would facilitate the documentation of the undocumented IK. Some national governments have already started documenting their resources into national registers. This process would supplement the IK resources copied from local repositories. Appropriate methods of collecting IK information for documentation must be used. Duplicate research should be detected and avoided as early as possible. Video and audio recording must be used where required, especially if cultural performances are involved. The indigenous language must preferably be used during the documentation process at national level (Posey & Dutfield 1996:30).

Full-text searches would only be possible where the local IK resource centres contributed full texts or complete resources to the national repository. Mainly keyword searches would be allowed on the national repositories, especially for the digitised IK in the indigenous language. The national repository would be directly accessed via the Internet without first having to go via the international repository.

7.3.1.3 International repositories

The international repository would be a consolidation of the metadata and complete digitised IK resources of all the national IK repositories. No complete IK resources would be contained in the international repository. It would serve as an international common catalogue of all the IK resources and would also be accessible via the Internet. The international repository would act as a service provider of the stored IK metadata. The Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH) is the standard to be used in harvesting IK in the local, national and international repositories. Any organisation interested in conducting IK research in a particular country would work via the IIKRC.

The international repository would serve as a register of all the IK resources available internationally. It would be an international database created for tracing any IK resource. The international repository would serve as an "IK body of knowledge" (Ikbok) that would be used as an international IK register. Any overlap of IK resources among nations on an international level could be determined by means of this repository.

7.3.2 National IK Resource Centres

A global network of Indigenous Knowledge Resource Centres (IKRCs) has been growing since 1987 (IUCN 1997:174-7). The network could be used to ensure that there is a free flow of information for the benefit of developing countries and local communities. The purpose of IKRCs is to collect, record, organise and disseminate information pertaining to IK. The Centre for International Research and Advisory Networks (CIRAN) in Iowa, Leiden Ethnosystems and Development Programme (LEAD) in the Netherlands and the Centre for Indigenous Knowledge for Agriculture and Rural Development (CIKARD) in the USA all have global mandates and interests. ARCIKA in Nigeria and REPPIKA in the Philippines both have regional mandates. An Indigenous Knowledge and Development Monitor is published three times a year by CIRAN in partnership with the other centres. The Indigenous Knowledge and Development Monitor contains matters of common interest on IK. All the IKRCs in a country should be consolidated into a National IK Resource Centre (NIKRC). NIKRCs should develop and maintain national IK databases that contribute to sustainable development and education (IUCN 1997:174-7; Posey & Dutfield 1996:30).

The appendix to this thesis contains a list of some currently active IKRCs. The most important function of these centres is to protect and promote indigenous resources in the national interest of their countries. The national repositories would be located at the NIKRCs.

The NIKRC could perform or consolidate the following functions in conjunction with the relevant local populace or IKRCs:

- Identify national IK resources
- Document IK
- Digitise IK

The NIKRC would ensure that IK is included alongside scientific knowledge as part of a national and international effort to promote and protect IK.

Each NIKRC must ensure that the electronic copyright management systems used to protect IK resources integrate many different techniques to identify the authors and owners of rights. The systems at each IKRC must provide information about the terms and conditions for the use of works, provide billing systems, and track royalties paid to rights holders. It is strongly recommended that such systems form an integral part of each national repository (Harris 1998:173; Mansell & Wehn 1998:210).

Digitised IK resource requested from a national repository would be available for downloading by the requester on completion of the payment that would be deposited in the bank account of the appropriate IKRC. The payment could be based either on a predefined subscription system or on a per transaction purchase basis. Online electronic payment will have to be effected before complete digitised IK resource could be downloaded. The rules on the apportionment of payment for a period-based subscription would have to be determined by WIPO in consultation with all the parties involved. A subscription would have to be purchased for a predetermined period of time during which any number of resources can be downloaded.

Where a subscription for a specific period has been purchased, a note with the original receipt details with a zero fee would always be generated for each download. IK resources would be downloaded in a compressed format. The purpose of employing compression techniques on digitised resources is to enable minimal use of network resources during transmission and download. Users would have to apply a private key when accessing the compressed source for the first time on a machine. Compressed

IK resources will be auto-extractable and will not require any specialised uncompressing software.

7.3.3 International IK Resource Centre

Another possible way of managing the protection and promotion of IK is to establish an international IK repository managed by an International IK Resource Centre (IIKRC). The Institute of Intellectual Property in Japan identified a need for the establishment of a Digital Information Centre as a collective administrative centre in which information related to copyright works would be readily accessible to efficiently facilitate copyright clearance. The same kind of centre is required for the administration of IK. It is proposed that the IIKRC would be used for this purpose, under the auspices of WIPO (Hart 1995:128; Shiozaki 1999:105). Currently, one kind of centre for such information operates through the World Bank, which maintains an international IK database to which anyone can contribute. The bank is supposed to support endeavours aimed at promoting and protecting IK in conjunction with WIPO, rather than operating independently.

The IIKRC would have to maintain the international repository and the NIKRCs would have to contribute their metadata to the international IK repository. This means that WIPO would not necessarily need to directly maintain the repository but would rather be indirectly involved in each NIRC.

The IIKRC would have to act as an internationally recognised mediator or ombudsman for any dispute that might arise in relation to IK resources among nations. The IIKRC would assist in ensuring that the financial benefits derived from the acquisition of IK information benefits the local communities and/or their governments. IK resources cannot continue to be used by interested multinational companies as raw material for the production of goods without compensation to the indigenous owners of such resources.

7.4 Deploying ICT to protect IK

The IK resources contained in the national repositories would have to be protected against any infringement such as the IW identified in chapter two. Cryptography and digital watermarking are mechanisms to be employed to protect digitised IK resources.

Protecting digital IK would require secure marking mechanisms, such as embedded digital registration numbers to label works. This would be done so that IK owners are easily identifiable for the purpose of licensing materials such as a picture, an audiovisual sequence or a piece of music wanted for use in a multimedia work. Such arrangements would then be used by the clearinghouse authorised to grant requested licences. Failing this, they would at least provide contact information for the current copyright owner (Hart 1995:128; Shiozaki 1999:105).

7.4.1 Cryptography

Cryptography is the most popular technology effective in the protection of information that is transmitted via the Internet. Thus, a possible solution to the problem of infringement of digitised IK may lie in the field of cryptography or digital signature. Because of the non-physical nature of electronic communication, traditional methods of physically marking artefacts are obsolete. Cryptography is the most widely used method of protecting information from potential infringement. Public key cryptography allows users of an insecure network, like the Internet, to exchange data with confidence that it will be neither modified nor inappropriately accessed. This is accomplished through a transformation of the data according to an algorithm parameterised by a pair of numbers, the so-called public and private keys. Information is encrypted so that it is unusable until a key is transmitted and applied. This kind of transmission is limited to a one-off transmission and is regarded as being costly, time-consuming and complex to implement, although it is very effective (Harris 1998:173; Mansell & Wehn 1998:210).

The exchange of intellectual property data over digital networks is heavily dependent upon the technology of secure systems. The technologies of digital authentication and encryption can be used both to validate a data source and to demonstrate the integrity of a retrieved data. Secrecy-enhancing technologies will have extremely important consequences as they can radically improve the protection of IK resources over the Internet. The purpose of encryption is to keep information confidential. Encryption is a function, like adding or dividing, to calculate new numbers from old numbers. As ICT advances, it is expected that various transaction costs will be lowered and that investors can be remunerated more easily through higher protection (Granstrand 2000:339; Pretorius 2000:121; WIPO 2000:79). IK resources would be available via the Internet. Anyone who acquires any digitised IK resource would have to own a private key, to be able to access the documents.

One widely used privacy protection mechanism for electronic information protection a is what cryptographers call a secret key. Logon passwords and cash card PINs are examples of secret keys. Consumers share these secret keys only with the parties with whom they wish to communicate, such as an online subscription service or a bank. Private information is then encrypted with this password, and it can only be decrypted by one of the parties holding that same key (Pretorius 2000:121). The same mechanism can be employed when information on IK resources is made available via the Internet to the requesting party.

Positive identification of IK resources is needed when it is sent to the requester via the Internet from the national repository. The most realistic way of doing this is to provide identification in the cyber world by trusted references, in a specific domain and for a specific role. This would allow risk to be determined on the basis of trust and identity. The most common solution to the identity problem is to use a trusted third party, known as a certification authority (CA), to authenticate the key holders' identity. CAs are computerised databases that issue digital certificates. They may be run by government or the private sector. A digital certificate is a computer record sent via a computer network, such as the Internet, to a requesting party. It contains, at the minimum, the certification authority's name, the name of the person being certified, and that person's public key. A system that certifies the public key holder's identity is

known as a public key infrastructure (PKI). The current certification process used by the CAs is based on the public key infrastructure and X.509 certificate. Secret keys would be sent with the receipt details to the purchaser and should be applied the IK resource (Hofman et al. 1999:70-2; Pretorius 2000:128-31; WIPO 2000:79). The purpose of this would be to curb possible fraud or the illegal use of IK resources.

A private key would be downloaded together with the receipt details at the same time as the compressed copy of the IK resource. The key will make an entry on the machine's registry when applied. This is done to avoid another key being used for the same resource on another machine. Should people try to open a digitised IK resource on a different machine without a private key, they would be unsuccessful. Should a key be lost or destroyed by mistake and the IK resource be transferred to another machine in the meantime, a query should be entered at the local repository with the payment reference number and a new private key would be generated for the buyer of a specific IK resource. This would reduce the incidence of unauthorised copying of IK resources.

This system should be incorporated into WIPONET, with WIPO overseeing its implementation. WIPO launched a major project in 1998 (the project deployed in 2000), which was intended to develop and establish a global information network officially known as the WIPO Global Information Network (WIPONET). WIPONET is a state-of-the-art project designed to ensure that WIPO is able to respond to the remarkable growth of electronic commerce and the increased demand for electronic data exchange services (Idris 2000:63; Finger & Schuler 2000:521; Mashelkar 1999; WIPO 2000:54&59).

Although no encryption methods have been accepted as a standard, encryption has been used to an increasing extent. Until 1977, the International Traffic Arms Regulation in the United States prevented American firms from exporting encryption techniques. In addition, the Organisation for Economic Cooperation and Development (OECD) developed an initiative to harmonise the use of encryption techniques among its member countries and the OECD Council adopted a set of guidelines in March 1997 to formalise the encryption techniques (Bettcher et al. 2000:528; Mansell &

Wehn 1998:211). These guidelines will have to be ratified by WIPO before they can be implemented as digital technologies to protect IK.

7.4.2 Digital watermarking

Digital watermarking is a technique for secretly hiding copyright information in digital content such as digital images. Watermarking audio material with a code of numbers does not affect the sound quality of a recording but offers a method of establishing whether or not the material has been used by a non-licensed user. Other techniques related to digital watermarking are holograms and fingerprinting. Holograms are embedded in the conduit of the digital resource (this technique was initially employed for CD-ROM packages) or media to authenticate the legitimacy of a copy. This was devised to limit the reproduction of digital media, such as second generation copies, by making it almost impossible to copy. Fingerprinting digital images by embedding originator-specific data-within-data is a potential method of legally demonstrating originality, which is attracting the interest of publishers. This technique is also relevant to digitised IK resources. In principle, all of these methods might be circumvented, but in practice their increasing use is a deterrent to those who might consider infringing digital IK (Harris 1998:173; Mansell & Wehn 1998:210; Shiozaki et al. 1999:100).

The use of technical systems for IK protection would increasingly be supported by IK owners, researchers and policy makers. However, a study on the methods of copyright protection adopted by small and medium-sized electronic information publishers in the United Kingdom suggests that the use of digital watermarking is not yet widespread (Mansell & Wehn 1998:210). The following factors contribute to the relatively low take-up of new techniques:

- the absence of an agreed standard
- rising costs of production and customer support
- the need to make electronic publications user-friendly
- the perceived inadequacy of copyright laws
- the need to accelerate the time to market the products

Most of these issues are relevant to IK in the sense that digital watermarking would be a new feature added to digitised IK resources. The publishing industry is supposed to be the leader in this regard and their efforts would continue to guide the industry in the protection of digital information.

7.5 Deploying ICT to promote IK

It would be possible to use ICTs to facilitate communication between the international repository and the relevant IKRC repositories. ICT promotes networking as a dynamic, self-expanding form of communication which transforms all domains of social and economic life (Golding 2000:171; Luzwick 2000b).

7.5.1 Organising and retrieval of digital IK

The most efficient way to promote digitised IK is to improve its organising within repositories and to ease its retrieval. An IK resource would be organised according to metadata or content. Metadata retrieval would be based on the DC Metadata Element Set and would have to be OAI-compliant for efficient retrieval. Content retrieval should be full-text and/or CLIR-based. Metadata can be described as the content of a knowledge source and would be used as the standard adopted to organise information stored within repositories. Repositories are also referred to as digital libraries (DLs).

All the repositories, namely, local, national and the international repositories, would have their IK resources organised according to the DC Metadata Element Set and would be OAI-compliant. Should it happen that a search is launched from the international repository, the user would be pointed to the relevant local or national repository with the relevant IK resource. Users searching on a national repository would be pointed to the local repository. This would happen in cases where the IK resources themselves were never contributed to a national repository and only the metadata were made available. Keyword searches would be allowed in all the repositories. Full-text searches in the documenting language of the IK resource would

be allowed in cases where full-text resources are available, in other words, in the local and national repositories. The documenting language would in most instances be an indigenous language. Limited CLIR would be used where available. CLIR would be a futuristic development for information retrieval from repositories with fill-text resources. This would be the case until a standard in the CLIR field has been adopted to help ensure consistency in the CLIR systems developed.

There has been a general desire for systems to be interoperable at the levels of data exchange and service collaboration. A Resource Description Framework (RDF) would be employed for additional requirements not covered by the DC Metadata. RDF would support the consistent encoding and exchange of standardised metadata. It provides for the interchangeability of separate packages of metadata defined by different resource description communities.

There are different metadata initiatives aiming at unifying the naming of data worldwide. Dublin Core is the basis for further developments in metadata standards. RDF is used for the management of metadata on the World Wide Web and the MPRG-7 format covers many approaches for describing multimedia metadata. All these initiatives need to be consolidated for the management and naming of the IK data.

7.5.1.1 Dublin Core Metadata

The Dublin Core Metadata Initiative (DCMI) began in 1995 with an invitational workshop in Dublin, Ohio, that brought together librarians, digital library researchers, content providers, and text markup experts to improve discovery standards for information resources. The original DC emerged as a small set of descriptors that quickly drew global interest from a wide variety of information providers in the arts, sciences, education, business, and government sectors (ISO 15836:2003(E); National Information Standards Organisation 2001).

The DC Metadata Element Set comprises 15 descriptors (see table 7.2) that resulted from this effort in interdisciplinary and international consensus building. The DC now exists in over 20 translations and has been adopted by CEN/ISSS (European Committee for Standardisation / Information Society Standardisation System), and is documented in two Internet RFCs (Requests for Comments). It also has official standing within the WWW Consortium and the Z39.50 Standard. DC Metadata has been approved as a U.S. National Standard (ANSI/NISO Z39.85), formally endorsed by over seven governments for promoting the discovery of government information in electronic form, and has been adopted by a number of supranational agencies such as the World Health Organisation (WHO). Numerous community-specific metadata initiatives in library, archival, educational, and governmental applications are using the DC as their cataloguing basis (ISO 15836:2003(E); National Information Standards Organisation; Hakala 2001b).

The Dublin Core Initiative adopted the Resource Description Framework. Table 7.2 contains the DC Metadata Element Set required for cataloguing the intellectual content of an information resource and is also applicable to the field of IK. Anyone who infringes the rights as stipulated in the 'Rights' element, would be prosecuted.

7.5.1.1.1 Resource Description Framework

Resource Description Framework (RDF) is the result of a number of metadata communities (including Dublin Core, PICS, Digital Signatures) bringing together their needs to provide a robust and flexible architecture for supporting metadata on the Internet and the World Wide Web (WWW). RFD is thus a standard developed for the management of metadata on the WWW. RDF was developed under the auspices of the WWW Consortium and is an infrastructure that enables the encoding, exchange, and reuse of structured metadata. The RDF schema uses the Dublin Core schema as well as additional schemas for technical data (Hunter 2003; Miller 1998). It uses the vocabulary developed by the Dublin Core Initiative. Thus, RDF is extended DC metadata.

RDF as a framework for metadata provides interoperability between applications that exchange machine-understandable information on the web. It emphasises facilities to enable the automated processing of web resources. RDF is the result of a number of metadata communities bringing together their needs to provide a robust and flexible architecture for supporting metadata on the Web. The development of RDF as a general metadata framework, and as a simple knowledge representation mechanism for the Web, was developed under the serious influence of the Platform for Internet Content Selection (PICS) specification. PICS is a mechanism for communicating ratings of webpages from a server to clients. This is an initiative started by WWW Consortium, which also ratified the DC Metadata (Miller 1998; Lassila & Swick 1999).

RDF could thus be said to be a WWW Consortium proposed standard for defining the architecture necessary for supporting Web metadata. RDF is an application of XML that imposes needed structural constraints to provide unambiguous methods of expressing semantics for the consistent encoding, exchange, and machine processing of metadata. In addition, RDF provides means for publishing both human-readable and machine-processable vocabularies designed to encourage the exchange, use and extension of metadata semantics among disparate information communities (Miller 1998; Lassila & Swick 1999). This would also be very beneficial to those interested in IK.

7.5.1.1.2 MPEG-7

Audiovisual resources in the form of still pictures, graphics, 3D models, audio, speech, and video will play an increasingly pervasive role in the field of IK. Because of the complex, information-rich nature of such content, value-added services such as analysis, interpretation and metadata creation might become much more difficult, subjective, time-consuming and expensive. During the compilation of the MPEG-7 standard, the DC Metadata Initiative was taken into account. Standardised multimedia metadata representations that would allow some degree of machine interpretation would be necessary. The MPEG-7 and MPEG-21 standards have been developed to

support such requirements and should be adopted for IK (Hunter 1999; Hunter 2003). MPEG would have to be integrated with DC in order to ensure the implementation of common standardised metadata elements.

MPEG-7 defines an interoperable framework for content descriptions way beyond the traditional metadata. MPEG-7 has descriptive elements that range from very low-level signal features like colours, shapes and sound characteristics, to high level structural information about content collections. MPEG-7 also has unique tools for structuring information about content (Koenen 2001). Table 7.1 depicts MPEG-7 descriptors.

MPEG-7 is intended to describe audiovisual information regardless of storage, coding, display, transmission, medium, or technology. It can address a wide variety of media types, including still pictures, graphics, 3D models, audio, speech, video, and combinations of these, in other words, multimedia presentations. The MPRG-7 format covers many approaches for describing multimedia metadata. It is the Multimedia Content Description Interface, which is an ISO/IEC standard for describing multimedia content developed by the Moving Pictures Expert Group (MPEG). The goal of this standard is to provide a rich set of standardised tools to enable both humans and machines to generate and understand audiovisual descriptions. The goal of MPEG's latest initiative, MPEG-21, the Multimedia Framework, is to define the technology needed to support users to exchange, access, consume, trade and manipulate multimedia digital items in an efficient, transparent and interoperable way. Users may be content creators, producers, distributors, service providers or consumers (Koenen 2001; Hunter 1999; Hunter 2003)

Table 7.1 Overview of MPEG-7 descriptors

Type	Feature	Descriptors
Visual	Basic Structures	Grid layout
		Histogram
	Color	Color space
		Dominant color
		Color histogram
		Color quantization
	Texture	Spatial image intensity distribution
		Homogeneous texture
	Shape	Object bounding box
		Region-based shape
		Contour-based shape
		3D shape descriptor
	Motion	Camera motion
		Object motion trajectory
		Parametric object motion
		Motion activity
		Motion trajectory features e.g., speed, direction, acceleration
Audio	Speech Annotation	Lattice of words and phonemes plus metadata
	Timbre	Ratio of even to odd harmonics
		Harmonic attack coherence
	Melody	Melodic contour and rhythm

Source: Hunter (1999), Table 2

Table 7.2 Description of DC with proposed added subdivisions

User interface label	Definition	Comment	Added subdivisions
Title	A name given to the resource.	Title will be a name by which the resource is formally known.	
Creator	An entity primarily responsible for making the content of the resource.	Examples of a creator include a person, an organisation, or a service.	Creator.status
Subject	The topic of the content of the resource.	A subject will be expressed as keywords, key phrases or classification codes that describe a topic of the resource. Recommended best practice is to select a value from a controlled vocabulary or formal classification scheme.	Subject.keyword Subject.domain
Description	An account of the content of the resource.	Description may include but is not limited to an abstract, table of contents, reference to a graphical representation of content or a free-text account of the content.	
Publisher	An entity responsible for making the resource available.	Examples of a publisher include a person, an organisation, or a service. Typically, the name of "publisher" should be used to indicate the entity.	
Contributor	An entity responsible for making contributions to the content of the resource.	Examples of a contributor include a person, an organisation, or a service. Typically, the name of a contributor should be used to indicate the entity.	
Date	A date associated with an event in the life cycle of the resource	The date is associated with the creation or availability of the resource. Recommended best practice for encoding the date value is defined in a profile of ISO 8601 and follows the YYYY-MM-DD format.	Date.recorded Date.published Date.added Date.created Date.valid Date.available Date.modified Date.accepted Date.copyrighted
Type	The nature or genre of the content of the resource.	Type includes terms describing general categories, functions, genres, or aggregation levels for content. Recommended best practice is to select a value from a controlled vocabulary.	
Format	The physical or digital manifestation of the resource.	Typically, format may include the media-type or dimensions of the resource. Format may be used to determine the software, hardware or other equipment needed to display or operate the resource. Examples of dimensions include size and duration.	
Identifier	An unambiguous reference to the resource within a given context.	Recommended best practice is to identify the resource by means of a string or number conforming to a formal identification system. Examples of formal identification systems include the Uniform Resource Identifier (URI), the Uniform Resource Locator (URL), the Digital Object Identifier (DOI) and the International Standard Book Number (ISBN).	
Source	A reference to a resource from which the present resource is derived.	The present resource may be derived from the source in whole or in part. Recommended best practice is to reference the resource by means of a string or number conforming to a formal identification system.	
Language	A language of the intellectual content of the resource.	Recommended best practice is to use RFC 3066 [RFC3066] in conjunction with ISO 639 [ISO639].	
Relation	A reference to a related resource.	Recommended best practice is to reference the resource by means of a string or number conforming to a formal identification system.	

User interface label	Definition	Comment	Added subdivisions
Coverage	The extent or scope of the content of the resource.	Coverage will typically include spatial location (a place name or geographic coordinates), temporal period (a period label, date, or date range) or jurisdiction (such as a named administrative entity). Recommended best practice is to select a value from a controlled vocabulary (for example, the Thesaurus of Geographic Names [TGN])	Coverage.location Coverage.timespan Coverage.tribe
Rights	Information about rights held in and over the resource.	The rights element will contain a rights management statement for the resource, or reference to a service providing such information. Rights information often encompasses Intellectual Property Rights (IPR), copyright, and various property rights.	
Proposed addition			Funding agency

Source: Based on http://dublincore.org/

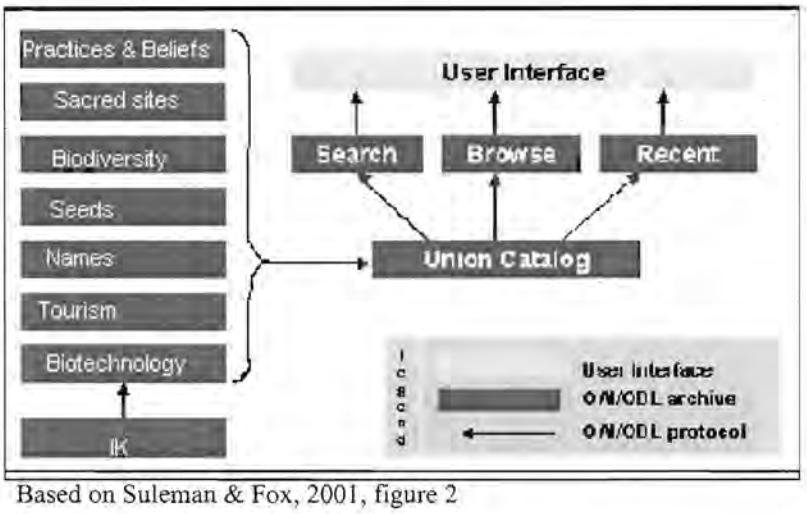
7.5.1.2 OAI

In October 1999 the Open Archives Initiative (OAI) was launched in an attempt to address interoperability issues among the many existing and independent digital libraries (DLs) to facilitate the sharing of the metadata. The focus was on high-level communication among systems and simplicity of protocols. The OAI has since received much media attention in the DL community, primarily because of the simplicity of its standards (Suleman & Fox 2001).

The Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH) is a transport protocol that oversees the transfer of any metadata from one computer, acting as the data provider (or repository) for another computer, which acts as the service provider (or harvester). A harvester can request information about the repository or request an individual record or groups of records that may be restricted by date or by other predefined groupings. In the case of IK, the local and national repositories would be data providers whilst the international repository, and the national repositories in some instances, would be the service provider or the harvester (Richardson & Powell 2003).

The OAI-PMH in essence supports a system of interconnected components, where each component is a DL in its own right. Since the protocol is simple and is becoming widely accepted, it is far from being a custom solution for a single project. Since the DLs are loosely defined, this collaborative system could be composed of individual component DLs, each with a different function. In the extreme case, each component DL would supply the functionality of exactly one service expected by a user. This is the approach taken for managing IK where repositories are modelled as networks of extended Open Archives, with each extended Open Archive being a source of data and the international repository being a provider of services. Based on this network of extended Open Archives, Figure figure 7.1 illustrates a so-called Open Digital Library (ODL) (Suleman & Fox 2001).

Figure 7.1 IK-based OAI



Based on Suleman & Fox, 2001, figure 2

Figure 7.1 illustrates various types of IK. Even though they may all appear in more than one repository, they would be subdivided as such in the backend of the catalogue of the international repository. User interface design and workflow management are complex tasks and would have to be implemented in the international repository. Common base-level services have emerged in practice, for example, supporting searching and browsing. There would be various IK DLs with different subjects on local and national repositories. Entries in all the repositories would be arranged according to the DC Metadata Element Set. The same principle would be applied when configuring the international repository housing the union catalogue.

In this case, the OAI Harvester is used to obtain a stream of data, which in turn is used to create indices for searching. Queries are then submitted through the OAI Data Provider interface. These queries overload the semantics of the OAI-PMH by using the OAI notion of sets to correspond to the dynamically generated result sets of a search engine. Analogously, when such a request is submitted, the query is mapped to the name of a set. Thus, without making any changes, the OAI-PMH can be used to serve as the interface to a search engine. With a few minor additions to the OAI-PMH, information such as cardinality of result sets also could be returned. To test the feasibility of ODL design, a suite of components has to be specified, implemented, integrated into a network, and assessed for their feasibility (Suleman & Fox 2001).

Table 7.3 Components used in prototype system

Component	Function
ODL-Union	Combine metadata from multiple sources
ODL-Filter	Reformat metadata from (non-OAI-Conforming) data sources
ODL-Search	Provide search engine functionality
ODL-Browse	Provide category-driven browsing functionality
ODL-Recent	Provide a sample of recently-added items

Source: Suleman & Fox (2001), table 1

Componentisation and standardisation are built into the system by design if every service is delivered by an extended Open Archive. This inherently supports reuse and allows for interoperability at the level of individual services within the DL. The ODL approach closely resembles the way that physical libraries work. In a physical library the individual systems interoperate within their own communities. For example, the purchasing department interoperates with the booksellers and the interlibrary loan department interoperates with peer departments at other libraries.

As mentioned earlier, the Internet is an extremely effective information dissemination tool. This is primarily due to the simplicity of the protocols it relies on and the hierarchical manner in which protocols such as HTTP are built. They are built on more fundamental protocols such as IP and TCP. The OAI provides a simple protocol to transfer metadata. Building simple layered extensions to this protocol would closely follow the proven methodology of the networking community.

7.6 Summary

This chapter used an Information Science perspective of IW to protect and promote access to IK. Specific ICTs were adopted to promote, protect and ease access to IK resources. The Internet is the most important tool for communicating information, including IK, in the digital age. Various instances were identified in which IK has been made available via the Internet without the consent of the indigenous communities involved. This necessitates the deployment of ICT to promote and

protect IK. Documented IK would have to exist in the indigenous language only and would have to be digitised and stored in the format deemed most appropriate by the IKRC. The NIKRCs would have to oversee the management activities of IK in each country. The digitised IK would have to be accessible from local and national IK repositories. The stored IK resources would have to be catalogued according to the DC Metadata Element Set.

All repositories, namely, local, national and international IK repositories, would be accessible via the Internet. As such, keyword and full-text searches would be done on local and national repositories whilst only keyword searches would be allowed on international repositories. The IIKRC, an international IK management body, would have to be established under the auspices of WIPO. The DC Metadata Element Set in both repositories would be in written in the English language. Cross-language information retrieval would be catered for, where possible. However, this subject is still under research and could not be fully implemented until a standard has been adopted. This is devised to promote the access to digitised IK. An Information Science perspective of IW was employed in this chapter through implementing ICT to promote and protect IK. This chapter answered the following research sub-question:

What ICT solutions exist to promote and protect IK?

Techniques of cryptography and digital watermarking are to be employed to protect IK. Cryptography uses private keys and digital certificates that are downloaded with an IK resource. CAs would be employed to authenticate the key holders' identity. A private key would always have to be used when an IK resource is accessed on a machine for the first time and would be written to the registry of the machine. Digital watermarking would employ holograms and fingerprinting to protect the authenticity of a copyrighted work. Holograms are embedded in the conduit of the digital resource. The fingerprinting of digital images is done by embedding originator-specific data-within-data, such as the author's signature, within a document.

The DC Metadata Element Set and OAI are to be employed respectively for the organisation and retrieval of digitised IK. DC is a standard that comprises of 15

Metadata Element Sets that would determine the schema of all the repositories or DLs containing digitised IK. Extended DC Metadata such as RDF, which is a standard for the management of IK on the World Wide Web, and MPEG-7 that would ensure implementation of multimedia objects, would be implemented. OAI-PMH is a protocol to be employed for harvesting IK resources and overseeing the transfer of metadata from one computer (acting as a repository) to another computer (acting as a harvester).

Chapter eight discusses the value of this research and presents conclusions and recommendations.

Chapter 8

Conclusions and recommendations

8.1 Introduction

This research set out to explore issues surrounding the following research problem statement:

To critically investigate IW against IK in the developing world with specific reference to intellectual property rights

A study of various problems that exist between indirect information sources and end-users led to the adoption of an Information Science perspective of IW that has formed the basis of this research. This study further identified various kinds of IPRs. IK is a form of IP that is greatly sought after for use as a resource. Its popularity may be in part because it is not well protected by the IP laws. It is notable that some agencies and organisations in the developing world have recently developed an interest in the field of IK.

The approach taken in this thesis with regards to the protection of IK was based on the technological developments of the information age. One of the characteristics of the information age is that information and knowledge are documented and digitised as much as possible to ease access to and availability of information. Information will have to be protected by means of available ICTs. This includes using the Internet as a medium to distribute information.

8.2 Research summary

This research adopted an Information Science perspective in investigating factors of IW perpetrated against IK. The Information Science perspective of IW entails an analysis of factors which inhibit access to indirect information sources. These factors contribute to IW against IK within the developing world. IK has recently become recognised as a resource by some sectors within the developed world. Some prospecting IK researchers started using IK without the consent and recognition of the indigenous communities from which this knowledge originated. No financial benefits were derived by the source communities from the exploitation of their IK. To fully understand this issue, various issues pertaining to IW, IP, IK and ICT had to be investigated. This research was based on an extensive literature analysis, which drew upon various sources of academic literature, including scholarly empirical articles, dissertations, monographs and books, electronic articles and other types of material such as non-empirical scholarly articles.

The problem statement, research focus and roadmap of this thesis were introduced in chapter one. Various types of IW were identified in chapter two. The evolution of IP legislation in different parts of the world was discussed in chapter three. The origin and purpose of IK was investigated in chapter four. Chapter five investigated specific cases that involved IK appropriation, while chapter six investigated various measures that are currently employed to promote and protect IK. Chapter seven explored various applications of ICT to protect and promote IK.

8.3 Answers to research questions

Information warfare against IK has been in existence for some time even though its origin cannot be traced back to the colonial era. Interest in IK is a recent phenomenon. A critical investigation of IW against IK in the developing world entails a multiplicity of factors. The main research question could not be answered without addressing these factors, which were translated into research sub-questions and addressed in each

chapter. The following sections summarise the findings relating toe ach of these sub-questions.

8.3.1 What constitutes information warfare?

This research sub-question was answered in chapter two. This chapter investigated various types of IW that exist. An Information Science perspective of IW was formulated and later adopted in chapter four because it was more deemed to be helpful in understanding various issues pertaining to IK appropriation. Other perspectives of IW identified were militaristic warfare, intelligence-based warfare, electronic warfare, psychological warfare, hacker warfare, economic warfare and cyber warfare. Military warfare is the oldest form of warfare and all other forms of warfare owe their origin to it. Although many forms of warfare exist, the Information Science perspective was adopted for this thesis because it emphasises the study of problems pertaining to the flow of information between information sources and end-users.

When information is recognised as a commodity, its management becomes paramount. If an individual or organisation has sole possession of a particular body of information, that information may enable the holder to achieve their desired objectives. As more information becomes commoditised, the economic value of such information increases. The original owners or originators of such information should also enjoy the financial benefits derived from the exploitation of their information resource. Excessive power and stringent control over access to information would curtail access to protected information. Protection of information would be further enhanced by the ICTs available in the information age (Debon, Horne & Cronenweth 1988:2).

In further answering this research sub-question, a definition of IW based on the Information Science perspective was also adopted. The formulated Information Science definition of IW is a deliberate or non-deliberate attempt to restrict and control access to information.

This definition of IW was found to be relevant in chapter five when various cases of IK appropriation were discussed, especially when indigenous names are registered as Internet domain names that have nothing to do with the real people who use such names. The relevant communities are subsequently barred from registering Internet domains with the same names. The cases investigated in chapter five affirmed the validity of this definition by demonstrating the appropriation of IK resources from developing countries by some organisations based in the developed world. This was seen to be a direct result of the commoditisation of IK resources for financial gains.

8.3.2 What is IP and what role does it play in globalisation?

This research sub-question was answered in chapter three by exploring the historical evolution of IP within the global context. The philosophy and the historical background of IPRs were explored and various perspectives of IP investigated. The Western perspective and its evolution in other parts of the world were investigated. The Eastern and African perspectives on IP were also investigated. The Western perspective is the basis that shaped the international IP regimes that evolved worldwide and may be considered the dominant perspective.

The Eastern perspective owes its origin to the Western perspective because it also recognises an individual or organisation as the sole holder of intellectual property rights. The African perspective is based on a system of communal ownership where all the community members are considered to be co-owners of any form of property that exists within the community. The most commonly known and recognised forms of IP that are discussed in chapter three are copyright, trademarks, patents and plant breeders' rights. Most countries have their own legislation on IP. This legislation was often strongly influenced by international conventions that were set up to harmonise the national IP legislation.

Conventions such as GATT and TRIPS achieved the harmonisation of various aspects of the IP legislation such as setting the lifespan of a patent at 20 years from the date of

filing. This ruling was extended to the developing world to protect the interests of those who register patents. Plant breeders' rights is the most common form of IP that should protect indigenous bioresources; however, patents are registered based on the properties of such resources. This action leaves the indigenous people helpless to protect their indigenous knowledge. Instead, the plant breeders' right protect those who invent a 'new' plant variety rather than the custodians of indigenous resources.

It is very expensive for the developing world to register an international patent or to acquire a product protected by an internationally registered patent. This is due to the higher fees linked to patent registration. The initial intention of IP was to provide access but also to protect the economic interests of the creator of knowledge. The advent of a monetary economy created a shift towards a stricter focus on protection and less emphasis on access to IP. Increased IP protection curtails access to IP by the developing world, to the economic disadvantage of the latter. IK starts to fall within the realm of IP because there are several patents registered on IK resources.

It is in the long-term interests of all countries to create IP systems that conform to the rulings established by TRIPS. Failure to implement TRIPS may undermine the system as a whole and delay progress in other key areas such as the development of improved protection for indigenous knowledge (Morris et al. 2001:81).

8.3.3 What constitutes IK and how is it treated in the global IP regimes?

This research sub-question was addressed in chapter four. Various researchers and organisations have adopted their own definitions of IK, as a universally adopted standard definition of IK does not yet exist. This research does not try to generate a universally acceptable definition of IK, but rather explores various definitions that exist. These definitions are generally very similar. They commonly define IK as knowledge that has been used and still exists within the developing nations of the world.

IK is also contrasted with Western or modern knowledge. Modern knowledge is the knowledge developed by universities, research institutions and private firms using a formal scientific approach. IK has been portrayed as value laden, and content driven. No convincing proof exists to show that Western knowledge is superior to IK. IK also exists in the globalised environment and it is thus influenced by globalisation factors. International agreements such as GATT support globalisation. Development agencies, especially bilateral donors, have historically displayed limited interest in indigenous peoples. They gave low priority to the preservation of traditional cultural values compared to the conservation of biological resources. This might have been caused by the oral nature of the traditional cultural values.

IK is not important to indigenous people only, but also to the Westerners who discovered it elsewhere. It has been an open treasure box for the unfair appropriation of items of value. When IK is appropriated, it is transformed into a constituent of the commercial process. Schools within traditional societies were never prepared to act as a medium for the promotion of IK and they never fulfilled that role. IK research should be conducted according to the principles of sustainable development to preserve existing knowledge and resources for future generations. Bioprospecting was identified as one of the reasons for the interest in IK shown by a number of researchers.

8.3.4 What is the current state of IW against IP?

This research sub-question was answered in chapter five. IW against IK within the developing nations is a serious threat to sustainable development within these nations. Various cases investigated confirmed that IW is perpetrated against IK within the developing nations. The IW definition coined within the Information Science perspective was also validated against the cases investigated.

The cases explored support the reasons for protecting IK. In order to do this, national biodiversity conservation regimes are starting to conform to the objectives of the Convention on Biological Diversity. The aim is for these regimes to provide legal

protection to biological resources and associated IK at the national level. In order to promote sustainable development, it is important to recognise the value of IK and facilitate the resource management of indigenous people (Van Dulken 2000).

The appropriation of some IK resources by the developed world constitutes a form of information warfare against the developing nations. For a patent to be eligible, inventions should be novel, non-obvious, and useful. In theory, intellectual property laws ensure that inventors and investors are rewarded for their endeavours if their product is successfully commercialised. IPR mechanisms give patent holders exclusive monopoly over their inventions for 17 to 20 years and royalties on the use of their invention. IPR mechanisms also allow patent holders to control access to their inventions. They may also set the conditions for the sale of the invention, because the patent holder can vary the licensing arrangement. The patent holder can also deny access to some customers. In practice, intellectual property regimes have evolved into mechanisms that allow some corporations to protect markets and to trade technologies among themselves, barring disadvantaged communities from entering the market (Grenier 1998:13).

8.3.5 Which measures are currently used to protect and promote IK?

Chapter six addressed this research sub-question by determining the current measures employed to promote and protect IK. Measures currently employed to promote and protect IK require that indigenous people be recognised as the original owners of IK. Various endeavours are underway by national governments to document their IK resources. Should any IK resource be appropriated it would be verified against the documented resource. Joint ventures and collaborative research projects are usually undertaken in IK research in which both the researchers and the local communities have a meaningful role to play in the process.

Indigenous people must have a stake in the management of local resources on which their subsistence economy is based. Cooperative or co-management arrangements, in which indigenous communities share management authority with other government

organs, are a vital step towards a self-sustaining economy. A number of compensation mechanisms such as funds, contracts and IPR agreements, nonbinding agreements, and defensive publications should be used to compensate indigenous communities. Defensive publications and benefit sharing can also be used for compensation. IW against IK and the lack of legal protection for biological and cultural heritage has made the indigenous communities of the developing world vulnerable to biopiracy and intellectual piracy. There is a dire need for a system of protection of indigenous knowledge in addition to the existing IP regimes.

Some indigenous communities have established databases which they maintain themselves. Community registers must be developed in IK-rich countries as a means of securing community control over traditional ecological resources. Locals would have to document all known plant and animal species with full details of their uses. The information would then be contributed to the national IK repository for protection and access (see chapter seven).

It is neither logical nor practical that the best system for the protection of the culture and intellectual property of indigenous people resides with the state or even with the international community. Protection can only be designed and implemented by indigenous communities themselves in partnership with individuals and organisations (local, national, regional and international) of their choosing, and on an informed basis. The body most capable of respecting and enhancing the unique needs of an indigenous community is one initiated, developed and staffed by the community itself, namely, Indigenous Knowledge Resource Centres (IKRCs) (Johnston 2000:95).

8.3.6 What ICT solutions exist to promote and protect IK?

This research sub-question was answered in chapter seven. ICTs could be employed to better protect and promote IK. Instead of reinventing the wheel, existing infrastructures could be employed to promote and protect IK. The ICT infrastructure includes the Internet, digitisation of documented or recorded IK by the national IKRCs and storage into national repositories, and the deployment of cryptography and

digital watermarking for the protection of IK. Access to IK could be improved by employing efficient information organising and retrieval mechanisms.

The Internet is the most important medium for communicating information, including IK, in the digital age. Various instances were identified in which IK has been made available on the Internet without the consent of indigenous communities. This necessitates the deployment of ICT to promote and protect IK. IK need only be documented in the indigenous language and would have to be digitised and stored in the national repositories in a format deemed appropriate by the IKRC. The national IKRC will have to oversee the management activities of IK in each country. The digitised IK would have to be stored in the national IK repository according to the Dublin Core (DC) Metadata Element Set. Subscription payments for all the IK resources will be effected to the appropriate bank account of the relevant IKRC.

The international repository will have to be established under the auspices of WIPO. The DC Metadata Element Set in all repositories will be in plain text and in the English language only. No cross-language information retrieval will be catered for because it is still under research. This is devised to promote the access to digitised IK. All IK repositories will be accessible to the public via the Internet, that is, searches would be done on any accessed repository.

The techniques of cryptography and digital watermarking are to be employed to protect IK. Cryptography uses private keys and digital certificates that are downloaded with an IK resource. A Certification Authority will be employed to authenticate the key holders' identity. A private key will have to be applied whenever the resource is accessed for the first time on a machine. An entry would be made to the machine's registry and the subsequent access to the resource would not require a key to be applied because it would be verified through the registry. Digital watermarking will employ holograms and fingerprinting to protect the authenticity of a copyrighted work. Holograms are embedded in the conduit of the digital resource. The fingerprinting of digital images is done by embedding originator-specific data-within-data, such as the author's signature, within a document.

The DC Metadata Element Set and Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH) are to be employed respectively for the organising and retrieval of digitised IK. DC is a standard that comprises of 15 Metadata Element Sets that will determine the schema of all the repositories containing digitised IK. Some additional elements are proposed for the further analysis of the intellectual content of the IK resources. OAI-PMH is a transport protocol that could be employed for harvesting IK resources and overseeing the transfer of any metadata from one computer acting as a repository (national and local repositories) to another computer acting as a harvester (international repository).

There are different metadata initiatives aiming at unifying the naming of data worldwide. Dublin Core is the basis for further developments in metadata standards. Resource Description Framework is used for the management of metadata on the World Wide Web and the MPRG-7 format covers many approaches for describing multimedia metadata. All these initiatives need to be consolidated for the management and naming of the IK data.

8.4 Conclusion

This research argues that there is increasing interest in the field of IK. This interest originated with the profit motives of certain individuals and organisations. The potential to use IK as a resource or raw material in the production of goods such as pharmaceutical products was discovered. Financial reward or recognition was seldom, if ever, given to the indigenous people who were the original practitioners or owners of such IK resources. This phenomenon progressed to a point where patents were registered on products derived from such discoveries. IK has now come to be regarded as a commodity and a form of intellectual property.

Various organisations such as academic institutions and the World Bank undertook to create and maintain IK databases. In some cases, the IK contained in such databases does not recognise the indigenous people as the proprietary owners of such information. Due to the intensification of globalisation, websites containing IK information later mushroomed; however, indigenous people were still not recognised.

This can be interpreted as a form of IW which is perpetrated against IK and the indigenous populace. The Information Science perspective was adopted to address the problem of IW perpetrated against IK. The Information Science perspective proposed using ICT to promote and protect IK. This would also improve access to IK.

This research proposes the use of the Internet as a medium of communicating digitised IK. IK has to be documented, digitised and stored in a national repository in each country's IKRC. An international repository will have to contain abstracts and descriptors of all the IK resources contained in local national repositories. All repositories will be accessible via the Internet. IK resources will be protected by means of cryptography and digital watermarking.

The information about the IK resources in all repositories will have to be catalogued according to the DC Metadata Element Set. The catalogued information is to be available in the English language only. Cross-language information retrieval would be implemented as soon as a standard has been adopted. Retrieving or harvesting information from the national repositories through the international repository will be done by means of OAI-PMH. These techniques will be implemented in support of the existing IP regimes to promote and protect IK.

8.5 Recommendations

The digitized IK is already available on the Internet and ICT would be required to access it. New ICTs are expensive and not pervasive, especially in the developing world. It would be necessary that the technology employed to access the digitized IK is compatible with the previous versions so that those who cannot afford leading technologies, but having earlier versions thereof are not left out. It is thus recommended the all the IK repositories or database should be equally usable by those using Internet Explorer or Netscape Navigator browsers (including older versions) to maximise possible use.

Free subscriptions to patent office sites or asking users to sign in as guests should be discouraged because this is a value-added service that requires subscription services

or payment per download. Help facilities on the international repository should indicate how far back the coverage extends and how up-to-date it is. The help facilities should also provide examples of how to enter searches; they should not be case-sensitive; they should explain how to truncate; and so on.

The Information Science retrieval mechanisms that support OAI-PMH must be fully employed. This includes the use of Boolean operators in information searches and truncation techniques. There should also be clear links to relevant classification or encoding schemes such as MESH, LCC, DDC and LCSH. An inventory of almost all sites listing all patents registered from IK resources can be provided.

8.6 Value of the research

This research would result in a large amount of tacit knowledge that impacts on the collection, digitisation and storage of IK being identified and stored in the local and national repositories. Various factors have been highlighted that justify the recognition of IK as a form of IP. IK has also been made available on the Internet, although this has rarely been done in consultation with the indigenous people who own such IK. For technological and political reasons, the current status of the protection of IP on a global level is uncertain. New technologies, including the Internet, undermine the effectiveness of IP because of heightened hacking. The speed at which hackers are able to reverse-engineer certain information products suggests that there is a serious need to integrate copyright with strong encryption (Morris et al. 2001:82).

It is suggested that this research holds the following value:

- An Information Science definition and perspective of IW has been coined.
- Various prominent forms of IPRs and their conventions have been identified.
- The background and current context of IK within the global IPR context has been explored.
- IK-related IW facing the developing world has also been uncovered.

- The use of ICT in promoting and protecting IK has been explored.
- The creation of national and international IK repositories may assist in determining the same and related forms of natural resources.

8.7 Limitations of the research

The research may have been more valuable and more representative of the Information Science field were it not for the following:

- The research was conducted by a single individual and an extended period of time has elapsed since its commencement. In the interim, some valuable papers may have been produced which have not been considered in the scope of this study.
- Various institutions haphazardly maintain independent IK databases. These institutions may refuse to cooperate with the formation of national and international IK repositories.
- Mechanisms for the exploitation of IK resources may appear in more than one country's national repository.
- Indigenous knowledge is investigated by various disciplines within their confined context. These disciplines may ignore many of the factors impacting on IK.
- This research does not investigate factors that can inhibit the development of the creation of an international IK repository.

8.8 Recommendations for further research

It is assumed that, in any research, there are more questions than answers. This research has exposed some of the complexities involved in the IW against IK from an Information Science perspective. There are a number of issues that warrant further investigation:

- The threat to biodiversity from wars, unstable economic situations and a lack of decision-making power about development projects were not investigated in any depth in this thesis and deserve further attention.
- Attention should be given to financial models for the apportionment of fees among various national IKRCs on downloads, established on a period-based subscription.
- The informational and economic value of IK derived products in the global economy should be investigated.

8.9 Final comment

This chapter evaluated this research and its contribution or value to the field. It showed that the use of ICT to promote, protect and improve access to IK (investigated in chapter seven) was executed according to good qualitative research principles. Furthermore, it was based on the available scientific literature and other electronic sources, and it was deemed that the contribution was a legitimate theoretical one.

It is important that appropriate solutions are devised and implemented to solve relevant information-based problems. Making IK available via the Internet reflects one of the prominent features of the information age. Contributions to the international repository are very important and must be highly controlled by each IKRC.

Viewing the architecture of various IK resources that form a union catalogue in the international repository in figure 7.1 puts into perspective the feasibility of making IK available via the Internet. This interaction cannot be considered in isolation; rather, it should be viewed according to the Information Science perspective on IW against digitised IK. We need also to understand the possible mechanisms by which digital IK can be protected as part of the global village. Indigenous owners of IK must also be beneficiaries of any profit that might be derived from the exploited IK resources.

ICT-related attacks that are very likely to be brought against IK on the Internet. These should be minimised. This can be addressed by making IK resources accessible on the Internet. Complete IK resources should be contained in the local national repositories. Cryptography and digital watermarking would be efficient in protecting digitised IK. It is difficult to conceptualise of digitised IK without considering the advent of various kinds of IW that have become a reality in the information age.

...oOo...