BLOCKCHAIN AS A STRATEGIC TOOL TO PROTECT TRADITIONAL KNOWLEDGE AND ADDRESS BIOPIRACY IN PERU: PROPOSALS FOR IMPROVEMENT

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I. ABSTRACT

Indigenous and native communities in Peru, like those in many other parts of the world, have been facing practices that harm both their cultural identity and biodiversity for decades. These harmful practices, such as biopiracy and the theft of traditional knowledge (TK), involve exploiting their genetic resources and ancestral knowledge without their consent. This not only robs them of fair compensation, but also threatens the preservation of their cultural heritage. This essay looks at how blockchain technology might be a game-changer in the fight against biopiracy and in protecting TK. By using blockchain's strengths—like transparency, traceability, and its unchangeable nature—the paper suggests using smart contracts for Genetic Resource Access Contracts (GRACs) and creating a platform that could track and document genetic resources and TK. Alongside this, the paper explores national and international laws, highlights successful cases from around the world, and proposes a pilot project for Peru. The aim is to ensure that indigenous communities are fairly compensated and empowered, and that Peru can keep up with global standards on the ethical use of biodiversity and traditional knowledge.

II. INTRODUCTION

Biodiversity and traditional knowledge are crucial for humanity. They help us conserve the environment, sustain ecosystems, and even drive progress in areas like medicine and culture. The 1992 Convention on Biological Diversity describes biodiversity as the incredible variety of life forms and ecosystems that keep life on Earth in balance. Peru, being one of the 17 megadiverse countries and a key Vavilov Center, is blessed with an abundance of unique species and genetic resources. These riches are tightly connected to the ancestral knowledge of the indigenous communities, who've preserved sustainable practices that work with nature to regenerate resources and maintain balance.

Traditional knowledge isn't just important for cultural reasons; it's also fundamental for modern medicine. Many plants used in traditional treatments contain bioactive properties that are incredibly valuable in pharmacology. These communities have a deep understanding of ecosystems and how to farm in a way that doesn't harm the environment. Bringing together this knowledge with modern science doesn't just boost conservation efforts, it also gives us a vital tool in tackling global environmental challenges and improving quality of life.

Unfortunately, this incredible cultural and natural wealth is under constant threat from biopiracy. Biopiracy is essentially the illegal appropriation of biodiversity and traditional knowledge through intellectual property (IP) rights, allowing large corporations to profit from these resources without the consent of the communities who've protected and passed down this knowledge. It's a practice that perpetuates a huge injustice by denying these communities both recognition and fair benefits. It also worsens historical inequalities, pushing those who've

contributed so much to global biodiversity and sustainable practices further to the margins. In the case of Peru, this essay will look at how biopiracy has been tackled in the past, and how we can protect this shared legacy, which belongs not only to indigenous communities but to all of humanity.

III. FRAMEWORK

The protection of genetic resources and traditional knowledge[1] has been a key issue in the fight against biopiracy and TK. In Peru, various laws and protocols[2] have established mechanisms to ensure fair access and use of these resources, requiring, among other things, that the benefits derived are shared equitably with indigenous communities.

A. International Agreements:

- **Convention on Biological Diversity (CBD) (1992)**: Establishes sovereignty over biological resources and ensures benefit-sharing.
- **Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) (1994)**: Includes biopiracy protections through origin disclosure obligations.
- **International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) (2001)**: Promotes sustainable use of agricultural genetic resources.

[1] Although biopiracy and theft of traditional knowledge are not essentially the same thing, this essay will be referring to both problems indistinctly when applying the solutions proposed in this paper.

[2] In the following lines of this essay, the technical application of Indigenous Knowledge, PI, and biopiracy rules will be analyzed from the Peruvian law perspective.

- **WIPO Committee:** Aims to safeguard traditional knowledge.
- **Decision 391:** Requires access agreements for intellectual property rights and mandates information exchange systems.

B. National Framework:

- **Law No. 28216 (2004):** Establishes the protection regime for access to Peru's biodiversity and the collective knowledge of indigenous peoples. It defines biopiracy and mandates the need for prior informed consent and the signing of access agreements for the use of these resources.
- **Law No. 27811 (2002):** Regulates the protection of collective knowledge related to biological resources, requiring access to be formalized through licensing agreements and ensuring the fair distribution of benefits.
- **Supreme Decree No. 019-2021-MINAM:** Governs access to genetic resources in Peru, reinforcing the obligation to formalize access through access agreements with the State, aiming to prevent the misuse of these resources.
- **Law No. 27658 - Law on the Modernization of State Management:** Plays a fundamental role by establishing the foundations for modernizing administrative processes, promoting efficiency and transparency in public management.

Specifically, according to the national and international regulations indicated above, when traditional knowledge and biological material is used in Peru, it is mandatory to sign a license or access contract to obtain prior informed consent with the representatives of the

indigenous communities, except in cases where such knowledge has already been previously published. In addition, any bioprospecting activity must be formalized through a license contract that is then registered with the National Institute for the Defense of Competition and Protection of Intellectual Property INDECOPI through the National Commission Against Biopiracy with prior authorization from The National Forest and Wildlife Service (SERFOR), the National Institute of Agricultural Innovation (INIA), Ministry of Production (PRODUCE) or the National Service of Protected Natural Areas by the State (SERNANP), and its use must benefit the communities possessing the TK. This regulation seeks to ensure the fair participation of the communities in the benefits derived from the use of their resources and knowledge.

THE NATIONAL COMMISSION AGAINST BIOPIRACY (NCAB)

The National Commission Against Biopiracy (hereinafter the Commission), created in May 2004, aims to protect the traditional knowledge of indigenous peoples and Peruvian-origin biological resources. Attached to the Presidency of the Council of Ministers and chaired by **INDECOPI** (National Institute for the Defense of Competition and Protection of Intellectual Property), the Commission coordinates with various public and private institutions to implement defense and prevention strategies against biopiracy. Among its functions, it highlights monitoring cases of biopiracy, challenging illegal patents, and working together with national and international actors such as the Ministry of Foreign Affairs and the Ministry of Foreign Trade and Tourism. Since its creation, the Commission has been refining its approach to monitor and address identified biopiracy cases. The Commission has

created a priority list of 268 genetic resources, mainly plants and crops. Of this list, 68% have patent records or activity. From this group of 269 268 resources, 370 biopiracy cases have been identified to date, associated with the patent system—especially regarding novelty and inventive step—of which 25% correspond to the year 2023. The cases are concentrated in the patent offices of the United States of America (15% of cases), followed by the European Union, Japan, China, and Brazil, with lesser cases in other countries. Of the 406 biopiracy cases identified, 149 have been successfully addressed and resolved favorably.

NOTABLE EXAMPLES OF BIOPIRACY IN PERU

The Commission has played a crucial role in defending Peru's biological resources and traditional knowledge, confronting landmark cases of improper appropriation. One of the most prominent is the case of maca (*Lepidium meyenii*), where the Commission investigated and presented effective oppositions against patent applications in Japan and South Korea that sought to monopolize the use of this ancestral plant. These efforts resulted in the invalidation of such applications, protecting both access to and cultural rights related to the resource.

Another significant example is the case of sacha inchi (*Plukenetia volubilis*), in which international patents attempting to capitalize on the traditional uses of this Amazonian resource were reviewed. Thanks to the Commission's actions, irregularities were identified, and its defense was promoted in foreign markets. Similar cases include *yacón* (*Smallanthus sonchifolius*), where attempts to register new uses as inventions, which were actually part of traditional knowledge, were detected, and *uña de gato* (*Uncaria tomentosa*), whose derivatives were monitored to

prevent unauthorized appropriation. Below is a summary table of some notable cases where the Commission actively participated.

Case	Resource or Knowledge Affected	Action Taken by the Commission	Results Achieved
Maca case	Maca (*Lepidium meyenii*)	Investigation and opposition to patents	Patent applications in Japan and South Korea attempting to monopolize the use of Peruvian maca were invalidated.
Sacha Inchi case	Sacha Inchi (*Plukenetia volubilis*)	Review of international patents	The Commission identified irregularities and promoted its defense to prevent the improper appropriation of this resource in foreign markets.
Yacón case	Yacón (*Smallanthus sonchifolius*)	Analysis of granted patents	Attempts to register traditional uses of Yacón as new inventions were

Case	Resource or Knowledge Affected	Action Taken by the Commission	Results Achieved
			detected, and inter-national authorities were notified about these practices.
Uña de Gato case	Uña de Gato (*Uncaria tomentosa*)	Supervision and monitoring	Attempts to patent derivatives of this resource were observed, leading to strengthened defense through technical and scientific documentation.
Quinoa case	Quinua (*Chenopodium quinoa*)	International collaboration	Peru worked with countries like Bolivia to halt patents in the United States that sought to restrict the use of traditionally developed quinoa varieties.

Nonetheless, the Commission also faced the challenge of patent applications that were improperly granted. This includes patents US 6,267,995 (Extract of Lepidium meyenii roots for pharmaceutical applications), US 6,428,824 (Methods for Increasing Testosterone Levels in a Male Animal Using Extracts of Lepidium), and US 6,552,206 (Methods of Treating Sexual Dysfunction Using Extracts of Lepidium), issued between 2001 and 2003 by the United States Patent and Trademark Office to the company Pure World Botanicals, Inc.. These patents related to processes for extracting alkaloids from maca, a native resource of the Peruvian Andes known for its medicinal properties. The registration of these patents sparked controversy, since their composition was based on the traditional knowledge of the Andean communities, so these patents should not have been granted, since they did not have the proper authorization, thus violating the rights of local communities and international standards on access and benefit sharing.

However, the registration of these patents are unfortunately isolated cases. Other examples, such as patent US 4,844,901 (Stable Antimicrobial Composition Comprising Alkaloids from Uncaria Tomentosa), were also granted in the United States, reflecting similar patterns of misappropriation. The registration of these patents demonstrated that international regulations and authorities have not adequately protected TK and have not adequately fought biopiracy. In that sense, these cases highlight the importance of integrating innovative technologies, such as smart contracts, to ensure traceability, transparency, and compliance with national and international regulations in the management of genetic resources.

IV. BLOCKCHAIN AS A STRATEGIC TOOL TO ADDRESS BIOPIRACY AND SAFEGUARD TRADITIONAL KNOWLEDGE

Before delving into how blockchain can help address the issues previously discussed, it is important to examine the necessary regulatory reforms to enable the effective use of this technology.[3]

As previously mentioned, the Law on the Modernization of State Management (Law No. 27658), enacted in 2002, provides the legal framework for improving public administration in Peru. Its primary objective is to modernize the state's structures and processes to make them more efficient, transparent, and citizen-oriented. While the law does not specifically regulate blockchain or smart contracts, it creates a conducive environment for the adoption of innovative technologies to enhance public management.

Nevertheless, despite the validity of this law, it is insufficient to modernize the state through the implementation of blockchain technology. Therefore, this paper proposes a legislative amendment to the Law on the Modernization of State Management (Law No. 27658) to incorporate specific provisions that recognize blockchain as a key tool for traceability, authenticity, and the automation of administrative processes. These ideas could be realized through the development of a long-term interdisciplinary National Blockchain Strategy, as has already been adopted by countries such as Malta, Mexico, the United Arab Emirates, and Vietnam. Such a strategy would coordinate efforts, establish a clear governmental vision for this

[3] This paper recognizes that the Commission faces other pressing challenges, such as ensuring universal Internet access, providing training for Peru's ancestral communities, or addressing funding shortages in public and private institutions. However, these issues lie beyond the scope of this paper and will not be addressed here.

technology, and plan its implementation effectively. Another example we can found in Saudi Arabia's *Vision 2030*, which advocates for blockchain to enhance public services, and Thailand's *Thailand 4.0* initiative, which aims to transform the economy through blockchain applications in transportation, logistics, finance, and digital identity.

For instance, this National Strategy could promote the development of blockchain-based digital platforms to ensure transparency in public management, such as monitoring administrative procedures, supervising budgetary resources, and verifying the authenticity of official records. Additionally, it would reduce the ambiguity or lack of regulation surrounding this technology. The strategy could also mandate the use of smart contracts in public management, allowing for the secure automation of agreements and payments based on predefined and verifiable rules.

Furthermore, the National Strategy could introduce specific incentives, such as offering tax benefits to technology companies similar to those outlined in the *Works for Taxes Law*.[4] This approach would enable private companies to actively participate in technological projects aimed at modernizing public administration by deducting the amounts invested in blockchain implementation from their tax obligations. Such a mechanism would foster collaboration between the public and private sectors, facilitating the funding and execution of pilot projects in various state entities while attracting private sector investments to modernize public management through blockchain technology.

Similarly, the proposed plan or strategy should include the financing of pilot technology-related projects led by the government, as well as the continuous training of

[4] The **Works for Taxes (OxI) Program** in Peru is a government initiative that allows private companies to finance and execute public infrastructure projects using their tax payments

public officials and the general population (including indigenous communities) on the use of blockchain, ensuring its effective implementation. With this regulatory reform, the government will not be the exclusive financier of these projects, but also private capital, thus promoting not only the use of blockchain in public administration, but all technological advances in public administration.

WHY USE BLOCKCHAIN AND HOW DOES IT ALIGN WITH IP PRINCIPLES?

When I was reflecting on the topic for this essay, I didn't want to follow the "trend" of discussing AI or new technologies in IP. Instead, I aimed to provide a solid foundation for connecting blockchain and IP. During my research, I discovered that this technology is highly compatible with intellectual property systems. As stated in WIPO's Whitepaper, "[i]n relation to industrial property rights, blockchain technologies might be of great help from the generation of an intangible asset to the commercialization of IP rights," so I confirmed that blockchain technology emerges as an innovative solution to protect traditional knowledge and biodiversity, while honoring the commitments undertaken under Decision 391, particularly the mandate for "the creation of information exchange systems on authorized access contracts and granted intellectual property rights." This technology, with its capacity to record data in an immutable, decentralized, and transparent manner, becomes an ideal tool to combat biopiracy, ensure recognition for indigenous communities, and promote ethical business practices. This idea is supported by Clark, who states: "The use of blockchain technology for IP rights management offers significant possibilities. Registering IP rights on a distributed ledger, rather than on a traditional database, could transform them into smart IP rights."

In this sense, blockchain technology stands out for its immutable and secure ledger characteristics, ensuring full traceability and fraud prevention through advanced mathematical algorithms. Furthermore, it fosters transparency and trust by enabling communities, governments, and businesses to verify the use of genetic resources and TK in real-time. Its automation capabilities, powered by smart contracts, would significantly reduce administrative costs and time, granting indigenous communities greater control over the benefits derived from their resources.

In summary, blockchain technology—with its immutable, secure, and transparent record-keeping—strengthens the protection of traditional knowledge and biodiversity. Its compatibility with intellectual property rights makes it the ideal technology for safeguarding TK and combating biopiracy, as will be further explored in the following sections of this essay.

GLOBAL EXPERIENCES WITH BLOCKCHAIN IN GOVERNMENTAL APPLICATIONS

The use of blockchain technology is being explored globally to tackle various obstacles, ranging from resource management to data protection, all within the broader framework of sustainable development. According to the United Nations, notable examples include:

Country	Blockchain Use Case	Objective
Thailand	Digital identification platform with timestamps	Ensure equitable access to economic resources and financial services through digital

Country	Blockchain Use Case	Objective
		authentication.
Australia	Sustainable management of marine and coastal ecosystems	Protect environmental ecosystems and create alternative income sources for landowners.
Namibia	Wildlife credits for conservation	Provide payments to communities for preserving habitats and wildlife.
United Kingdom	Tracking international aid with smart contracts	Coordinate aid transactions with transparency and accountability.
Kenya	Traceability in low-carbon tea production	Ensure transparency in carbon emissions associated with the product.

These cases highlight the versatility of blockchain in addressing complex issues related to resources and sustainability.

One noteworthy example is Australia's innovative use of blockchain for marine and coastal ecosystem protection. A collaboration between the Commonwealth Bank and Biodiversity Solutions resulted in a blockchain-based prototype platform aimed at enhancing the resilience,

health, and productivity of these ecosystems. This initiative not only safeguards biodiversity but also provides landowners with an alternative income source, incentivizing them to preserve the environment.

An example more in line with Peru's reality, as they are also countries with significant biodiversity, are India and Brazil, which have applied technological solutions to safeguard genetic resources and traditional knowledge. India created the Traditional Knowledge Digital Library (TKDL) to digitize ancestral knowledge and prevent biopiracy. This initiative aims to collect information on traditional medicinal practices, particularly those related to Ayurveda, thus enabling the Indian government to demonstrate the state of the art in patent applications and prevent unauthorized claims on traditional knowledge. By providing a structured database, TKDL not only protects indigenous knowledge, but also facilitates access to researchers and companies interested in the ethical use of these resources. Undoubtedly an example worthy of imitation by the Peruvian government.

One of the most notable achievements of the TKDL has been its ability to assist the Indian government in revoking or limiting patents that were erroneously granted to foreign companies. For instance, data from the TKDL have been used to challenge patents related to the medicinal properties of turmeric and neem (Indian lilac). Since its inception, it is estimated that evidence has been presented against more than 215 patent applications in various international offices, leading to a 44% decrease in patent applications related to Indian medicinal systems.

Meanwhile, Brazil leverages digital technologies for product traceability, particularly in the case of açaí. The Brazilian government has established systems that allow consumers to trace the origin of açaí products from local producers to the market. This traceability ensures that the benefits derived from açaí production are shared equitably

with local communities who have historically utilized this resource. By implementing these digital solutions, Brazil promotes sustainable practices and enhances the market value of its biodiversity while empowering local communities.

Both countries exemplify how technological innovations can play a crucial role in protecting traditional knowledge and addressing issues related to biopiracy. Their experiences provide valuable lessons for other nations rich in biodiversity, such as Peru, which could benefit from similar strategies to safeguard their cultural heritage and natural resources. Additionally, as an additional piece of information, the native communities of Peru already have experience with the use of technology. For example, the community of Nuevo Saposoa in Ucayali - Peru is already using mobile applications and drones to combat illegal practices such as deforestation.

V. PROPOSAL FOR A PILOT PROJECT: AN 'INTEROPERABLE PLATFORM FOR GENETIC RESOURCES AND TRADITIONAL KNOWLEDGE CONNECTED THROUGH BLOCKCHAIN FOR THE PROTECTION OF BIODIVERSITY AND ANCESTRAL KNOWLEDGE'[5]

Drawing inspiration from these experiences, we propose that Peru implement a Pilot Project to develop an 'Interoperable Platform for Genetic Resources and Traditional Knowledge' (hereafter referred to as the Platform) based on blockchain technology. This system would ensure the immutability of records and facilitate secure information sharing with international organizations, such as WIPO, thereby strengthening the country's position against biopiracy. Additionally, the Platform could integrate access agreements with sustainability metrics, promoting the equitable and responsible use of Peru's biodiversity. The proposed pilot project aims to develop a blockchain-based platform for genetic resources and traditional knowledge. Its key features include:[6]

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[5] Although the practical steps for implementing the proposed blockchain-based platform—such as institutional leadership, budget allocation, and a phased roadmap—are critical for its success, these considerations fall outside the primary focus of this legal essay. The detailed examination of these elements, including budgetary requirements and specific institutional roles, would require a separate interdisciplinary analysis encompassing public policy, technology, and economics. This essay prioritizes the legal dimensions, particularly the regulatory reforms needed to integrate blockchain technology within Peru's existing legal framework.

[6] This paper will develop the features related to the Registry of Genetic Resources and Traditional Knowledge , the Use of Smart Contracts, and Interoperability, as I consider these to be the most legally relevant. Although traceability and monitoring are crucial aspects of a blockchain-based platform, for the purposes of this essay, I will focus on those elements that pose greater regulatory and legal challenges,

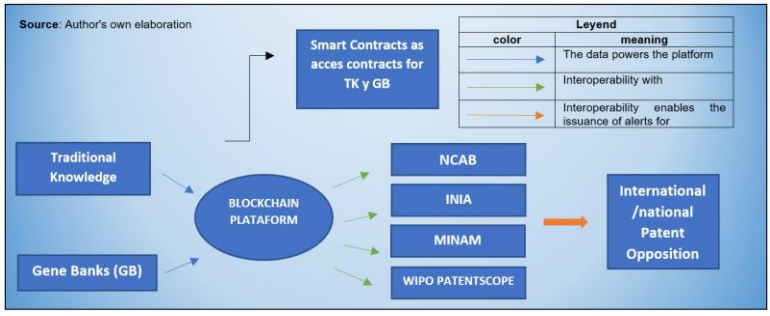
1. Traceability and monitoring: Monitoring every stage of resource use, from collection to commercialization, to ensure transparency and compliance.

2. Genetic resources and TK documentation: Creating a centralized system to authenticate and protect genetic resources and traditional knowledge against biopiracy.

3. Use of smart contracts for GRACs (Genetic Resources Access Contracts): Automating access contracts to enhance efficiency and enforce conditions securely.

4. Interoperability: Ensuring integration with global databases and enabling an alert system for patent applications involving protected knowledge. This feature could enable an interoperability system for an online Alert and Opposition System for patent applications attempting to be recognized using protected genetic material or traditional knowledge.

For better understanding, I present a graphic illustrating how the Platform would operate, which will be explained in the following lines.



such as the protection of indigenous communities' rights, the implementation of smart contracts, and integration with existing regulatory frameworks.

A. Documentation of Genetic Resources and Traditional Knowledge

Why is the documentation of genetic resources and traditional knowledge important for the Platform? As noted by Arana[7] regarding the improper registration of maca, "the main obstacle was **the lack of documented records in Peru that described the traditional procedures of the Andean peoples**. This lack of documentation deprived the Peruvian State of strong legal arguments to claim ownership of the resource or to request the annulment of the patent." Thus, it is crucial to prevent cases where companies, as in the example of maca, obtain patents by using Peru's biological material or TK. The documentation of genetic resources and traditional knowledge, as mandated by international agreements, becomes essential to safeguard these assets.

Such documentation can represent a significant challenge in terms of logistics, technology, and political will. However, there are already several initiatives documenting genetic resources in various countries. These initiatives include genetic Banks (GB) or biobanks established to preserve tissue samples and extract specific organic or inorganic molecules, such as proteins or nucleic acids (DNA or RNA), from specimens held by institutions dedicated to the study of biodiversity. These institutions also safeguard extracts or genomes, which constitute a unique genetic heritage. This heritage is proving invaluable for studying temporal trends and serves as an

[7] Dra. Maria del Carmen Arana Courrejolles is a prominent Peruvian specialist in intellectual property and biodiversity. She has actively worked in defending Peru's genetic resources and traditional knowledge. Her work was crucial in identifying and analyzing the improper registration of maca (*Lepidium meyenii*) by the company Pure Botanicals, Inc., highlighting the need for documented records to protect the traditional practices of Andean communities.

essential tool in fields such as ecology, evolution, taxonomy, and systematics.

Regarding traditional knowledge, a critical aspect is the creation of a TK catalog associated with genetic banks. This catalog should include traditional practices related to the use of medicinal plants, food, and other natural resources, as well as cultural information connected to these resources. Such an effort would not only protect cultural heritage but also ensure that the benefits derived from these practices are fairly shared with indigenous and local communities, who are the legitimate custodians of this knowledge.

In Peru, despite the enactment of Law No. 27811 in 2002, it was not until 2008 that a plan for documenting traditional knowledge was devised. This plan involved directly engaging with indigenous communities to gather their knowledge, leading to a team led by INDECOPI to coordinate the documentation of traditional knowledge associated with plant biodiversity. Initially, 200 entries were documented, and this number has since grown to approximately 4,000.

Nevertheless, as the World Intellectual Property Organization (WIPO) highlights in its *Guide for Documenting Traditional Knowledge*, it is important to note that the process of collecting and documenting collective TK may give rise to intellectual property rights derived from the work of collectors. These include databases, photographs, audiovisual recordings, and other tools. It is therefore crucial to regulate ownership and use of these rights to avoid conflicts and ensure that the benefits primarily accrue to indigenous communities. This scenario raises significant legal and ethical implications that must be explicitly addressed in applicable regulations.

OWNERSHIP AND CONTROL OF RIGHTS GENERATED IN THE DOCUMENTATION PROCESS

It is also a possibility that during the TK documentation process, intellectual property rights may be generated by those who carry out such process, which could lead to the exclusive appropriation of products linked to traditional knowledge, which could undermine the collective rights of indigenous communities. For example, a person who wants to document the process for the elaboration of a syrup derived from cat's claw could draw the process with his or her own imprint, thus generating IP rights for that person. To avoid this, the regulations should require that the IP rights generated during the documentation process be transferred to the indigenous communities, either directly or through a public entity such as INDECOPI, which would act as a custodian for their benefit. This would ensure that the tools derived from TK are not used without consent or in a manner that undermines collective rights.

According to Law No. 27811 in Peru, the collective knowledge of indigenous peoples must be protected under a framework that recognizes their rights as custodians of this knowledge. However, this law does not explicitly address the ownership or control of rights derived from its documentation. Moreover, WIPO's Guide for Documenting Traditional Knowledge emphasizes the need to protect both traditional knowledge and the tools generated during its documentation. To address this gap, specific provisions must be incorporated to regulate the ownership of generated rights. Authorities should also provide adequate training to indigenous communities to develop their own access protocols, specifying how their TK should be used by third parties or institutions.

Thus, Law No. 27811 and its regulations should promote the training of Peru's native communities to

enable them to establish their own protocols and principles, ensuring respect for their cultural expressions and traditional knowledge. These principles should be based on respect, self-determination, communication, consultation and consent, interpretation, cultural integrity and authenticity, secrecy and confidentiality, attribution, benefit-sharing, continuity of cultures, and recognition and protection, as recommended by WIPO's *Guide for Documenting Traditional Knowledge*.

An illustrative example is the Australian approach, where, despite legal limitations in protecting cultural expressions and traditional knowledge of First Nations, updated ethical protocols have been developed by the Australia Council for the Arts. These protocols outline principles such as respect, self-determination, prior consultation, and equitable benefit-sharing, aligning with international standards like the United Nations Declaration on the Rights of Indigenous Peoples. Inspired by this model, Peru could propose implementing a similar guide to reinforce its existing legal framework and promote the ethical use of genetic resources and traditional knowledge. This would ensure that indigenous communities are the primary beneficiaries of the use of their heritage while fostering respect and cultural authenticity in all interactions with their legacy.

Such regulatory changes would prevent third parties from appropriating the rights generated during the documentation process and guarantee that indigenous communities retain control over their collective knowledge, strengthening their cultural and economic sovereignty. Additionally, this would align Peruvian regulations with international standards, such as those established by WIPO and the Nagoya Protocol, promoting the ethical and fair use of TK.

In conclusion, regulating the ownership and control of rights generated during the documentation of TK is

essential to protecting the collective interests of indigenous communities, avoiding any form of misappropriation or unauthorized use. New regulations should promote continuous training for indigenous communities to autonomously manage their rights and ensure the effective integration of their knowledge into technological platforms, such as blockchain.

B. GRACs as smart contracts

As previously mentioned, national and international regulations require that any individual or company seeking access to Peruvian biodiversity and TK must obtain a GRACs granted by the Ministry of the Environment (MINAM), in accordance with Supreme Decree No. 019-2021-MINAM. This decree governs access to genetic resources and their derivatives in Peru, as well as the mechanisms to ensure fair and equitable participation in the benefits derived from their use.

Smart contracts, which are agreements programmed in code, offer an innovative tool for streamlining this process. They execute automatically when predefined conditions are met, ensuring efficiency, immutability, and security through their integration into a blockchain. However, their irrevocable nature underscores the critical importance of precise programming to avoid errors.

Although the application of smart contracts is valid under Peruvian civil law, their integration into the legal framework governing access to genetic resources in Peru would require a modification of Supreme Decree No. 019-2021-MINAM to explicitly recognize electronic contracts as valid instruments. This would involve adapting existing procedures to accept the validation of agreements through digital signatures and allowing the automated execution of terms via blockchain. Such changes would ensure greater

efficiency and transparency in the process of accessing and distributing benefits.

Automating contracts through smart contracts would improve public sector management by reducing bureaucracy, minimizing errors, and speeding up response times. This optimization enhances decision-making processes.

In summary, while smart contracts are viable within the Peruvian legal framework, they must also be explicitly recognized in the specific regulations governing access to these resources. Nevertheless, they represent an innovative tool for optimizing the management of intellectual property rights and ensuring their effective enforcement.

GRACs IN PERU AND THEIR ENHANCEMENT WITH BLOCKCHAIN

According to Decision 391 and Peruvian regulations, GRACs must include essential clauses such as capacity and consent, benefit-sharing, and monitoring and control. However, their implementation faces challenges such as adequate monitoring, compliance with terms, and transparency.

As evidenced in the cases of maca and previously granted patents, the current intellectual property rights registration systems fail to provide sufficient guarantees to protect genetic resources and ancestral knowledge. This is due to the lack of proper registration of such knowledge or the untimely opposition to requested patents. The root causes include insufficient traceability, international interoperability, and transparent mechanisms to ensure compliance with rights.

Based on the problems previously discussed, blockchain technology can enhance each of these clauses by transforming GRACs into a smart contract version that will automate and secure their execution. The following

section outlines potential advances to the most important clauses of GRACs.

Clause	Improvement with Blockchain and Smart Contracts	Main Benefit
Capacity and Consent	Immutable record of prior consent and identity validation through digital keys.	Ensures legitimacy and prevents legal disputes over consent.
Benefit Sharing	Automation of payments and benefit distribution through smart contracts.	Eliminates non-compliance and ensures transparency in benefit delivery.
Technology Transfer	Secure record of technology transfers and access control.	Guarantees that transferred knowledge is used as agreed.
Intellectual Property	Record of innovations derived from the use of genetic resources.	Protects the rights of the country of origin and the provider communities.
Monitoring and Control	Continuous monitoring of compliance with contractual conditions via	Facilitates audits and reduces administrative costs.

Clause	Improvement with Blockchain and Smart Contracts	Main Benefit
	blockchain.	
Sanctions Regime	Automatic execution of penalties in case of non-compliance.	Ensures penalties are applied immediately and fairly.
Termination and Renegotiation	Record of contract modifications and automated execution of termination terms.	Avoids ambiguities and ensures transparency in renegotiations or termination.

Using smart contracts to manage GRACs in Peru could be a game-changer for how these resources are handled. These contracts allow for more efficient monitoring and ongoing auditing of the agreements in place. This is really important, especially in a country like Peru where bureaucracy often slows down or complicates things. Based on personal experience, this red tape can make it hard for the public administration to meet its obligations, and smart contracts might just be the tool to make the process smoother and more reliable.

One of the biggest advantages is how these contracts could automate the distribution of benefits. Right now, delays—or even no payments—in payments can cause real problems for the people and communities that are supposed to benefit from agreements related to biological resources. Automating these processes would mean payments are faster and more reliable. Communities, like those who hold

rights to genetic resources, wouldn't have to wait endlessly for the benefits they're promised. This would also build trust in a system that, frankly, hasn't always been very trustworthy.

What I'm proposing is not science fiction. In fact, smart contracts could transform dispute resolution by integrating Online Dispute Resolution (ODR) mechanisms. Currently, conflicts over benefit-sharing agreements can be costly and prolonged, leaving communities without timely solutions. However, by incorporating ODR clauses into smart contracts, disputes could be resolved efficiently through decentralized arbitration or AI-assisted mediation. As Colin Rule[8] mentioned, "the side of it where we build in online dispute resolution to every smart contract, I think that is very interesting too, where every smart contract created, just like in person contracts, we have an ADR clause. I can see smart contracts having an integrated ODR clause."[9]

Take the case of maca, for example—a highly valued Peruvian resource. With a blockchain-based smart contract with ODR mechanisms, any commercial entity

[8] Colin Rule is a recognized pioneer in the field of Online Dispute Resolution (ODR) and is the co-founder of the ODR platform, Kleros. He has played a key role in advancing the integration of technology into dispute resolution processes. In the interview, he discusses the role of companies like LegalZoom and RocketLawyer, which are increasingly offering smart contracts integrated into blockchain platforms. He suggests that these providers could greatly benefit from incorporating a dispute resolution mechanism directly within their smart contracts, creating an automated and accessible process for resolving conflicts that arise from these contracts.

[9] ADR (Alternative Dispute Resolution) is a term encompassing methods of resolving conflicts outside of courts, such as mediation and arbitration. ODR (Online Dispute Resolution) is a modern form of ADR that uses digital platforms and technologies to resolve disputes. When smart contracts include ODR clauses, the dispute resolution process is automated, enabling efficient and accessible resolution without the need for complex legal interventions.

looking to access maca's genetic information would need to get prior informed consent, and the system could ensure that Indigenous communities automatically receive their share of the benefits. Every single transaction would be logged on the blockchain, so there'd be no room for shady dealings or missing payments. Plus, the self-executing nature of smart contracts would help avoid the usual issues with non-compliance.

As mentioned earlier, there are still barriers to overcome, such as limited internet penetration in native communities; however, adopting blockchain for GRAC management in Peru could be a real turning point. Automating processes, ensuring transparency, and creating a permanent record would not only help fight biopiracy but also make the use of Peru's biodiversity fairer and more sustainable.

C. Interoperability for an online alert and opposition system

According to WIPO, interoperability is defined as "the ability of two or more systems or applications to exchange information and to mutually use the information that has been exchanged." Thus, a platform should be interoperable with various national and international institutions to issue alerts and, consequently, enable online opposition to patents that are intended to be registered or have already been registered. Both pre-grant and post-grant systems rely on transparent procedures to maintain a balance between protecting innovations and preventing unjustified monopolies. Blockchain technology can enhance the efficiency of these processes, as demonstrated in recent studies by enabling secure, traceable, and interoperable digital platforms for managing patent opposition filings and evidence.

From an operational standpoint, a key issue in the interoperability of any blockchain platform is standardization. For a platform connected with other international systems, it is indispensable to "speak the same language." According to the WIPO Whitepaper, "The Global Blockchain Business Council has highlighted two main challenges: aligning standards and codes of conduct across jurisdictions and industries, and ensuring equitable representation of stakeholders of all sizes. To address these issues, it is crucial to synchronize efforts among all parties working on blockchain to avoid fragmentation and encourage cohesive technology adoption."

In the IP sector, technical standards are crucial for driving the digital transformation of IP offices and their services. Organizations like WIPO have developed standards that harmonize the filing, processing, and exchange of IP data, such as WIPO Standard ST.96, which recommends XML for managing IP information, and Standards ST.27, ST.61, and ST.87, which streamline the global exchange of legal status data for patents, trademarks, and industrial designs, enhancing reliability and accessibility.

By ensuring smooth integration of IP ecosystems and standardized data exchange among global IP offices, these efforts highlight the importance of INDECOPI in Peru adopting international standards such as those developed by WIPO (e.g., ST.96, ST.27, Ethereum Standards, etc.) to guarantee system compatibility. This can be achieved by creating Technical Interoperability Guidelines, which define how INDECOPI's technological systems will integrate with international platforms. Leveraging blockchain standards will ensure data security, traceability, and authenticity.

In this sense, implementing interoperability through blockchain and international standards is a crucial step for INDECOPI, through The Commission, to modernize its

intellectual property management systems. By adopting globally recognized technical standards and fostering secure, traceable and transparent data exchange, Peru can strengthen its capacity to protect its biodiversity and the TK of native peoples, not only balancing the scales in favor of native peoples, but putting the public administration at the forefront of technology.

VI. PROPOSALS AND CONCLUSION

After considering all the points discussed, we can conclude that, although certain limitations—such as state budget constraints, access to technology, or training for indigenous communities—were not the primary focus of this work, blockchain holds significant potential to transform how the rights of indigenous communities are protected. However, to initiate this transformation, it is essential to implement the following measures:

1. Creation of a National Blockchain Strategy: Design a long-term interdisciplinary governmental plan aimed at attracting investments and promoting technological development to benefit indigenous communities while meeting international standards. This strategy should include the following regulatory reforms:

1.1. Update Law No. 27811: Regulate the process of cataloging traditional knowledge to protect the intellectual property rights of ancestral communities through access protocols based on the principles outlined in this essay.

1.2. Amend Supreme Decree No. 019-2021-MINAM: Explicitly recognize smart contracts as valid instruments.

1.3. Reform the Law on the Modernization of State Management - Law No. 27658: Create a regulatory framework that

facilitates the use of blockchain technology within state institutions and establishes incentives for private investment through public-private partnerships and mechanisms such as "works for taxes."

1.4. Develop Technical Interoperability Guidelines for INDECOPI: Define how INDECOPI will integrate its technological systems with international platforms, utilizing blockchain standards to ensure data security, traceability, and authenticity.

2. Implementation of a Pilot Project for an 'Interoperable Blockchain-Based Platform for Genetic Resources and Traditional Knowledge to Protect Biodiversity and Ancestral Knowledge: This pilot plan should include key features such as traceability and monitoring—an essential aspect for identifying actors and the destination of resources being accessed; a **registry of genetic resources and TK**, which involves the creation of a decentralized registry for genetic resources and TK as explained in this work; adaptation of GRACs as smart contracts, enabling the benefits outlined earlier; **interoperability**, where the platform should connect with databases from various national and international institutions; and an **international patent alert system**, allowing for the issuance of alerts in cases where unauthorized entities attempt to obtain patents.

In conclusion, the implementation of blockchain to protect traditional knowledge and biodiversity in Peru represents not only a technological advancement but also an opportunity to empower indigenous communities that have safeguarded this legacy for generations. This tool ensures traceability, transparency, and equitable benefit-sharing, but its true impact lies in addressing historical social inequalities and preserving the cultural identity of

indigenous peoples. Beyond its technical aspects, blockchain should be understood as a bridge connecting innovation with social justice, fostering a sustainable development model that honors and values the contributions of these communities to global well-being, restoring their control over the ancestral knowledge they have safeguarded for generations.

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