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Natural Resources Governance Employing Blockchain-Based Decision-Making

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Abstract

Natural resources are essential structures of socio-economic systems which shape the well-being of humanity, environment, and the economy. Human actions have become the critical responsibility for environmental changes and pressuring many planetary boundaries. Having a systematic approach can provide a governance platform including the inherent characteristics of the resource, the historically established form of use, and transaction costs. A natural resource governance framework is developed by applying Blockchain technology as the primary goal of this study to regulate and manage the extraction and trades. Blockchain technology provides a distributed concurrency monitoring system for sustainable resource management. Persistent and pervasive cooperation of all the stakeholders improves the sustainable management of the resource and the perception of the legitimacy of the results. This methodology tries to bridge knowledge boundaries and embedded terminologies amongst all parties to deal with uncertainties surrounding the decision-making process of managing the natural resources. Moreover, it can be instrumental in establishing trusted relations and interactions to reduce environmental risks and ecological scarcities. This study aims to provide an integrated system consisting of rules and policies to decrease the high organizing costs and defects of centralism by enhanced control of all the involved parties, accountability, and transparency.

Key Words: Natural Resources Governance, Blockchain Technology, Decision-Making

1 Introduction

Natural resources are critical inputs for economic and social development. The unsustainable use of the resources has led to environmental and resource depletion which has imperiled the well-being of humanity and the environment. There is a need for global consensus on sustainable management that avoid excessive disruption of the local and global environmental systems [1]. Monitoring the sustainable usage and protection of the ecological system can help in reducing people's vulnerabilities to disasters also enhancing biodiversity conservation [2]. The uncertainty and ecological complexity require the promotion of rights based on approaches within collaborative natural resources management. An integrated systemic scale within a common conceptual framing is necessary to confront the challenges and risks of depletion of the natural resources. This study aims to provide a framework in applying the blockchain technology to enhance the natural resource management decision-making, reduce the risks on the human beings and the environment. The rest of the paper is organized as follows. Section 2 presents a series of related studies of the applied tools in the field. Section 3 proposes the methodology. Section 4 contains the discussion on the proposed model. The paper is concluded in section 5.

2 Literature Review

Natural resources play a crucial role in economic and social activities. The widening trade of the resources can shift from conservation to depletion [3]. Due to the depletion of natural resources and the environmental impacts and the rippling consequences of this interrelationship generate the need to formulate comprehensive plans and goals to address and reduce the rate of extractions. The impacts of extracting of some natural resources have been overlooked in most studies on the field. Nonetheless, the focus of the studies is on extraction and effects on specific sites, not in a broader context. Therefore, a comprehensive monitoring system is necessary to manage the planning, mining

operation, and the trade of natural resources. A systematic governance framework can enhance natural resources management.

2.1 Natural Resources Governance

Natural resources must be used economically, to prevent the rapid exhaustion and ensure they could benefit future generations as well [4]. The high rates of economic development resulted in an acceleration in the use of natural resources [5]. The haphazard use of natural resource challenges the sustainability of the resource and poses serious threats [6]. Henckens [4] argue that several resources may be depleted in recent future without effective policies to help reduce extraction to more sustainable levels. Effective governance and management for the dynamic natural resources are required due to financial issues and political chaos that impacts socioeconomic settings, livelihood dependency, local communities, and the resources themselves. Developing a natural resource governance framework can help in identifying essential information to make knowledge-based decisions for sustainable resources and most probable challenges and risks regarding resource use. The framework could serve as a supportive tool to national scales through participatory processes involving critical decision-makers. Several studies have focused on natural resources governance. There are two theories of Coase [7] and Ostrom [8] regarding the forms of ownership over natural resources. Slaeve and Collier [5] discuss on coexisting and effectiveness of both model with proposing a framework for defining policies for natural resources management. Based on this framework, a) rules and regulations are required to be established for property rights, b) resource governance is improved by enhancing the systems of management.

Social organization engagement has become a key strategy for natural resource management in different studies. However, there are challenges regarding decentralization, sustainability, and livelihoods [9]. The key aspects of considering society participation in natural resources governance are a) economic, social, cultural, and political values, b) forms of exchanges and struggles, c) legitimation and boundaries. Baldwin [10] used the term of distributed governance for the regulation that is no longer centralized and is an emerging paradigm distributed among government, market, and civic participants. Consumer and environmental advocates could be active in monitoring the impacts. In this process, stakeholders would have an active role in decision-making as part of collaborations in governance arrangements. The benefits of such a process include access to more accurate information, enhance problem-solving, and democratic accountability. This study is using Blockchain technology to enhance the benefits of the distributed governance framework.

2.2 Blockchain Technology

The basic idea of blockchain technology is allowing the actors in a system to transact digital assets using a peer-to-peer network that stores these transactions in a distributed way across the network [11]. The blockchain is a mere data structure with distributed multi-version concurrency control [12]. The mechanism of blockchain is depicted in Figure 1 [13]. Blockchain technology enables the development of a new governance system for natural resources management with participatory decision-making and decentralized relevant organizations that can operate over a network of computers without any human intervention [14]. Certain necessary technologies that are required for any governance system are first a way of both recordings a set of rules, second a way for people to interact with the rules, and third a way to enforce the rules. The blockchain is ideal for recording information that can be later verified as authoritative and offers a novel method of accomplishing the three essential functions of governance. Blockchain would enable end users to verify exactly how the product is traded, thereby denying illegal and counterfeit extraction [15].

Recently, several studies have focused on the applicability of blockchain in different aspects of management. Tian [16] studies the utilization and development of blockchain technology in agri-food management. The integration of the supply chain through the blockchain technology to achieve disruptive transformation in digital supply chain management and networks is explained in the research by Korpela [17]. Kshetri [18] examines how blockchain is likely to affect key management objectives such as cost, quality, speed, dependability, risk reduction, sustainability, and flexibility by presenting early evidence linking the use of blockchain to increase transparency and accountability. However, the application of blockchain technology on enhancing the decision-making process for natural resources management is not considered in the literature. Hence this study aims to apply blockchain technology to this concern. Therefore, the extraction and trades of the resource can be monitored by all the key stakeholders, and in a case of critical situation for the resource, the involved actors in the network can take part in the decision-making process. Experts of different fields can be used to bridge the gap between limited capacity and the aspiration for the governance. Applying blockchain technology provides new opportunities for enhanced transparency and increased engagement in environmental management. Smart contracts can be utilized to set up autonomous digital entities to manage the resource and help societies to become more sustainable [19].

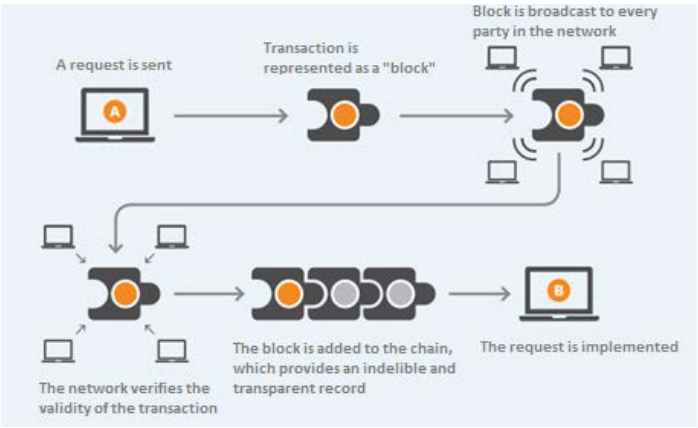

Figure 1: Blockchain Mechanism [13]

Coordination and collaboration across value chains are complicated in many cases due to the dynamic nature, power structures, and the inability of involved actors to have access to accurate and complete information about the resource and the dependencies [20]. Without holistic identification of the hazards, accurate information would not be available. To improve resource management, measurements are required for the decision-making process. A systematic model for the resources management would enhance the knowledge of the involved actors in the decision-making process.

2.3 Decision-Making

Understanding the complexity of natural resources management and the outcomes requires identifying and analyzing a broad context which determines integrated natural resources management decisions [21]. Natural resources management is mostly determined by human actions. A specific set of steps and goals forms the management approach. Decision-making in natural resources is a complicated procedure regarding both impacts and financial reasons. Human activities result in a change in the status of the ecosystem, which in turn can affect the services derived from the resource. Several studies have been focused on the decision-making process in natural resources management.

Different decision-making techniques have been applied in natural resources management. Schmoldt [22] suggest an analytical hierarchy process for decision-making in natural resources management and environmental fields. Group decision-making methods have become increasingly important for natural resources management. In the study of [23], some of the participatory tools that are effective in natural management are evaluated and the results recommended an integration use of the methods will make more robust outcomes. Groot [24] launched a platform of communication on ecosystem services approach for environmental planning and management at all level of decision-making.

Indeed, most of the key stakeholders are not aware of the impact of unsustainable development of natural resources. Usually, there is a mistrust within the public for the natural resources management decision-making processes. The discourse of interested organizations can help to shape a broader view for decision-making. All actors can strategically employ to achieve specific goals. This study aims to develop a methodology for the evaluation of natural resources management system based on integral index reflecting potential environmental hazards with the involvement of all the related parties.

3 Methodology

As the community involvement grows, the desire of understanding and sense of trust of practitioners to be effective would increase. Different stakeholders frequently have competing demands and obligations. Conventional management approaches may fail in recognition of multiple interests, interactions, and involved variables [23]. Based on Hedelin [25] the well-established principles of sustainable development in natural resource management are integration and participation. For this study, a participatory decision-making framework has been developed to establish ways to systematically integrate planning and decision-making procedures to the concept of natural resource governance. The process is shown in figure 2.

The vital emerging tools that are applied for participatory decision-making framework in this study are as follows:

I. Blockchain Technology: high secure and distributed database can be provided by this tool. A peer-to-peer network of the stakeholders shares the responsibilities for maintenance and integrity of the

contained data. Data from stakeholders is collected and stored on a Blockchain network. Blockchain technology provides a trusted platform for all stakeholders to be involved in the decision-making process. Moreover, the distributed database offers a structure for systematic interdisciplinary knowledge integration to improve natural resources governance.

II. Smart Contract: the complex business logic can be encoded, and the computations would be carried out without human intervention. The data is combined in a smart contract with expert knowledge to create a risk model.

III. Fuzzy Theory: During the decision phase, the model results are analyzed by fuzzy cognitive maps to assist in developing the action phase. A fuzzy set can be defined mathematically by assigning each possible factor a value representing the grade of membership as the fuzzy number. The fuzzy models help to demystify, assessing and learning about the decision factors.

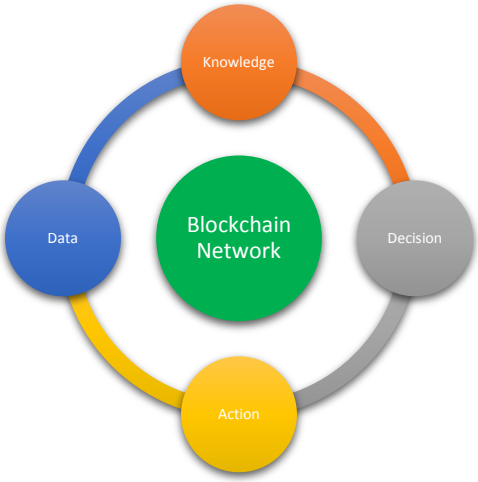

Figure 2: Participatory Decision-making

The methodology steps are as follows:

1. A blockchain platform is developed that include all the key stakeholders in a decentralized network of communication.
2. The objectives and data from each stakeholder are added to the network database.
3. Through the network, the responsibilities and barriers are identified with the contribution of all involved parties. For each task, above 50% votes from the actors is required to decide for implementation of an action.
4. Any new transaction request must be aggregated and validated. If the new change is trusted, the transaction is encrypted and turned to a block. All the transactions will take place using smart contract Ethereum.
5. The risks and sustainability improvement factors are identified using expert judgment.
6. The factors are evaluated within the decision-making framework
7. The factors are mapped on fuzzy cognitive maps and fuzzy sets are applied to assess the factors
8. The results are discussed through the network to make the optimum decision regarding natural resource governance.

4 Discussion

Uncertainty exists concerning sustainable use, and potential benefits derive from natural resources. The natural resources management potential outcomes are often constrained by the unavailability or lack of information. Therefore, natural resources decision-making models are required with an adequate level of information. Employing Blockchain-based decision-making model provide a database of information for all the key stakeholders that help them with the decision-making processes and fill the gap to deal with the uncertainties. In the most natural resources management, there is no monitoring system on the extraction and trades as well as the environmental impacts on the human beings and the ecosystem. The intended outcomes of the proposed methodology would be a monitoring system which can reduce the negative consequences as well as implementing sustainability programs for the resource.

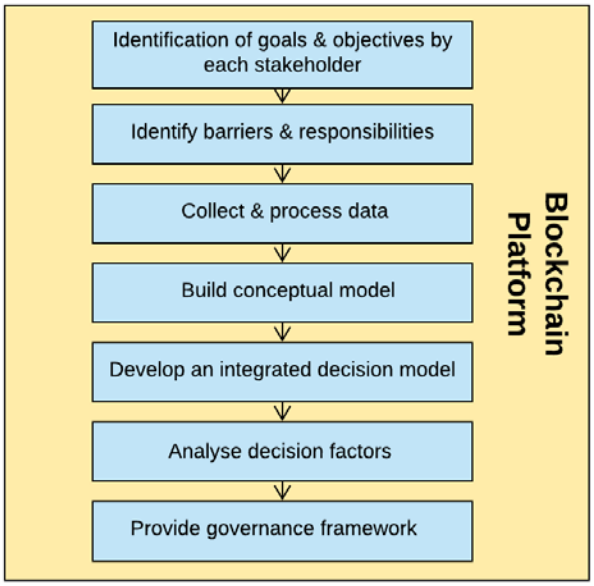

Figure 3: Methodology

5 Conclusion

It is time to treat natural resources like key assets that nations seek to manage for the future. There is a need to develop a framework for natural resource governance, along with global and regional strategies. This methodology can eliminate the unsupervised extraction and trades by monitoring the resources through the blockchain technology. Moreover, the negative impacts on the environment can be reduced by taking immediate actions for the critical regions which can be identified through the applied methodology. In addition, it can arm regulators with policy-making of natural resources treatments. Applying the decentralized blockchain system and using influential parties through the decision-making framework generates significant effects from a discrete decision to the cooperative outcome. In the proposed framework, all data and analysis are governed by smart contracts on a blockchain. The key stakeholders have access to the platform to collaborate in decision-making processes. The utility of blockchain networks assists in providing a participatory decision-making framework for natural resources governance. The purpose of this study is to develop a decision-making framework to reduce vulnerability and strengthen the sustainability of natural resources.

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