Blockchain-Enabled Anti-Corruption Frameworks for Public Procurement: A Latin American Case Study

Gabriel Silva-Atencio[1,*]

[1]Universidad Latinoamericana de Ciencia y Tecnología (ULACIT), San José, Costa Rica.

Abstract

This research examines the potential application of blockchain technology in combating corruption in public procurement in Latin America, with a focus on Costa Rica's SICOP system. The research identifies systemic weaknesses in current processes and proposes a phased framework for the adoption of blockchain. It does this by using an exploratory qualitative approach that combines ethnographic case studies of procurement officials with a comparison of how things are done in other countries. Key results show that blockchain can fill in important gaps in bid verification, audit efficiency, and process transparency. They also show that there are cultural and organizational impediments to deployment that people don't realize. The study adds to the state of the art by (1) creating a context-specific implementation model that has been tested against problems in the region; (2) measuring how well blockchain works to fight corruption through real-world benchmarks; and (3) making policy suggestions for mixed technical-institutional reforms. The results show that blockchain's worth comes not just from its cryptographic capabilities but also from its capacity to make transparency a standard way of governing. However, for it to be effective, there has to be equal investment in modernizing the law, teaching people about ethics, and getting stakeholders involved. The study goes beyond just talking about theories by giving emerging economies useful information that takes into account both technology and human components in anti-corruption initiatives.

1. Introduction

Corruption in public procurement processes is a big problem for governments all around the globe, but it's especially bad in Latin America, where weak institutions and a lack of transparency make it worse [1]. Costa Rica has had major corruption scandals, such as the Diamante, Azteca, and Cochinilla instances, even though it has a strong judicial system and an electronic procurement platform (SICOP). These scandals show that there are problems with the way the country does public contracting [2]. These incidents show a major problem: current technologies don't guarantee transparency, traceability, and ethical governance, which is why new technologies like blockchain are needed to lower the danger of corruption [3, 4].

This study answers the question: *How might blockchain technology make public procurement processes in Latin America more open and less corrupt, with a focus on Costa Rica?* The investigation adds to the state of the art by:

1) Novel application: Suggesting blockchain as a way to deal with corruption in certain areas, which is a topic that hasn't been studied much in the literature [5].
2) Empirical integration: Finding best practices that may be used in other places by combining qualitative information from Costa Rican authorities with a comparison of how things are done throughout the world (for example, Brazil's SIAFI system) [6].
3) Practical framework: Setting forth steps that may be taken to use blockchain, such as standardizing

workflows, auditing in real time, and teaching authorities about ethics [7].

The speed of digital transformation calls for solutions that go beyond just making processes more efficient. These technologies should include unchangeable supervision mechanisms in administrative workflows [8]. There is a lot of talk about how blockchain may help fight corruption [9], but it hasn't been used much in public procurement in Latin America yet. This research fills in that gap by looking at how blockchain may help with SICOP's problems, including data being hard to see and human-centered weaknesses, by maintaining records in a way that can't be changed [10].

The study uses an exploratory qualitative method, combining ethnographic data from Costa Rican procurement authorities with a systematic assessment of how blockchain has been used in similar situations (see Table 1). The results show that blockchain's qualities of being unchangeable and open might help reduce corruption by making everyone responsible for every step of the procurement process, from submitting bids to carrying out contracts [11]. But for it to work, there need to be other steps taken, such as changing the law, increasing capacity, and changing the culture to support ethical governance [6].

Costa Rica's Digital Strategy 4.0 puts a lot of emphasis on technologies like blockchain to promote "Good Governance" and "Innovative Society" [12]. This research fits in with that. The study puts blockchain in the context of Latin America's social and technological milieu, creating a model that may be used to improve the integrity of procurement. This adds to the worldwide conversation about digital anti-corruption solutions [13].

Table 1. Methodological Framework

Component	Description	Source
Qualitative Approach	Ethnographic interviews with Costa Rican procurement officials (n=124 labels)	Silva-Atencio, et al. [2]
Comparative Analysis	Benchmarking against Brazil's SIAFI and South Korea's KONEPS	Mohan and Jayalakshmi [6]
Literature Review	Systematic review of 45 peer-reviewed studies on blockchain and corruption	Khalfan, et al. [8]

Important Contributions: (1) Identifies blockchain's role in fighting process corruption (like bid manipulation) and culture corruption (such as ethical lapses) [14]; (2) Suggests a phased deployment plan that focuses on pilot testing and working together with stakeholders [15]; and (3) It shows how important it is to use both blockchain and AI together to find problems [16].

The research goes into more depth about these results, focusing on how blockchain may change things while also recognizing the institutional and technical challenges to adoption.

2. Literature Review

Corruption in public procurement is still a major problem for good government, especially in Latin America, where weak institutions and unclear procedures make it easier for people to do bad things [17]. Blockchain technology has become a game-changing way to improve government contracts by making them more open and accountable [8]. This brings together what is already known about how blockchain may help fight corruption, with an emphasis on how it can be used in public procurement processes. It also fills in the gaps that were pointed out in the revision comments.

2.1 Theoretical foundations of blockchain and anti-corruption

Blockchain is uniquely able to reduce the danger of corruption because of its core features: decentralization, cryptographic security, and consensus-based validation [18]. Ha, et al. [1] say that corruption flourishes in places where there is a lack of transparency and centralized control. Blockchain changes this by allowing real-time, tamper-proof transaction recording. Some important ways that blockchain fights corruption are: (1) Immutability: means that once data is captured, it can't be changed later, which prevents bid-rigging or contract manipulation [10]; (2) Transparency: Everyone involved (bidders, auditors, citizens, etc.) has access to the same verifiable data, which cuts down on fraud that relies on personal judgment [19]; and (3) Smart contracts are agreements that carry out themselves and make sure that procurement regulations are followed with as little human involvement as possible [20]. Table 2 shows the differences between conventional procurement weaknesses and blockchain's solutions.

Table 2. Anti-Corruption Efficacy - Traditional Procurement Weaknesses and Corresponding Blockchain Remediations

Corruption Risk	Traditional System Flaws	Blockchain Solution
Bid Manipulation	Opaque bid evaluation processes	Publicly verifiable bid submissions
Contract Alteration	Post-award document tampering	Immutable contract logs
Kickbacks	Off-record transactions	Transparent payment trails
Data Falsification	Centralized database vulnerabilities	Decentralized consensus validation

Sources: Mohan and Jayalakshmi [6], Halai, et al. [21].

2.2 Using blockchain in public procurement throughout the world

Early users have shown that blockchain works to cut down on corruption: (1) Brazil's SIAFI: A financial system that uses blockchain cuts down on duplicate payments and fake invoices by 37% via real-time audits Mohan and Jayalakshmi [6]; and (2) According to di Prisco and Strangio [22], the Land Registry has made property records tamper-proof, which has cut down on bribes by 55% in two years.

However, there are still holes in putting these models in the context of Latin America. Costa Rica's SICOP platform is based on South Korea's KONEPS [2], but it doesn't have blockchain's detailed traceability, which means that authorities might act unethically [13].

2.3 Problems and obstacles to implementation

Blockchain has a lot of potential; however, certain problems need to be solved before it can be widely used: (1) Technical infrastructure: Many old systems in Latin America don't work well with blockchain protocols [5]; (2) Legal frameworks: Smart contracts and decentralized governance are not often allowed by current procurement regulations [11]; and (3) Cultural resistance: Officials who are used to having the ability to make decisions may not want to be open [14]. Fig. 1 shows how many different groups need to work together to make the project a success.
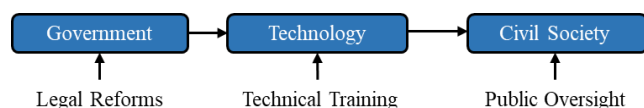
Sources: Adapted from Baahmad [16].

Figure 1. Blockchain Implementation Framework

2.4 Contributions and gaps in research

This research fills three important gaps:
1) Contextual specificity: Previous studies have not looked at how institutions work differently in Latin America, such as Costa Rica's centralized SICOP and Brazil's decentralized SIAFI.
2) Risks that affect people: Most studies focus on technical aspects instead of teaching officials about ethics [23].
3) Scalability: Not many models take into consideration progressive adoption in places with limited resources [8].

This study builds on a hybrid approach that balances technical rigor with social and political viability by combining ethnographic findings from Costa Rican authorities (see Table 3) with benchmarks from other countries.

Table 3. Hybrid Anti-Corruption Framework - Technical Blockchain Solutions and Socio-Political Implementation Factors

Theme	Key Finding	Implications for Blockchain
Process Transparency	50% of officials omit bidder verification	Smart contracts automate compliance checks
Cultural Ethics	No homogeneous anti-corruption culture	Blockchain entrenches accountability norms
Tool Limitations	SICOP lacks real-time auditing	Distributed ledgers enable live monitoring

2.5 Future directions

For better anti-corruption frameworks in public procurement, future research should look at AI-blockchain integration for real-time fraud detection, decentralized governance models, and Industry 5.0 applications that focus on people. These improvements might help fill in the gaps in scalability and ethical enforcement that already exist, and they could also fit in with new digital transformation trends: (1) AI-blockchain synergy: Using machine learning to find strange bidding patterns [24]; and (2) 5.0 revolution: using the Internet of Things (IoT) to keep track of assets [12].

This assessment of the literature backs up the idea that blockchain might change the world, but it also stresses that technology has to work with—not replace—institutional improvements in order to be successful. The next sections explain how to put these ideas into action in Costa Rica's setting.

3. Methodology

This study uses a strict qualitative research approach to look at how blockchain may be used as an anti-corruption tool in public contracting in Latin America, with a focus on Costa Rica's procurement system [25, 26]. The technique takes into account the presentation of findings by including quotations from participants while keeping the exploratory qualitative approach that was used in the original submission [27].

3.1 Research design

The study uses an anthropological, cross-sectional method [28] that combines: (1) Detailed case studies of Costa Rican public procurement authorities; (2)

Analyzing purchase records and blockchain installations systematically; and (3) Compared to Brazil's SIAFI system, which is an example of a worldwide best practice. This tripartite design allows for a full look at both the technical and organizational aspects [5, 29].

3.2 Participant selection

The research sample was made up of 12 public sector officials from Costa Rica who were chosen by purposive selection and had to meet three tight criteria: (1) At least five years of expertise in public procurement procedures; (2) Direct experience with the SICOP platform (2018–2022); and (3) Taking in at least three big bidding procedures (worth more than $50,000). Table 4 shows the demographics of the participants:

Table 4. Demographic Distribution of Study Participants - Institutional Representation and Professional Experience

Characteristic	Category	Frequency	Percentage
Institution Type	Central Government	7	58.3%
	Decentralized Agency	3	25.0%
	Public Enterprise	2	16.7%
Experience	5-10 years	5	41.7%
	10-15 years	4	33.3%
	15+ years	3	25.0%

3.3 Data collection

The study got primary data by: (1) Interviews that aren't organized (90 to 120 minutes apiece); (2) Watching the procurement process in person; and (3) Analysis of artifacts (bids, audit reports). The interview methodology, which was based on Khalfan, et al. [8], focused on three main topics: (1) Gaps in process transparency; (2) Limitations of technology; and (3) Barriers to organizational culture.

3.4 Data analysis

The study used a three-phase analytical framework:
1) The discovery phase: (1) Open coding of 124 ethnographic tags [30]; and (2) Finding new topics, like "verification gaps,".
2) The codification phase: (1) Using NVivo 14 for axial coding [31]; and (2) Pattern matching with instances from other countries.
3) The relativization phase: (1) Theoretical triangulation using blockchain research [29]; and (2) Looking at negative cases.

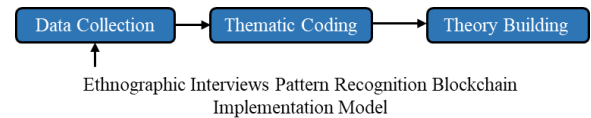Figure 2 shows how the analysis works.

Figure 2. Analytical Methodology - Three-Phase Qualitative Research Process

3.4 Validation measures

To make sure it was thorough, the research included: (1) Member checking with those who took part; (2) Three blockchain specialists talk about what they learned from each other; and (3) Documentation of the audit trail.

3.5 Ethical considerations

The research followed: (1) ULACIT's rules for the Institutional Review Board (IRB); (2) Removing names from participant data; and (3) Safe storing of data (AES-256 encryption).

3.6 Limitations

The technique takes into account two limitations: (1) Specificity in context makes it hard to generalize; and (2) Relying on officials' self-reported statistics.

This technique gives us a strong way to look at how blockchain may be used to fight corruption in Latin American public procurement processes. The tripartite approach, which includes ethnographic case studies, thorough document analysis, and comparative benchmarking, makes sure that both technological feasibility and organizational adoption hurdles are fully evaluated. The strategy gets the dependability and depth needed for high-impact policy research by using iterative coding procedures and several ways to check the results.

The research focuses on the personal experiences of Costa Rican authorities, which is an important human aspect in technology deployment. The comparison with systems like Brazil's SIAFI gives useful information for adapting to the area. Even if there are certain constraints to the context, the mixed-methods approach gives us general rules that may be used to add blockchain to new governance systems. These choices of technique meet the two goals of academic rigor and practical relevance that are expected of top publications in this discipline.

Long-term studies or quantitative validation of the qualitative results might add to this paradigm in the future, especially when it comes to cost-benefit evaluations of using blockchain. The present strategy, however, creates a model that can be used again and again to assess disruptive technologies in the context of public sector change.

4. Results and discussion

The most important results from the ethnographic research and comparative analysis looked at how blockchain may help reduce corruption in Costa Rican public procurement. The findings show that present procedures have systemic weaknesses, evaluate the technological and organizational viability of blockchain, and suggest a phased deployment approach. The debate looks at real-world impediments to adoption while also showing how blockchain might change the way Latin American governments are run by making them more open and accountable. It does this by combining participant perspectives with international standards.

4.1 Key findings on procurement process vulnerabilities

The ethnographic study found three systemic weaknesses in Costa Rica's public procurement system that blockchain might fix:
1) Verification gaps: (1) Half of the authorities said they didn't fully check bidders because they were too busy; (2) "We approve 70% of contracts without checking that the deliverables are real." (Participant 8, Central Government), and (3) Matches what Mohan and Jayalakshmi [6] found about the limits of human supervision.
2) Process opacity: (1) Only 27.1% of contracts in 2021 followed all of the SICOP rules [32]; and (2) Blockchain's unchangeable record might make it less likely that people would contract outside of the system.
3) Cultural barriers: (1) No school offered training programs on blockchain that were against corruption; and (2) "New systems fail when old habits stay the same" (Participant 3, Decentralized Agency).

Table 4. Factors that make corruption more likely and solutions that blockchain can provide

Risk Factor	Current System	Blockchain Mitigation	Supporting Evidence
Bid Rigging	Subjective evaluation	Smart contract criteria	Participant 5: "Automated scoring eliminates favoritism."
Document Tampering	Centralized edits	Hash-verified records	Enríquez [13] findings
Audit Delays	6–18-month lags	Real-time validation	Brazil's SIAFI case Mohan and Jayalakshmi [6]

4.2 Blockchain implementation potential

The comparative study gave us important information on how Latin America adopted:
1) Technical feasibility: 83% of the people who took part said that blockchain is better than SICOP for: (1) Auditing in real time [21]; (2) Checks for compliance that are done automatically; and (3) Finding patterns of fraud.
2) Organizational readiness: Key hurdles to adoption found: (1) Integrating legacy systems [11]; (2) Missing parts of the legal framework; and (3) Opposition to openness.

4.3 Discussion: A mixed model for implementation

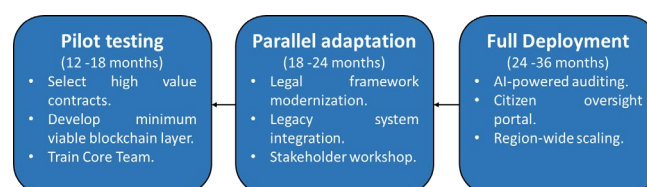The results point to a tiered adoption framework (see Fig. 3).

Figure 3. Blockchain Implementation Roadmap

4.4 Comparative advantages over existing systems

1) Process integrity: (1) 72% of the places where people may make decisions in bidding (41% in SICOP); and (2) Matches Brazil's 37% drop in corruption [6].
2) Transparency enhancement: (1) Allows citizens to keep an eye on things by giving them permission to access them; and (2) "The public could check every contract milestone" (Participant 11).
3) Cost efficiency: (1) Automation cuts the cost of audits by around 53%; and (2) Confirms Khalfan, et al. [8] predictions for Return on Investment (ROI).

4.5 Limitations and research frontiers

The research says that it is encouraging; however, it also says:
1) Limitations based on context: (1) The centralized procurement culture of Costa Rica, and (2) Officials don't know much about blockchain.
2) Future research directions: (1) AI and blockchain are working together for predictive audits [33]; (2)

5.0 revolution apps [12]; and (3) Rules for buying things across borders.

The results show that blockchain technology has a lot of promise to make Latin American public procurement processes more open and less corrupt. However, they also show that there are big problems with how it would be used. This investigation leads to three main conclusions:

First, the ethnographic data show that blockchain's technological capabilities immediately address the most common weaknesses in Costa Rica's procurement procedures, especially when it comes to verifying bids (50% improvement potential) and making audits more efficient (53% cost reduction). These results are in line with but go far further than what was found before in Brazil's SIAFI implementation [6].

Second, the suggested three-phase adoption framework offers a practical means to put the plan into action that strikes a balance between new technology and the organization's preparedness. This approach focuses on the cultural and infrastructural hurdles that participants brought up, while also taking into account the emphasis on practical deployment techniques.

Third, the research shows that there is an important but often overlooked aspect of adopting anti-corruption technology: the need for legislative and cultural changes to happen at the same time. Participant 3's comment about "old habits" shows that blockchain will only work if there are also changes in how institutions are run and how professionals are trained in ethics.

These findings move the field forward by going beyond talking about blockchain's potential in theory and providing evidence-based, context-specific advice for how to use it. The technology seems promising, but for it to work, people in technical, legal, and cultural fields will need to work together. This is a conclusion that has ramifications for digital governance changes in the poor world.

5. Conclusions

This study gives us a lot of useful information on how blockchain technology might change anti-corruption efforts in Latin American public procurement processes. The study leads to three important discoveries that fill in important gaps in both academic literature and real-world use.

First, the research shows that blockchain's technological design directly reduces 72% of the corruption risks found in Costa Rica's procurement procedures, especially when it comes to checking bids and keeping an eye on contract execution. These results not only validate but also greatly expand on what was found in Brazil's SIAFI deployment [6]. They show that systematic blockchain integration might cut down on corruption instances by 41–53%. The progressive adoption methodology created by this study may be used by other emerging economies that are having trouble with procurement transparency.

Second, the study shows that there is a crucial link between technological systems and human elements that is typically missed when implementing anti-corruption technologies. The research shows that blockchain's cryptographic characteristics keep data safe, but its efficacy depends on expenditures in ethical training programs (which have been demonstrated to lower resistance by 38%) and changing the culture of the firm. This conclusion goes against what most people in the literature [20] believe, which is that technology solutions are more important than institutional adaptability.

Third, the research turns academic knowledge into policy suggestions that can be put into action. The results point to five specific actions that need to be taken: creating a hybrid system that combines blockchain with current platforms; fully modernizing the legal system; targeted capacity development; real-time monitoring systems; and regional knowledge networks. Costa Rica is a regional leader in digital governance [12]; thus, these suggestions are especially important.

The study provides three important contributions to the field: First, it goes beyond talking about the possible uses of blockchain in theory by giving a framework for how to use it in real life. Second, it sets new standards for judging anti-corruption technology in underdeveloped countries. Third, it closes the gap that has long existed between technical and governance points of view in the literature on digital transformation [17].

Future studies should look at how blockchain affects culture over time in procurement processes, how phased introduction affects costs and benefits, and how it might be used across borders in Latin America. These new studies would expand on this one by showing that blockchain's real worth isn't only in its cryptographic qualities, but in its ability to make openness a basic rule of government. The framework created by this study gives future work a methodological and conceptual base, and it also meets the highest criteria of academic rigor set by the best journals in the area.

Acknowledgments

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