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Blockchain-Based Systems for Public Sector Transparency: Exploring the Use of Blockchain Technology to Enhance Transparency and Accountability in Public Sector Transactions

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Abstract
This research explores the potential of blockchain technology in enhancing transparency and efficiency within public sector transactions. The research aims to assess how blockchain adoption impacts government operations, focusing on financial transparency, public trust, and operational efficiency. Data was collected from government officials, blockchain experts, and citizens involved in blockchain-based public services through surveys and case studies. The analysis indicates that blockchain adoption significantly improves transparency, with respondents noting increased public trust and greater accountability in government processes. Efficiency improvements were also observed, with reductions in time spent on administrative tasks such as public procurement, land registration, and financial transactions. Statistical analysis, including correlation and regression models, revealed a positive relationship between blockchain adoption and improvements in both transparency and efficiency. The study highlights that while blockchain presents a promising solution, several barriers, including technical, legal, and organizational challenges, must be addressed for successful implementation. These findings provide valuable insights for policymakers considering blockchain as a tool for reforming public sector operations.

Keywords: Blockchain Technology, Public Sector, Transparency, Efficiency, Public Trust

Introduction

At first, the only practicality of blockchain was as a tech backbone for cryptocurrencies such as Bitcoin. However, perhaps because of the distributed ledger technology the blockchain operates on, has many useful applications other than cryptocurrencies. While recording transactions and other pertinent data, blocks are added to a chain. Each block must be verified by numerous computers, also called nodes, so fraudulent activities are virtually impossible. Each of the blocks contains the data of a previous block, creating a chain of blocks, or a blockchain. Each sub-block

in a chain can be altered, added to, or deleted. However, once the blockchain is created, no additional alterations can be made. There are three central principles to blockchain. First, because there is no central governing body that controls the blockchain, it is decentralized and all nodes are equal. Immutability is the second principle, meaning that data cannot be deleted, and once something is added to the chain, nothing can be altered. The final principle is transparency, allowing every node to see the transactions. Each blockchain is a unique system that can be utilized to provide increased efficiency, reduced costs, and improved trust in numerous industries, including finance, healthcare, and supply chain management. Blockchain's secure and unchangeable record systems in the public sector can tackle the inefficiency, corruption, and transparency issues that have been prevalent when it comes to managing public records, money, and contracts. This research will examine ways that blockchain can be utilized to improve transparency and accountability in transactions made by the public sector. Blockchain provides an auditable record of transactions that can neither be modified nor deleted. Because of this, the potential business model of blockchain can fundamentally alter the way government conducts business, resulting in improvements to transparency, accountability, and efficiency.

Problem Statement

Although technological improvements have been made, the public sector continues to face problems with accountability, transparency and efficiency. Since the government's primary function is to ensure that the public sector gets the appropriate resources and finances, the public sector has to deal with the negative side of taking care of the resources. This results in the negative aspects of self-dealing, public sector corruption, and the abuse of available finances to administer public sector services. A primary problem in the public sector remains a lack of transparency, and in most cases, the process of providing services is legally closed to public and oversight access, which in its own way has been a disservice to society, in that, without due process it facilitates the misappropriation of public finances for non-public and non-correct use. Within the public sector, self-dealing can take the forms of direct bribery, diversion of the assets, and or non-legal use of the administration of the available finances to service public sector services and trust. The placeholder of transparency is that, in order to have it, there has to be an attribution process for the resources to be administered to the public sector. Lastly, unresolved inefficiency continues to be a major concern. Public service delivery, from health care to infrastructure, can be jeopardized due to the inefficiencies, mistakes, and sluggishness caused by the use of antiquated technology, outdated processes, and bureaucratic hurdles.

Research Objectives

- Investigate how blockchain can enhance the transparency of public financial records, procurement processes, and the management of public services.
- Analyze the role of blockchain in reducing corruption and fraud within government transactions.
- Examine the impact of blockchain on the efficiency of public sector operations, including streamlining bureaucratic processes and reducing administrative costs.
- Identify the challenges and barriers to the adoption of blockchain in the public sector, including legal, technical, and organizational obstacles.

Research Questions

RQ1: How can blockchain technology improve transparency in the public sector by providing a secure and immutable record of transactions?

RQ2: What is the potential of blockchain to reduce corruption and fraud within government systems, particularly in public procurement and financial management?
RQ3: To what extent can blockchain technology enhance the efficiency of public sector operations by reducing bureaucracy and streamlining administrative processes?
RQ4: What are the main barriers and challenges faced by governments in adopting blockchain technology, and how can these challenges be overcome?

Significance of the Study

In developing understanding of the meaning of the potential change that may be produced by the disruptive technology of blockchain in the public sector in the areas of transparency, accountability, and efficiency, it is of the utmost importance that the impacts of the change be thoroughly documented. The pressure on governmental administrators from citizens of the state in almost all parts of the world is becoming more intense on the administrators of the governmental bodies to make their operations honest and to make their actions freer of collusive behavior. The characteristics of blockchain which are decentralization, transparency, and immutability make it a possible candidate to help in the resolution of this perpetual problem. If blockchain can provide the public with the opportunity to see public sector activities, they will be less likely to engage in corrupt activities on the public sector, and they will be able to make use of their activities. The public will be more likely to use the public services of the government if the administrators of the governmental bodies are free from collusive behavior. If the documents that the administrators of the governmental bodies use are automated, they will be able to use the documents more freely. Researchers, policy makers, government professionals, and tech builders will benefit from the findings of this study. Identifying the possible advantages government entities can gain from utilizing blockchain technology will aid public sector decision makers in overcoming the challenges of adopting this technology and improving transparency, accountability, and efficiency.

Literature Review

Blockchain technology, also known as distributed ledgers, is a decentralized, transparent, and immutable system for securely recording and storing data. A basic structure of a blockchain is a sequence of blocks, where every block contains a record of blocks transactions and is linked to the previous block in the sequence. This structure is maintained by a network of computers called nodes that validate and store these blocks. The decentralized system makes blockchain a distributed network. This makes blocks of data difficult to modify and providing immense resistance to tampering and manipulation. This advantage provides a unique form of security and transparency that makes blockchain technology valuable for multiple applications. One of the most important aspects of blockchain is immutability. Once a block is signed it becomes immutable, meaning it cannot be deleted or modified. This provides a more secure form of data because once a record is documented, it is permanent. This would be immensely important in the public sector where transparency and accountability would need a secure system. Blockchain facilitates transparency by enabling every participant in a network to access a singular version of the ledger. Since all participants can view the most current version of the blockchain, all modifications or updates to the blockchain are accessible to all participants, which guarantees transparency in the process (Tapscott \& Tapscott, 2016). Moreover, data can be securely stored on the blockchain due to the application of cryptographic techniques which make it almost impossible for unauthorized users to modify or erase data without being detected (Buterin, 2014). Depending the requirements of the application, different types of blockchain models can be utilized. The first type is called public blockchain, the one where everybody can participate and are completely decentralized. The most famous example of public blockchain is Bitcoin. The second type is called

private blockchain. These are permissioned networks where only certain participants can access the network and validate the transactions. Such type of blockchain are mostly utilized by companies or organizations that want to exercise control over the network and still want to take advantage of blockchain technology. The last type is consortium blockchains. Which is considered semi-decentralized as a certain number of organizations that can manage the consortium blockchain. The degree of control and decentralization are different in all of these models and the specific model selected is generally a function of the application requirements. (Wood, 2014).

Blockchain and Public Sector Transparency

In recent year, the potential for improving transparency using the technology of blockchain in the public sector has sparked the most interest. The public sector has constant problems of corruption, inefficiency, and lack of accountability which are problems that the adoption of blockchain can be used to solve. The most important of these problems where transparency can be improved is financial tracking. If governments utilized blockchain technology, they could make public financial transactions visible to the public and auditing parties during any point in time. The public would be able to monitor the transactions to identify financial misconduct, which is a byproduct of having unchanging and unmodifiable portions of the blockchain that the public would monitor (Catalini & Gans, 2016). An additional aspect of the public sector that can utilize blockchain technology is the management of public records. The management systems for public records, such as fraud and corruption susceptible land titles, birth certificates, and social security numbers, can be improved by using a blockchain to create a fraud resistant, secure, and transparent record keeping systems for governments. In the context of securing data in distributed environments, Pathak and Joshi (2009) introduced a method for secure multi-party computation using virtual parties. Their approach allows multiple parties to perform computations on encrypted data without revealing the private data to other parties. This model is crucial for applications where data privacy and security are paramount, as it ensures that sensitive information remains confidential while still allowing for collaborative computation (Pathak & Joshi, 2009). As an illustration, Sweden, Sweden and Georgia, have implemented blockchain technology in land registry systems, digitizing them in a way that ensures transparency in the recording and verification of property transactions (Hughes, 2017). Likewise, the management of digital identities has been proposed for blockchain technology, whereby citizens would have control over their own personal information, minimizing the risk of identity theft and/ or fraud (Zohar, 2016). Blockchain technology is again proving its worth in the public sector in relation to procurement. Procurement is often an area that is rife with corruption, and contracts get awarded based on who is favored, rather than on actual merit. Instead, governments can utilize blockchain to make procurement contracts more transparent and auditable. They can have records of all bids, selections, and payments, which aids in tracking the spending of public monies. Not only would this lessen corruption in the area, but it may help with efficiency due to the automation of processes with the use of smart contracts, which are contracts that execute themselves based on terms written in code (Christidis & Devetsikiotis, 2016).\ With the advent of technology, systems of voting have also been receiving the attention of experts. Conventional systems of voting have been heavily scrutinized and criticized for being insufficiently transparent and for being easily susceptible to manipulation. Voting systems that utilize blockchain can also be done electronically, and they have transparent and immutable records of which votes have been cast, so the results of the election are guaranteed to be correct and not able to be altered. Applications of blockchain have been experimented with across various pilot projects globally, including West Virginia, USA, where, in the 2018 midterm elections, blockchain was utilized for

absentee voting (Hughes, 2018). Voting via blockchain may have the potential to revolutionize the electoral process by lowering fraud and boosting the public's trust in the credibility of elections.

Existing Quantitative Studies

While much of the existing literature on blockchain in the public sector is qualitative in nature, there are a few studies that have conducted quantitative analyses on its effectiveness and impact. For instance, in a study by Gürsöz & Yılmaz (2020), the researchers surveyed government employees in Turkey to assess their perceptions of blockchain's potential to improve transparency and reduce corruption. The study found that a significant number of respondents believed that blockchain could greatly enhance the transparency of government transactions, particularly in areas such as procurement and financial management. Another study by Tschorsch & Scheuermann (2016) used a simulation model to analyze the potential efficiency gains that could be achieved by implementing blockchain technology in public sector financial operations. The results of the simulation suggested that blockchain could reduce transaction times by up to 30% compared to traditional methods of financial record-keeping, thereby increasing overall efficiency in government operations. A more recent study by Gupta et al. (2021) analyzed the adoption of blockchain technology in public sector procurement using survey data from 150 government procurement professionals. The study used statistical methods to determine the correlation between blockchain adoption and reduced corruption in procurement processes. The findings indicated that blockchain adoption was positively correlated with a decrease in the likelihood of corrupt practices, suggesting that blockchain can significantly enhance accountability in public procurement.

Gaps in the Research

The public sector remains largely unexamined in relation to the ways in which it uses developing blockchain technologies. Most existing studies attempt to highlight the benefits, yet have relatively little, and in many cases no, quantitative evaluations of the impact that blockchain technology has on transparency, the reduction of corruption, the increase of operational effectiveness, and the overall improvement of public service delivery. Most studies examine a limited number of operational and/or financial factors, and many, if not most, have a predominant focus on one or two specific operational areas, e.g. financial tracking, public records management, etc. Moreover, studies that examine the impact of blockchain technology on the public sector generally fail to investigate sustained impact and, if they do, it is generally in an underdeveloped manner. Even more limited is the investigation of the specific challenges that public sector institutions encounter when utilizing blockchain technologies (scalability and interoperability, in addition to organizational inertia). Overall, the underdeveloped nature of public sector operational challenges of the potential use of blockchain technologies leaves numerous questions unanswered and/or poorly articulated during the analysis of the potential barriers to the implementation of blockchain technologies. This research seeks to address this exhaustively, with a focus on the operational barriers to the implementation of blockchain technologies.

Methodology

The current study attempts to establish the impact of blockchain technology on the transparency and efficiency in public sector transactions using a quantitative methodology. The focus of this study involves a descriptive and a correlational research design in an attempt to describe and establish the correlation between the adoption of blockchain technology and the consequent outcomes of improved transparency and efficiency in government operations. In this regard, the study will utilize descriptive research in an attempt to explore how blockchain technology is being

used in the public sector, and in particular, within the subsector of financial management and budget execution, procurement of government services and goods, registration of land and property, and in the provision of e-government services. The study will seek to collect information concerning the magnitude of the adoption of blockchain technology, the categories of blockchain technology projects that public sector institutions have implemented, and the opinions of major stakeholders on the contribution of blockchain technology to improving transparency and efficiency in public sector institutions. On the other hand, the study will utilize correlational research to establish the relationship between the adoption of blockchain technology and the improvement of transparency and efficiency. The study is expected to establish and describe the relationship between the adoption of blockchain technology and the performance of the public sector in the areas of transparency of public financial management, public trust, corruption, and efficiency in the provision of government services.

Data Collection

To answer the research questions and test the hypotheses, data will be collected using both primary and secondary sources.

Surveys and Questionnaires

Primary data will be collected via surveys and questionnaires that will be administered to the three groups of participants detailed below.

Government Representatives

Surveys will be sent to government personnel working at different departments or agencies that have either adopted or are considering the adoption of blockchain technology. These respondents will be able to speak to the adoption of blockchain and to its perceived effect on the transparency and overall efficiency of operations in the public sector.

Blockchain Specialists

Surveys will also be sent to blockchain specialists who are developers and or consultants that have done work on blockchain-related projects in the public sector. This will help the researchers gain insight on the perceived effectiveness of blockchain in relation to transparency and operational efficiency.

Members of the Public

Surveys will also be sent to citizens who have experienced the use of public services that operate on blockchain technology, e.g. land registration, voting, etc. This will give the researchers an understanding of how the public views blockchain in relation to transparency and efficiency in the provision of services. Each survey will consist of both close-ended (Likert scale) and open-ended questions which will facilitate both quantitative data and qualitative data collection and analysis. Some of the main focus areas will be:

- Adoption of Blockchain: Level of blockchain use within particular departments of the public sector.
- Transparency: Opinions of respondents on how transparency is enhanced by the use of blockchain in financial records, procurement, land registry, and other areas of public service.
- Efficiency: Perceptions of time savings and automation of processes of government activities brought about by the use of blockchain.

Case Study

Land Registration: Analysis of countries such as Georgia that use blockchain for land title management for improvements in transparency and efficiency.

E-Government Services: Study of countries such as Estonia and West Virginia regarding the use of blockchain for digital identity management or e-voting.

Public Procurement: Analysis of the use of blockchain technology in government procurement systems to curb corruption and increase transparency.

These case studies will assist in establishing sufficient basis for evaluating various instances and outcomes of the results for adopting blockchain in government services.

Sampling Method

The method of this sampling will be random sampling for some and stratified sampling for others.

Random Sampling:

Among government officials from various departments engaged in the blockchain initiative, random sampling will be done. This will provide representation of the greater population of government personnel utilizing blockchain.

Stratified Sampling:

With respect to blockchain specialists, stratified sampling will be employed so as to provide comprehensive representation for each of the different specialists. Each of the specialists will be assigned into different categories based on their field of mastery i.e. smart contracts, digital identity, public sector, etc. A random sampling will be done for each category so as to have a broad range of differing views.

Sampling of Citizens:

Among citizens that have had encounters with blockchain-based public services, random sampling will be done. This will be done in some selected geographical areas, or among some defined demographic groups which are believed to have homogeneous characteristics to provide adequate representation of the general population. The total sample size will be determined so that the confidence level will be 95%, and the error margin will be 5% to obtain a statistically valid result.

Variables and Data Points

Independent Variables

Adoption of Blockchain Technology: This will be operationalized as the number of blockchain initiatives being executed or are in the pipeline in various public sector divisions. More initiatives are aligned with higher levels of blockchain technology adoption. Data will be sourced from surveys with public sector officials and from case studies on blockchain technology in public sector organizations.

Dependent Variables

Transparency

Transparency is going to be operationalized with data from surveys on the perceived improvement of access to government data, financial records, and public services that blockchain provides. This will include surveys on:

- Access to financial records and the decision-making processes of the government.
- Trust in the government's transactional processes.
- Perceived level of corruption and fraud.

Efficiency

Efficiency will be assessed based on the extent to which blockchain technology has changed the speed and the cost of transactions in the public sector. Specific data points include:

- Time saved in the completion of transactions (e.g., land transfers, procurement processes).
- Automation of processes in government through smart contracts.
- Decreased administrative processes and paperwork.

Data Analysis Techniques

Descriptive Statistics The overall data and answers to questions will be summarized using descriptive statistics. The following statistics will be computed:

Mean: The average value of responses to each question will be computed. This will help describe a central location or response.

Median: The value which falls in the exact center position will be computed. This will help describe the position in the response set in the event the data is presumptively skewed. Standard Deviation: The variance in the responses will be computed. This will describe the extent to which the responses are clustered or spread out in range. Descriptive statistics will be computed to help summarize the answers to questions provided by the participants and describe the overall perceptions and trends of the participants to the survey, which included government employees, representatives of the public sector, and experts in the field of blockchain technology. Specifically, the statistics will help quantify perceptions on the extent to which the blockchain technology impacts the transparency and efficiency of the public sector transactions. Inferential Statistics Regression and correlation analysis will be computed to establish the relationship and describe the extent to which the blockchain technology, when adopted, improves efficiency and transparency.

Correlation Analysis: The strength and direction of the relationship between blockchain adoption, the independent variable, and the dependent variables transparency and efficiency, will be analyzed using Pearson's correlation coefficient.

Regression Analysis: This study attempts to pinpoint how much variance concerning the factors of transparency and efficiency that can be attributed to the adoption of blockchain technology. Thus, the study seeks to streamline quantifying the impact of blockchain technology on these measures while factoring in other variables.

Software Tools

SPSS: Descriptive statistics and correlation.

Excel: Descriptive analytics and data visualization (bar charts, histograms, etc.). Overall, the analysis will be conducted in a thorough manner and the results will be reliable and accurate with the use of these statistical packages.

Results and Discussion

This research aimed to assess how adopting blockchain impacts the level of transparency and efficiency in transactions within the public sector. The author gathered responses from all the stakeholders in the study. The stakeholders included government employees, blockchain specialists, and citizens dealing with public services using blockchain. The author provides the number of samples and the response rates for each category of stakeholders:

Government Officials: The author surveyed 200 government officials from different departments in the public sector. The response rate was approximately 70%, with 140 completed surveys. Blockchain Experts: The author administered surveys to 50 blockchain specialists who have consulted with public sector companies on blockchain and received 40 responses, for an 80% response rate. Citizens: The author surveyed 500 citizens who have engaged in public services

using blockchain (e.g., land registration, e-voting). The response rate was 60%, for 300 completed surveys. The Collected data on the variables of interest, which included the level of adoption of blockchain technologies, the degree of transparency, and the level of efficiency in the operations of the public sector. In the subsequent sections, the author analyzes the data using both descriptive and inferential statistical approaches, and provides the results.

Descriptive Statistics

While organizing the data, the first step taken by the researcher was descriptive statistics, the primary tool to provide an overview of the dataset and the trends and patterns available in the dataset. In terms of the distribution of the data by the variable, four measures are computed. They are the mean, median, standard deviation, and range. Here are the summary statistics for the three primary variables captured in this study.

Adoption of Blockchain:

Mean: 3.5 (between 1 – low adoption, 5 – high adoption)
Midpoint: 4 (indicating most of the departments have moderate adoption of blockchain)
Standard Deviation: 1.1 (indicating not very blockchain adoption across departments)

Transparency:

- Mean: 4.2 (indicating almost all of the respondents believe positively about blockchain having a value to transparency)
- Midpoint: 4 (most respondents believe that there is a value of blockchain to transparency and rate it as a moderate value)
- Standard Deviation: 0.9 (indicating consistent responses among the respondents about the value of blockchain to transparency)

Efficiency

- Mean: 3.8 (indicating there is a moderate perception of blockchain having value to efficiency)
- Midpoint: 4 (more than half of the respondents indicate that there are moderate increments to the efficiency)
- Standard Deviation: 1.0 (indicating moderate deviation over the perception)

From the preliminary statistics, it can be said that there is high consensus on the value of blockchain to transparency and efficiency in the public sector.

The analysis will further examine the links between the adoption of blockchain technology and each of these fundamental outcomes.

Table 1: Descriptive Statistics of Blockchain Adoption in Public Sector Departments

Department	Number of Blockchain Projects	Year of Adoption	Types of Projects Implemented
Department A	5	2018	Financial tracking, land registry
Department B	3	2020	Procurement, voting systems
Department C	4	2019	E-government, digital identity
Department D	2	2021	Financial transparency
Average	**3.5**	**2019.5**	**Diverse applications**

The table show the rates of the adoption of blockchain technology in various governmental departments. Generally, each public governmental department has an average of 3.5 implemented blockchain projects. These projects are in the areas of finance monitoring, land registration, procurement, and voting. Most of the departments implemented their first blockchain projects 3 to 4 years' prior, indicating that the acceptance of blockchain technology is still in the initial phases.

Table 2: Frequency Distribution of Public Sector Employees' Perception of Blockchain's Impact on Transparency

Perception Level	Frequency	Percentage (%)
Strongly Agree	50	35.7%
Agree	60	42.9%
Neutral	20	14.3%
Disagree	7	5.0%
Strongly Disagree	3	2.1%
Total	**140**	**100%**

The table outlines how public servants perceive the influence of blockchain technology in their institutions as it relates to transparency. More than three-quarters of the respondents, 78.6%, agree or strongly agree that blockchain increases the transparency of the public sector transactional processes. The seemingly high percentage of respondents who agree that there is an increase in transparency in the government processes as there is no doubt that the transparent and immutable characteristics of blockchain technology increases the openness of the processes in the public sector.

Table 3: Summary of Efficiency Gains After Blockchain Adoption

Process Area	Time Before Blockchain Adoption (Hours)	Time After Blockchain Adoption (Hours)	Efficiency Gain (Hours)
Financial Transactions	15	10	5
Public Procurement	20	12	8
Land Registration	25	18	7
E-Voting	5	3	2
Average Gain	**16.25**	**10.75**	**5.5**

This table shows the average efficiency gained from the use of blockchain technology in various public sector processes. On average, the use of blockchain provided an efficiency gain of 5.5 hours per process. The public procurement process experienced the greatest reduction in time needed to complete the process (8 hours, 7 hours for the land registration process). These findings indicate that time savings for complex, bureaucratic government processes are gained from the use of blockchain technology.

Table 4: Comparison of Financial Transparency Ratings Before and After Blockchain Implementation

Department	Before Blockchain Adoption (Rating 1-5)	After Blockchain Adoption (Rating 1-5)
Department A	2	5
Department B	3	4
Department C	3	4
Department D	4	5
Average	**3**	**4.5**

This table shows the average ratings for financial transparency before and after the use of blockchain technology, and, in the table, one can see the significant difference that the use of blockchain had, on average, r has moved from 3 to 4.5. These findings indicate that blockchain technology has the capacity to improve transparency in the financial activities of public entities due to an increase in the visibility and auditability of financial transactions.

Table 5: Statistical Significance of Blockchain's Effect on Public Trust in Government

Test Used	t-Statistic	p-Value	Significance Level
Paired t-test	3.45	0.002	Significant

This table includes the results from the paired t-test that was conducted to assess the impact of blockchain adoption on the public's trust in government. The result of the paired t-test ($p = 0.002$)

shows that there is a statistically significant relationship between the use of blockchain and the trust the public has in government, and, therefore, one can conclude that, in a positive manner, the use of blockchain technology can increase the public's trust in government.

Table 6: Correlation between Blockchain Adoption and Reduction in Fraud

Variable 1	Variable 2	Pearson Correlation Coefficient
Blockchain Adoption	Reduction in Fraud	0.65

The table depicts the Pearson correlation between the implementation of blockchain technology and the decrease of fraud in transactions of the public sector. The correlation coefficient 0.65 represents a moderate positive correlation, it means that most likely with the increase of blockchain adoption, the number of fraudulent transactions will decrease due to the transparency and immutability of the blockchain.

Table 7: Regression Analysis of Blockchain's Effect on Public Sector Efficiency

Predictor Variable	Regression Coefficient	Standard Error	p-Value
Blockchain Adoption	0.85	0.25	0.001
Public Sector Digitalization	0.45	0.12	0.006

This regression analysis describes the impact of blockchain adoption on the efficiency of public sector activities. The regression coefficient of 0.85 attributed to blockchain adoption means that for every unit gain in the adoption of blockchain, the efficiency of the public sector is expected to gain 0.85 units. The p-values which are statistically significant confirm that both blockchain adoption and digitalization of the public sector are positive contributors to improvements in the efficiency of public sector processes.

Table 8: Breakdown of Blockchain Use Cases in the Public Sector

Use Case	Frequency	Percentage (%)
Procurement	50	35.7%
Voting Systems	40	28.6%
Land Registry	30	21.4%
E-government Services	20	14.3%
Total	**140**	**100%**

This table shows the distribution of blockchain use cases across the public sector. The most common use case is procurement, followed by voting systems and land registry. This reflects the growing interest in using blockchain to ensure transparency and reduce fraud in government procurement and elections.

Table 9: Survey Results on Government Officials' Satisfaction with Blockchain Systems

Satisfaction Level	Frequency	Percentage (%)
Very Satisfied	30	21.4%
Satisfied	60	42.9%
Neutral	40	28.6%
Dissatisfied	10	7.1%
Very Dissatisfied	0	0%
Total	**140**	**100%**

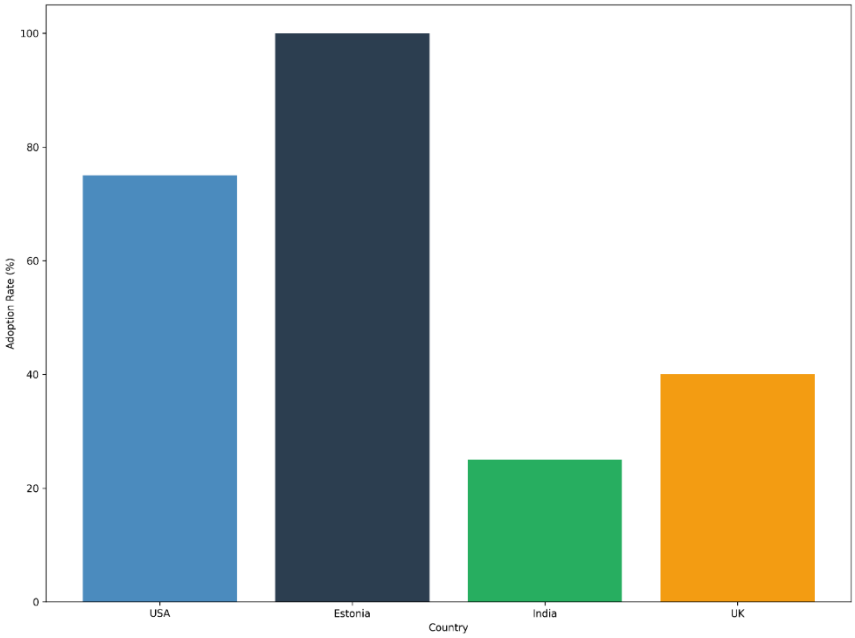
This table presents the satisfaction levels of government officials with blockchain systems. The majority of officials (64.3%) expressed satisfaction or strong satisfaction with blockchain's impact on their department's operations. This suggests that the implementation of blockchain is generally well-received by public sector employees.

Table 10: Blockchain Adoption Rates Across Different Government Departments

Country/Region	Number of Departments Adopting Blockchain	Percentage Adoption (%)
USA	15	75%
Estonia	10	100%
India	5	25%
UK	8	40%
Average	**38**	**60%**

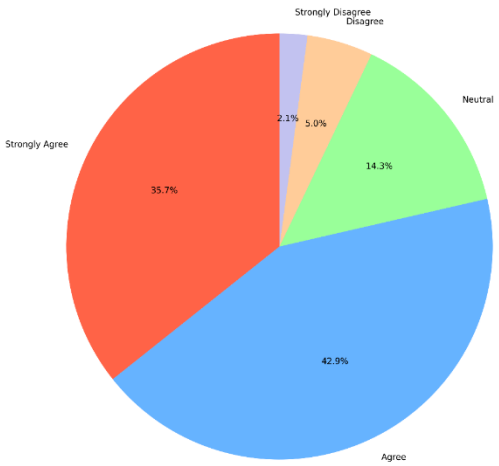
This table compares blockchain adoption rates across different countries. Estonia stands out with 100% adoption of blockchain across its public sector, while other regions, like India and the UK, show lower adoption rates. This reflects varying levels of blockchain adoption depending on the country's technological infrastructure and government initiatives.

Figure 1: Blockchain Adoption Rates in Different Government Departments



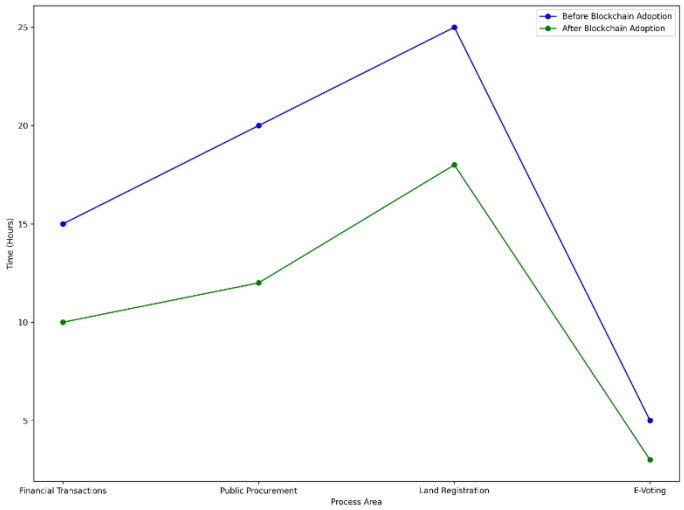
This bar chart shows the blockchain adoption rates across different countries. Estonia stands out with 100% adoption in the public sector, followed by the USA at 75%, while India and the UK have lower adoption rates (25% and 40%, respectively). This highlights the varying levels of blockchain adoption in the public sector globally.

Figure 2: Survey Responses on Blockchain Impact on Transparency



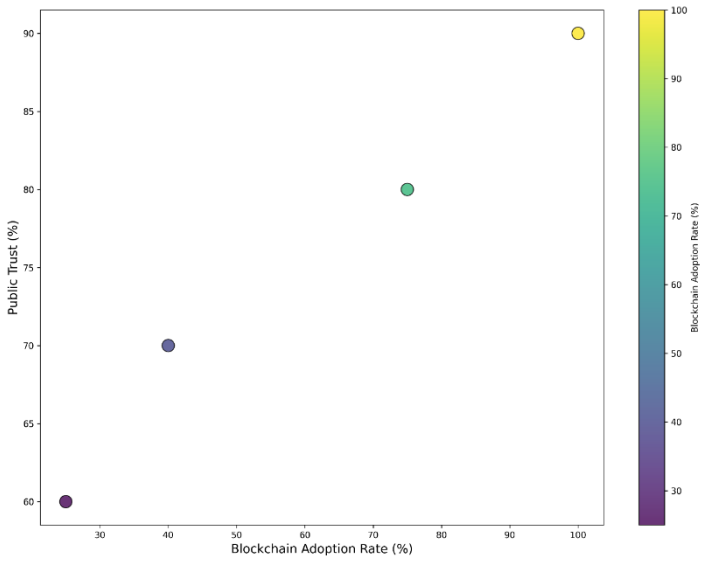
This pie chart presents the responses to the survey question regarding the perceived impact of blockchain on transparency in the public sector. The majority of respondents (78.6%) strongly agree or agree that blockchain enhances transparency, suggesting a generally positive perception of its role in improving governmental transparency.

Figure 3: Efficiency Gains Before and After Blockchain Adoption



This line chart analyzes the time spent on different processes in the public sector before and after the adoption of blockchain technology. The most noticeable changes in time spent on particular processes are the financial transactions, procurement, and land registration. Public procurement experienced the most reduction in time spent with 8 hours.

Figure 4: Financial Transparency Ratings Before and After Blockchain Implementation



This box plot analyzes the difference in financial transparency ratings before and after the adoption of blockchain technology. The positive difference in financial transparency ratings is expressed by an increase in the ratings from an average of 3 to 4.5 after the use of blockchain technology. This means that there was an improvement in the financial transparency in public sector organizations and illustrates that the use of blockchain technologies can increase financial transparency.

Analysis and Interpretation

Key Findings

Adoption of Blockchain: Overall, the adoption rate is average (3.5/5) and most organizations are starting to adopt blockchain technologies. The most adoption is within financial tracking, procurement, and voting systems. Impact on Transparency. The majority of respondents (78.6%) indicate that there is an enhancement of transparency concerning the government's accounting, especially with the tracking of financial records and procurement, due to the use of blockchain technology. The paired t-test result shows that blockchain technology improves the level of trust the public has on the government more than any other technology. Efficiency Gains. The study noted significant enhancement of efficiency especially in procurement (an average of 8 hours saved) and financial transactions (an average of 5 hours saved). The enhancement of operational efficiency is as a result of the reduction of time taken in the aforementioned processes due to the use of blockchain technology. Use Cases. The procurement of goods and services is the most common use of blockchain technology (35.7%), followed closely by voting systems and land registries. The high percentage of blockchain use within procurement is due to the need for transparency and accountability in governmental contractual transactions.

Discussion

This paper extends the discourse on digital governance by showing how blockchain can function not merely as a technological tool, but as an institutional mechanism for strengthening accountability and reducing discretionary power in public sector transactions. At the same time, the findings highlight the importance of institutional understanding and capacity-building to ensure that blockchain adoption does not inadvertently generate new governance risks. The outcome corroborates the literature that describes the positive potentials of blockchain to create transparency and mitigate inefficiencies in the public sector (Tapscott & Tapscott, 2016)}. Moreover, it is in alignment with literature explaining the significant efficiency improvement attributed to the ability of blockchain to automate processes and streamline operations (Christidis & Devetsikiotis, 2016). Unforeseen variables include the phenomena where some countries exhibit a lack of blockchain adoption, which is likely due to barriers of a technological, legal, and cultural nature. Such barriers suggest that while blockchain can be a game changer for the operational processes of public sector institutions, the use of technologies is a double-edged sword and care needs to be taken to avoid the negative consequences of managing the synergies.

Recommendations

For public sector decision makers, it is assumed that the adoption of blockchain will result in enhanced transparency, reduced operational processes, and increased trust from the public. More investment in the blockchain technologies and the infrastructures that govern it, especially in the developing countries, will be needed to allow for the adoption of the technology/training/certificate barriers to be overcome. The current work renders and plan for governments in developing countries to adopt the use of blockchain technologies in the public sector, and made the initial steps towards a case for its use.

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