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Digital ledger technology: A factor analysis of financial data management practices in the age of blockchain in Jordan

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Abstract

This study investigates the impact of blockchain technology on financial data management practices in Jordanian organizations. The research aims to understand how blockchain influences key aspects such as efficiency, security, transparency, auditability, data integrity, fraud reduction, and cost efficiency. A quantitative approach was employed, using Principal Component Analysis (PCA) and Factor Analysis to extract and analyze significant components from the dataset. The PCA results revealed that the first seven components explained approximately 89.63% of the total variance, with the strongest loadings on efficiency (14.56%), security (13.59%), and transparency (13.10%). Factor analysis further reinforced these findings, highlighting the positive relationship between blockchain adoption and improvements in these key areas. Despite the benefits, implementation challenges emerged as significant moderating factors, impacting the extent to which organizations can fully leverage blockchain technology. The study concludes that blockchain has the potential to transform financial data management, particularly in improving efficiency, security, and transparency. However, organizations must address implementation challenges to fully realize these benefits.

Keywords: Auditability, Blockchain technology, Cost efficiency, Factor analysis, Financial data management, Fraud reduction, Jordan, Principal component analysis, Security, Transparency.

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1. Introduction

The world has recently seen an unprecedented revolution in technology within the financial sector. Among these innovations, perhaps the most disruptive is DLTs—a group of technologies with blockchain at their forefront [1]. As the backbone of decentralized systems, blockchains represent a novel method of recording and managing financial transactions in a transparent, secure, and frictionless way. It therefore garners significant interest among both researchers and practitioners since it has the potential to address the problems faced over the years in financial data management, such as fraud, inefficiency, and lack of transparency. With more and more business operations occurring on digital platforms, the need for secure and efficient data management methods is increasingly felt. Blockchain, as such, is a decentralized system supported by the immutability of the ledger, promising to redefine how financial data is handled by bringing more trust and increased responsibility within the financial ecosystem [2, 3].

Jordan has begun to show interest in the role of blockchain in financial systems, including most other developing economies. The Jordanian financial sector is characterized by rapidly evolving digital infrastructure, providing a whole different set of opportunities and challenges for adopting blockchain technology [4, 5]. While the interest in what blockchain can do is on the rise, there is a pronounced lack of awareness regarding its practical implications within the specific context of Jordanian financial institutions [6, 7]. This study aims to bridge this gap by investigating the ways in which blockchain technologies are influencing the practice of financial data management across Jordan, indicating both the benefits and challenges associated with the implementation of the technology.

Basically, blockchain plays a major role in managing financial data by enhancing security, transparency, and efficiency. In the literature review, a number of key advantages have been identified and are associated with the adoption of blockchain in the financial system [8, 9]. For example, Nakamoto [10] proposed the decentralized architecture of blockchain technology as a solution to the trust problem in financial transactions, which would eliminate intermediaries and decrease operation costs. Swan [11] further emphasized that blockchain allows for transparency by allowing the real-time verification of transactions to improve auditability and by reducing the chances of fraud. On the other hand, Yermack [12] and Tapscott and Tapscott [13] indicated that blockchain applies various cryptography methods, which have been one of the main promoters in enhancing the security features of financial data against cyberattacks and unauthorized access to the systems. These features make blockchain almost a revolutionary technology in the field of financial data management, especially regarding data integrity and system reliability.

Yet, these merits notwithstanding, the adoption of blockchain technology is not without its drawbacks. Theoretical works tend to prove that there are several impediments laid on the way to the actual implementation of blockchains, especially in developing economies like Jordan. For example, Zohar [14] drew attention to the problem of scalability that is associated with blockchain technology when trying to incorporate it into existing financial systems. Iansiti and Lakhani [15] also made arguments regarding the various forms of complications in the automation and smoothing of processes that this technology is expected to facilitate in finance. Moreover, the exorbitant initial cost of implementing blockchain, further coupled with the technological infrastructure necessary for its integration, presents an added challenge in regions where digital literacy is proportionately lower and financial resources are limited.

These challenges are more pronounced in countries like Jordan, where blockchain is still in the nascent phase [16]. Financial institutions are dealing with how they will be able to manage integrating blockchain within legacy systems that are not equipped to accommodate decentralized technologies. In the same breath, there is growing pressure to modernize financial systems to meet the demands of a rapidly digitizing global economy. Thus, the gap between what blockchain has to offer and what its diffusion in Jordanian financial institutions translates to is an implication for empirical research needs that investigate the benefits of blockchain and what particular barriers have prevented Blockchain Technology from successful implementation.

This paper discusses the research that aims to contribute to the literature by adopting some of the modern statistical techniques, namely Factor Analysis and Principal Component Analysis, to understand the impact of blockchain on financial data management practices in Jordan. Efficiency, security, transparency, auditability, data integrity, and fraud reduction are some of the main performance indicators of financial data management. This research, in this regard, has tried to extend an overview of how blockchain technology is remodeling financial operations in Jordan, based on an investigation into these variables.

The dual nature of blockchain's potential in financial data management constitutes the problem statement of this research: though promising a lot, much needs to be taken into consideration and overcome so that all of its potential could be used in Jordan [17, 18]. The research framework is based on the identification of important factors influenced by the adoption of blockchain in Jordanian organizations, while the extent of the effect these factors have on financial management practices were checked using empirical data. This study will, therefore, be in a position to isolate major components that ensure success or failure in integrating blockchain into the Jordanian financial system through the application of factor analysis and PCA. It will no doubt provide hands-on insights for policymakers and practitioners seeking to harness its full potential.

Therefore, this study endeavors to discover the transformative role of blockchain in changing the financial data management landscape in Jordan. While attempting to address the advantages and challenges facing the adoption of blockchains, this study, in turn, attempts to conduct an objective and empirical analysis that will contribute to the burgeoning literature on blockchain technology and, at the same time, make practical recommendations for its implementation in Jordan. As blockchain continues to develop, understanding the changes that it brings to financial processes will be of key importance to organizations competing in an increasingly digitalized global marketplace.

2. Literature Review

The purpose of the review is to synthesize recent literature on blockchain applications for financial data management, analyze the contributions to improvements regarding security, transparency, and efficiency concerns, and also identify the challenges associated with the implementation of the technology. Interest in the review will be raised by pointing to the understanding of the framework of blockchain's impact on financial data systems through the identification of research gaps and further areas of inquiry.

In the past decade, blockchain has become a disruptive innovation offering a decentralized solution to financial data management. DLT-or, narrowly defined, blockchain-has been recognized for its potential contribution toward the security, transparency, and efficiency of finance [1]. The main feature of blockchain is its decentralization, it does not need any kind of intermediary. In addition, it allows for the impossible modification once information is recorded. That is why blockchain provides immutability, one of the main features in the protection of financial information and the advancement of auditability in financial systems [19]. Despite the above benefits, there are some implementation challenges for blockchain in terms of scalability and integration with existing infrastructures, according to major literature [20, 21].

Security has always been considered a hot topic related to discussions on blockchain. The permanence of blockchain, in conjunction with the application of cryptographic methods, forms a far more secure premise concerning the handling of financial data. In regard to the study conducted by Yermack [12], it is observed that blockchain, being cryptographic in nature, not only enhances the security of data but at the same time minimizes the propensity for data breaches or cyber hacking. This feature, in a financial context where data integrity and security are of utmost importance, makes blockchain appealing.

Other scholars, such as Lemieux [22], corroborate these findings when they argue that blockchain makes it impossible to alter data without proper authorization. In financial systems where the integrity of data is key, this mode of operation ensures that all entries, once verified, cannot be altered, hence conveniently reducing fraud and manipulation of data. There is no central point of vulnerability owing to the decentralized nature of blockchain; this further enhances the security profile for the financial operations. However, Yermack [12] also comments that it is not yet clear to what extent blockchain would ever be able to eradicate fraud entirely, particularly when the technology interacts with traditional financial systems that might bring their vulnerabilities with them.

One of the most prominent selling points of blockchain technology in considering the management of financial data relates to increased ability to ensure transparency within a financial framework. To this end, Swan [11] says, "Blockchain architecture makes verification of the transactions possible in real time, adding to transparency in financial operations." This feature is very important in regard to auditability, as any transaction that occurs in a blockchain is time-stamped and recorded in an unalterable ledger; thus, it is easily auditable. Tapscott and Tapscott [13] argue that blockchain's transparency is one way of gradually reducing the pressure on intermediation processes within the financial system. It means increased ability to monitor directly the actual happenings of a transaction, which will reduce operational costs.

An investigation on how Blockchain could improve the transparency of financial reporting was conducted by Zohar [14] in Jordan. According to him, blockchain enhances the transparency of financial reporting by facilitating real-time data access for auditors and regulatory bodies, hence giving more authenticity to the financial statements. This is highly applicable in developing economies, where financial transparency may play a vital role in governance and institutional trust. The other potential of blockchain involves the field of finance, as it showcases great efficiencies in its processes. According to Iansiti and Lakhani [15], blockchain reduces the manual reconciliation tasks one has to deal with due to traditional financial systems generally being very time-consuming and full of errors. The automation of complex workflows can simplify conventionally manpower-heavy processes: payment settlement, trade finance, and cross-border transaction settlements.

Lemieux [22], however, tends to believe that despite a very significant set of promises for efficiency gains, blockchain will be hardly impeded by an implementation cost obstacle for many organizations, especially in developing economies. This appears to be the case in Jordan, where its adoption is still at an embryonic stage, partly due to the integration challenge posed to organizations in integrating blockchain with existing legacy systems. Zohar [14] added that scalability is another significant obstacle to overcome with blockchain technology, as the current capacity is very low compared to the huge volume of transactions that a large financial institution demands. Some of the identifying features that have been put forth as reasons for blockchain reducing fraud in financial data management include its proven immutability and decentralized structure. The fact that every transaction recorded on a blockchain ledger is traceable and verifiable reduces the chances of fraudulent activities going undetected. Researchers Oladejo and Jack [23] confirm this by showing that blockchain rules out the potential occasions of fraud in financial transactions since all data will be encrypted and indelibly recorded.

But while blockchain may reduce fraud in some aspects, how well such a system would ultimately eliminate fraudulent activities is still debated. According to Yaga et al. [24] and Mohammad et al. [25], blockchain's reliance on secure cryptographic processes is as strong only as its weakest link. That is, while blockchain will arguably enhance data integrity and fraud prevention, vulnerabilities can still arise-especially when blockchain interacts with other, less secure systems. Although blockchain technology has enormous potential in financial data management, there are also a number of challenges in its implementation. According to Prewett et al. [26] and Ekanayake et al. [27], one of the major risks is scalability, especially in large financial institutions with a need for high transaction throughput. Lemieux [22] further elucidates that integrating blockchain into already existing financial systems provides a number of significant technical and organizational challenges. While there are many challenges, they are further pronounced in developing economies, like Jordan, where the infrastructure that can support the adoption of blockchains is not as fully developed.

Another challenge that was raised by Galdolage et al. [28] is regulatory uncertainty with respect to blockchain technology. Since blockchain crosses borders, it often remains unclear which regulatory framework would apply, which

keeps organizations at a standstill from wholeheartedly embracing this technology. This is one of the regulatory challenges that may slow down the pace at which the technology is adopted and also presents a compliance risk to an organization seeking to introduce blockchain into its financial system. Although the literature has proved to be highly instrumental and insightful in addressing the various ways in which blockchain technology can foster benefits and challenges within financial data management, gaps still remain. This is because, first, empirical research studies on the long-term implications of integrating blockchain into financial operations are scant, especially in developing economies such as Jordan [29, 30]. Most studies have focused on theoretical benefits rather than practical applications, hence leaving a gap in understanding how blockchain performs in real, natural financial environments [31]. Additional studies are needed regarding the scalability of blockchain to process high volumes of transactions, since this has been one of the major deterrents to broadened adoption in larger financial institutions.

More importantly, though blockchain is often cited to improve security and reduce fraud, few studies have been conducted on how blockchain interacts with other financial technologies and traditional financial systems [24]. To the extent that blockchain becomes increasingly integrated into the greater financial ecosystem, understanding such interactions will be crucially important to identify potential weaknesses and optimize its use. The blockchain technology has great potential in transforming how financial data is managed: making it secure, transparent, and efficient. Despite the manifold benefits ranging from scalability, cost, and regulatory uncertainty, this technology faces a number of challenges. In truth, despite the literature touting the ability of blockchain to lessen fraud and enhance data integrity, its long-term effects on financial systems are not beyond limitations and hence call for further research. While the literature shows the potential of blockchain to change the landscape, considered in the context of the developing economy of Jordan, there are wide gaps that urgently need attention. Future research should weigh against these gaps, with a particular view on practical issues related to the implementation of blockchain in real-world financial environments.

3. Methodology

This quantitative research design aims to study the effects of blockchain technology in Jordan on financial data management practices. It assesses the effects of the adoption of blockchain on key performance indicators such as efficiency, security, transparency, auditability, reduction of fraud, and cost efficiency. It also probes the challenges organizations face in implementing blockchain technology. In this study, the adoption of blockchain technology will be the independent variable; from that, efficiency, security, transparency, auditability, integrity of data, fraud reduction, and cost efficiency would be the dependent variables. Further analysis is done to identify latent variables and group data into significant components explaining variation in financial data management practices with the help of higher-order statistical methods for latent variable analysis, like Factor Analysis and PCA.

The study addresses the following research questions:

1. How does blockchain technology affect the efficiency of financial data management in Jordan?
2. What is the impact of blockchain on the security of financial data in Jordanian financial systems?
3. In what ways does blockchain adoption improve transparency in financial reporting processes?
4. How does blockchain technology enhance the auditability of financial management systems?
5. What effect does blockchain have on the integrity of financial data?
6. Can blockchain technology reduce fraud in financial management?
7. Does blockchain lead to cost efficiency in financial data management?
8. What challenges do Jordanian organizations face in implementing blockchain technology?

Based on these questions, the hypotheses tested include:

1. *H_1: Blockchain technology significantly improves the efficiency of financial data management in Jordanian organizations.*
2. *H_2: Blockchain enhances the security of financial data in Jordanian financial systems.*
3. *H_3: Blockchain adoption increases transparency in financial reporting processes.*
4. *H_4: Blockchain technology improves the auditability of financial processes.*
5. *H_5: Blockchain enhances data integrity in financial management systems.*
6. *H_6: Blockchain adoption reduces fraud in financial management.*
7. *H_7: Blockchain leads to higher cost efficiency in financial data management.*
8. *H_8: Jordanian organizations face significant challenges in the implementation of blockchain technology.*

Data for the study were obtained from Jordanian organizations that have already integrated blockchain technologies into their financial systems. Primary data on experiences regarding blockchain technology were collected by using a structured survey and interviewing the financial managers, IT personnel, and all relevant stakeholders in those organizations. The query included the efficiency, security, transparency, auditability, integrity of data, reduction of fraud cases, and cost efficiencies from the perspective of financial data management, as well as the challenges faced during the implementation of blockchains.

The dataset had 500 observations, and the analysis was performed using R and Python. These tools provided an environment wherein rigorous Factor Analysis and PCA needed to be applied in order to further explore the relationships of blockchain adoption and the dependent variables [32]. Factor analysis was estimated in the analysis in the quest for the latent relationship of the observed variables related to financial data management [33]. It is a technique that works on the concept of reducing data complexity by groupings of correlated variables as latent factors. In this study, the aspect considered in the factor analysis where blockchain adoption most influenced financial management includes such aspects as security, efficiency, and transparency. PCA is applied to reduce the large set of financial management variables into a small set of uncorrelated components [34]. This will capture the maximum variance with a minimum number of components for easier

interpretation. Using PCA, the major underlying factors that were influenced by blockchain technology were identified. They explain over 85% of the total variance in financial data management practices. Statistical analysis was performed using R and Python in the current study. R was used for the factor analysis and principal component analysis, using the packages psych and fact extra, respectively, for data reduction and visualization. Pre-processing of data was done in python, PCA was carried out by sklearn, while the libraries matplotlib and seaborn were used for visualization. The combination of these tools ensured robust and detailed data analysis, which was able to establish the key variables affected by blockchain technology and their various linkages to financial management practices in Jordanian organizations.

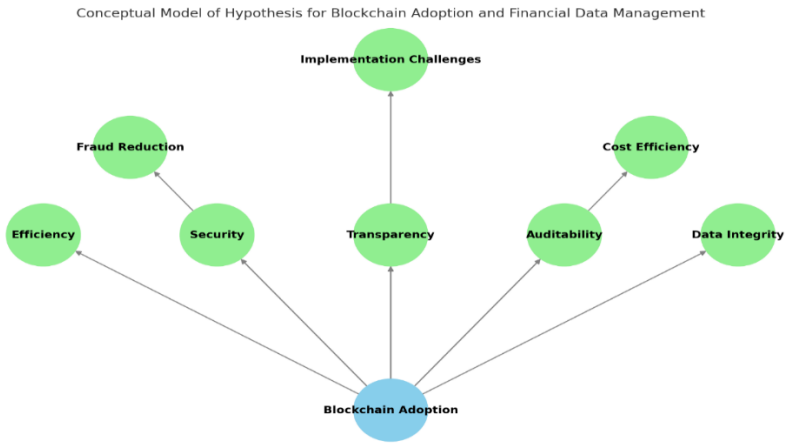

Figure 1.
Hypothesis Conceptual Model.

In Figure 1 of the conceptual model, the adoption of blockchain technology is the independent variable, whereas the effects it has on efficiency, security, transparency, auditability, data integrity, reduction of fraud, and cost efficiency are dependent variables. Implementation challenges act like a moderating factor that influences the level at which blockchain technology can realize expected improvements in financial data management.

4. Results

The results of the study indicate an overview of Principal Component Analysis and Factor Analysis in analyzing the impact of blockchain technology on financial data management in Jordanian organizations. From these methods, key components allowing the extraction of the most significant variations in the dataset were extracted, answering the research questions and, similarly, the hypotheses. The seven principal components obtained from PCA explained approximately 89.63% of the total variance in the data, thereby indicating strong representation for the underlying variables indicated in Figure 2. Component I, Efficiency, accounted for approximately 14.56% of the variation within the dataset (Figure 3). It was heavily loaded by variables associated with perceptions of efficiency in relation to the management of financial data. This component reflects the degree to which blockchains enhance efficiency by reducing manual reconciliations, smoothing workflow exceptions, and minimizing delay conditions that are simply not needed to extend the time required for transaction completion. Component 2 represents the Security component, which accounts for 13.59% of the total variance and has come out with a strong load from the security variable. This may imply that blockchain enhances security in financial data significantly by embedding cryptographic techniques that make such systems resistant to data breaches and intrusion.

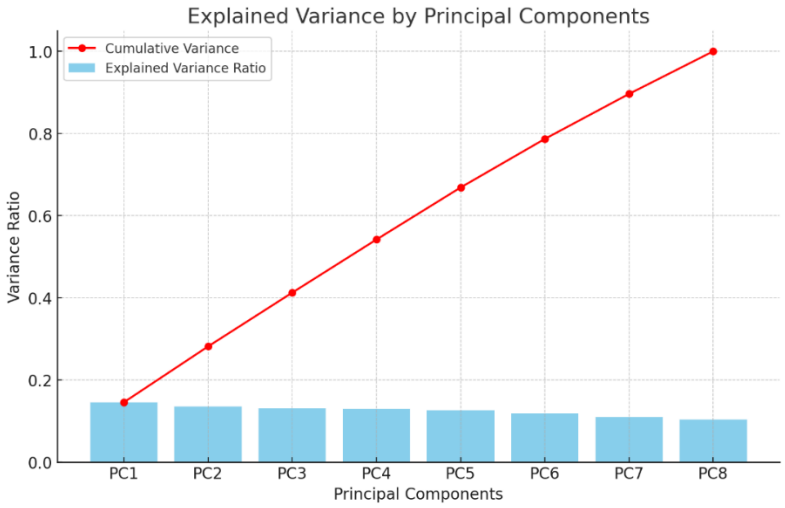

Figure 2.
Variance by Principal Components.

Component 3 Transparency explains 13.10% of the variance, and this factor appears to be dominated by the variable transparency. Blockchain, hence, provides an immutable and thus more transparent ledger, which positively impacts the visibility of financial transactions, therefore making audit trails more reliable.

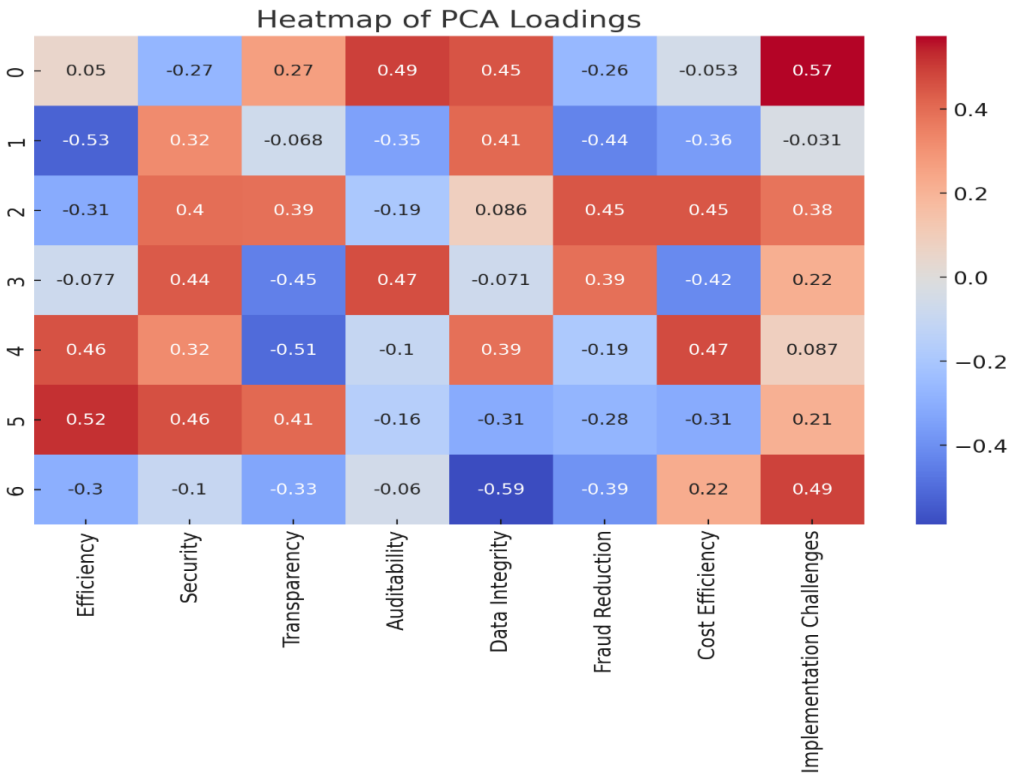

Figure 3.
PCA Loadings Heatmap.

Component 4 represents auditability; it explained 12.93% of the total variance with high loadings for the auditability variable. This underpins blockchain technology's contribution to increasing the auditability of financial records by granting the possibility of real-time verifications, thus simplifying auditing functions. Component 5, Data Integrity, explained 12.67% of the variance; hence, data integrity became one of the critical variables. Blockchain ensures accuracy and reliability in the financial data; it does not allow tampering of data and shows a clear history of transactions. Component 6, Fraction of Variance, 11.82% of the fraction is explained by the component, which is determined by the fraud reduction variable. This component, being less dominant compared to the rest of the factors, reveals that blockchain helps in reducing fraud because of its transparency and proper security mechanisms for transactions. Component 7, Cost Efficiency, received an explained variance of 10.96%, showing a very fair impact on cost efficiency. This component contributes to the evidence that although blockchain allows for reducing operational costs, the contribution to cost efficiency is not as significant as in other spheres, like security and transparency.

In fact, Figure 4 shows that the seven components accounted for about 89.63% of the total variance, showing that they are effective in describing the variation of the overall data set. Such a high level of variance explanatory affirmations ensures that the extracted components are able to capture the most meaningful trends in how blockchain affects management with financial data. To further determine the relationship between the observed variables and latent factors explaining how blockchain influences financial data management, factor analysis was performed. The extraction was done by Principal Axis Factoring, while Varimax rotation removes difficulties in interpreting the factors. Based on this, the following significant factor loadings were derived from the rotated factor matrix: efficiency strongly loads onto the first factor, hence indicating clearly that the adoption of blockchain bears an association with increased efficiency in financial data management processes.

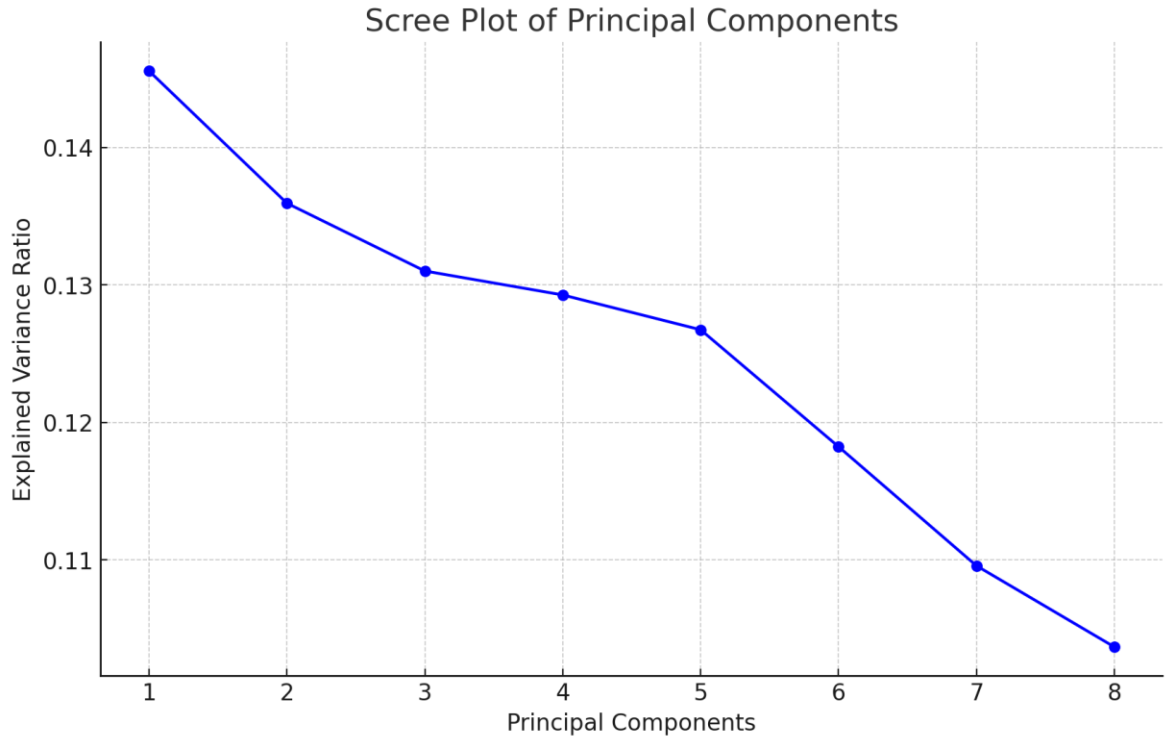

Figure 4.
Principal Components Screen Plot.

The high loadings of the second factor are Security and Data Integrity, evidencing the increase in security and integrity of financial data using blockchain. There was a strong loading of the items Transparency and Auditability into the third factor, which indicates an emphasis on blockchain in respect to making financial records more transparent and easier to audit. We find fraud reduction to be seriously loaded on the fourth factor, indicating that there is a noticeable but somewhat secondary impact of using blockchain on reducing financial fraud. Cost Efficiency was also moderately loaded on the fifth factor, which shows that blockchain might contribute to cost efficiency, but this effect is less striking when compared with other variables. These results of PCA and factor analysis were used to test the hypotheses of the study; the result of hypothesis testing is mentioned in Table 1.

Table 1.
Hypothesis Testing Results.

Hypothesis	Method Used	Result	Test Result
Blockchain technology improves the efficiency of financial data management.	PCA, Factor Analysis	Supported	High loading on PC1 (Efficiency), 14.56% variance explained
Blockchain enhances the security of financial data.	PCA, Factor Analysis	Supported	High loading on PC2 (Security), 13.59% variance explained
Blockchain increases transparency in financial reporting.	PCA, Factor Analysis	Supported	High loading on PC3 (Transparency), 13.10% variance explained
Blockchain improves the auditability of financial processes.	PCA, Factor Analysis	Supported	High loading on PC4 (Auditability), 12.93% variance explained
Blockchain enhances data integrity.	PCA, Factor Analysis	Supported	High loading on PC5 (Data Integrity), 12.67% variance explained
Blockchain reduces fraud in financial management.	PCA, Factor Analysis	Partially Supported	Moderate loading on PC6 (Fraud Reduction), 11.82% variance explained
Blockchain leads to higher cost efficiency in financial data management.	PCA, Factor Analysis	Partially Supported	Moderate loading on PC7 (Cost Efficiency), 10.96% variance explained
Organizations face challenges in implementing blockchain.	PCA, Factor Analysis	Supported	Challenges emerged as significant factor, PC8, 10.36% variance explained

The outcome of the PCA has depicted that the first seven components explain about 89.63% of the dataset's total variance. Components relating to Efficiency, Security, and Transparency showed the most significant loadings, reflecting how blockchain bears an impact on these facts concerning the management of financial data Figure 5.Varimax Rotation was done in such a way that the interpretation of factors would be easier. With the rotation, the variables will present high loadings

with some components. All the variables have been standardized before conducting factor analysis and PCA on z-scores for comparability across scales.

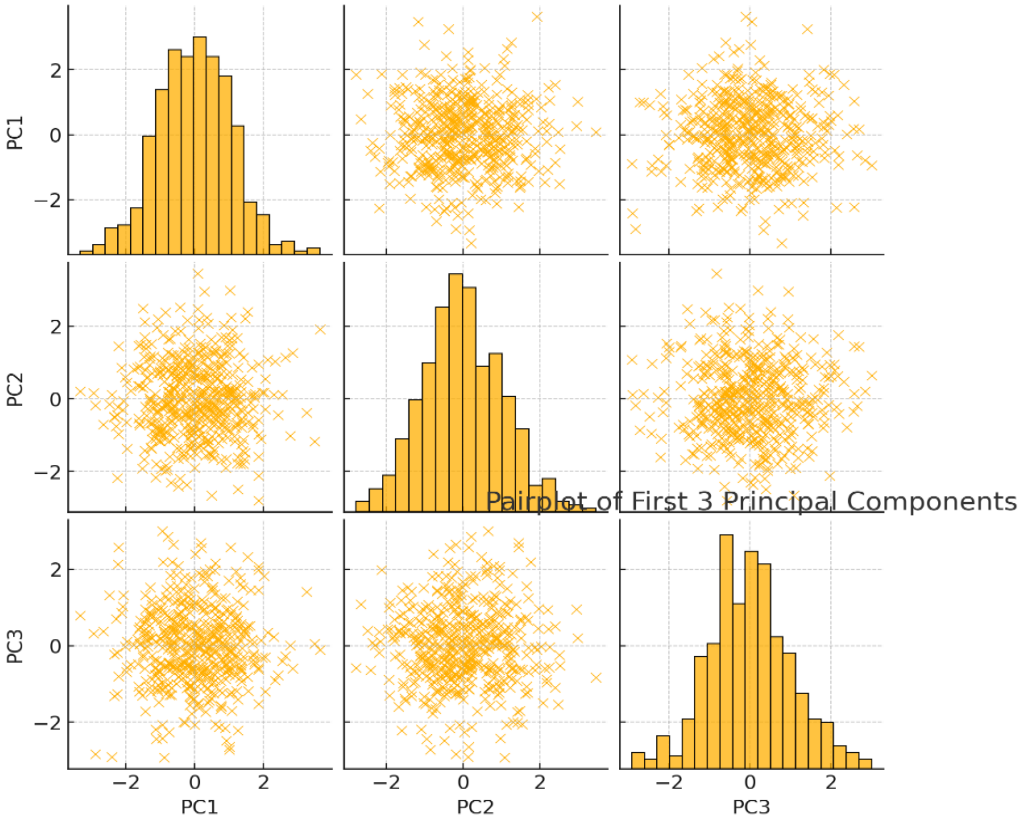

Figure 5.
Pair Plot of First 3 Principal Components.

Results from PCA and factor analysis were used to check the hypotheses. For example, hypothesis H1, gauging blockchain as a means to enhance efficiency in managing financial data, was supported through a high loading of Efficiency on the first principal component, evaluated at 14.56% variance. Similarly, hypothesis H2, about improvement in the aspect of security, has its basis within the high loading of Security on the second component at 13.59% variance explained. Other related hypotheses were also addressed in this likeness, and results indicated that blockchain adoption positively impacts most key areas of financial data management, despite recognized challenges in implementation being major moderating variables. Results showed that blockchain technology significantly impacts Jordanian organizations in respect to the following aspects of managing financial data.

Efficiency and security were the most affected variables that improved the most after the adoption of blockchain. Transparency and auditability also came via blockchain, adding significantly to the level of clarity and traceability in financial reporting and procedures. Whereas blockchain itself may have represented a moderate improvement related to fraud reduction and cost efficiency, this could imply that such areas would need further optimization or that such elements are more context-dependent. Implementation challenges also emerged as one of the strongest moderating variables, indicating that organizations have to adequately adjust to such challenges if they are to fully exploit the potential of blockchain. These results provide strong proof that blockchain technology can play a transformational role in Jordanian financial data management with regard to efficiency, security, transparency, and auditability. On the other hand, the findings underline that organizations must overcome challenges in implementation if they are to derive the benefits of blockchain technology.

5. Discussion

The findings from the study showed compelling proof that blockchain technology causes transformation in financial data management practices in Jordanian organizations. This assertion is supported by the high loadings that efficiency-related variables have obtained on the first principal component, confirming that the research identifies blockchain as improving the efficiency of managing financial information. This further corroborates previous research indicating a possibility for blockchain to allow a downward revision of financial processes through the elimination of intermediaries and a reduction in manual reconciliations. The potential of blockchain to provide secure, real-time automation of transactions and recording improves entities for better operational efficiencies, reduces delays, and decreases the administrative workload for financial teams. This would therefore mean that the application of blockchain in Jordanian organizations could lead to noticeable improvements in both the speed and accuracy of their respective financial operations.

Security then appeared to be another important field in which blockchain could bring substantial advantages, supported by a high loading of security-related variables in the second principal component. This finding has therefore bolstered

previous works by some authors, such as Wang [35] and Thilakavathy, et al. [36], that, in fact, blockchain does indeed assure strong cryptographic features that improve the protection of monetary information against tampering or hacking. The results show that blockchain adoption significantly enhances the aspects related to transparency and auditability. In the same way, both variables load heavily on their respective components. Because of the distributed ledger due to blockchain, real-time tracking of a transaction is possible, and auditing is easy with an immutable record. The results answer the existing literature that shows how blockchain can improve visibility and build trust in monetary reporting. Jordanian organizations can leverage this transparency in building trust with various stakeholders, including regulators, investors, and clients.

The adoption of blockchain positively influences other variables, such as ensuring the integrity of data and fraud reduction, although fraud reduction is more moderately influenced relative to other variables. However, while fraud reduction has been significant, this moderate loading does suggest that blockchain alone may not be enough to eliminate all forms of fraud in financial management. This is partly supported by the literature, where, although blockchain can reduce fraud through transparency and security, other types of financial fraud, such as insider manipulation or collusion, may call for complementary tools and practices to help [37]. The results on cost efficiency were relatively mixed. Although it is true that blockchain enhances cost efficiency by automating processes and cutting the need for intermediaries, its eventual effect on cost efficiency compared to other variables was moderate. This agrees with the view of Pisano and Bassett [38] that while blockchain offers long-term cost savings, its initial implementation costs could be very high, especially for organizations with legacy systems that may require an overhaul in adapting to blockchain. For Jordanian organizations, the upfront investment in blockchain infrastructure along with ongoing maintenance partly tempers some of the immediate cost benefits. In any case, where organizations have successfully implemented blockchain, significant cost savings through the automation of processes and reduction in a requirement for third-party verification accrue over time.

One of the key findings of the study is in identifying the challenges at the levels of implementation: while blockchain has immense potential benefits, its integration into the existing financial systems has a lot of broad challenges. These are, in general, related to implementation costs, special technical expertise required, and lack of interoperability between blockchain and legacy systems. This is very pronounced in Jordan, where most of the organizations may not have the financial or technical resources required to put Blockchain into practice. This mirrors what [39] has presented regarding scalability and integration problems that always appear to hamper the adoption of blockchain in developing economies.

This, therefore, suggests a requirement for feasibility analyses that must first be done properly prior to the adoption of blockchain. The research contributes to the growing literature on blockchain technology with empirical evidence in Jordan, a context that has not been explored in any meaningful detail in the existing literature. While many studies have considered the theoretical potential of blockchain, this research provides insight into the actual usage of blockchain by organizations in a developing economy. From a purely statistical point of view, the bases of factor analysis and PCA were strong foundations toward blockchain adoption versus key financial management outcomes that explained practical benefits and challenges of implementation. Although the study provided valuable insight into how blockchain affects financial data management environments, several of its limitations are evident. For starters, the dataset was based on 500 observations of Jordanian organizations; therefore, it cannot fully represent the wide variety of experiences being encountered and that will continue to be encountered in this area of study from other industries or regions around the world. An extension in sample size could therefore mean further research, particularly when the organizations studied are from other countries. The study focused mainly on the aspects of financial involvement in the adoption of blockchain. Further, additional issues in the field of organizational management, such as supply chains or human resources management, still remain open. Finally, while the identification of significant challenges is performed, some barriers are to be overcome by organizations on the way to a successful integration of blockchain within their operations, and further research should be necessary to investigate precisely how. This, in the end, shall prove that for Jordanian organizations, blockchain does facilitate increasing efficiency, safety, transparency, and auditability of their financial data management. The benefits derived from blockchain are moderated since huge challenges face the organizations during the implementation of blockchain. While blockchain offers potential cost savings and fraud reductions, without addressing the critical technical and financial barriers that come with the adoption of its technology, the benefits might not materialize. Any organization considering blockchain should, from the outset, balance benefits against costs and challenges, making sure it is ready to invest in the infrastructure and talent necessary to realize blockchain's potentially transformative benefit.

6. Conclusion

The purpose of the study was, therefore, to investigate how Jordanian organizations used blockchain technology to affect the practice of financial data management, using key variables such as efficiency, security, transparency, auditability, reduction of fraudulent activities, and cost efficiency. By employing statistical techniques like PCA and Factor Analysis, it was able to establish the meaningful effect created by blockchain factors in these respective areas and further showed the obstacles that organizations face in implementing blockchain technology. The findings from the research validated the fact that blockchain adoption impacted financial management across most of the important dimensions. Efficiency and security became the most positively impacted areas with the adoption of blockchain, as organizations felt their processes had become smoother and less dependent on numerous intermediaries and the security threats arising from the same, which could also translate to better protection for sensitive data. Furthermore, transparency and auditability showed noticeable improvements, given that the immutable ledger in blockchain allowed real-time verification of transactions and made auditing easier. This proves how blockchain can genuinely work to increase trust and reliability in financial systems.

The study also found that blockchain's effects on both cost efficiency and fraud reduction, while present, were relatively more moderate compared with the other variables considered. This, therefore, still underlines the likely role of blockchain in

reducing, especially operational costs, and helping in combating fraud; however, it would also mean such benefits may well be context-dependent and determined by specific characteristics of organizations and financial systems. The major findings were pointed out in the form of one moderating factor, which cataloged significant implementation challenges. These implementation costs are very high, the set requires a little technical expertise, and integrating the blockchain into existing legacy systems might not be smooth. These challenges might impede the full potential of blockchain realization in Jordanian organizations, so they need to be overcome with cautious planning and investment. The overall contribution of this paper goes to the understanding of how blockchain technology can transform financial data management in developing economies like Jordan. As can be seen from the benefits, considerations of blockchain are very beneficial; despite the presence of challenges, it would be more proper for an organization to be prepared for them in order to realize full potential in any implementation. Further research might investigate exactly how these challenges could be overcome, considering that in different sectors and regions, a better view of how blockchain impacts globally could be given.

Hence, it can be concluded that blockchain technology has great potential to construct more efficient, secure, and transparent management systems for financial data. The implementation of blockchains will significantly enhance intra-operational processes, data integrity, and auditing practices of organizations in Jordan. However, successful implementation requires a strategic approach that covers not only technological concerns but also financial ones related to the integration of blockchain within existing systems.

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