OPTIMIZING HEALTHCARE SUPPLY CHAIN MANAGEMENT: A COMPARATIVE ANALYSIS OF TRADITIONAL AND BLOCKCHAIN BASED APPROACHES

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ABSTRACT

There are no doubts that procurement, production, distribution, and transportation of medical supply chains and services are interconnected nodes in the complicated healthcare supply chain. The aim of the study is to identify how blockchain technology can help make healthcare supply chain management better by comparing current supply lines to those used with blockchain technology. Using traditional healthcare supply chains has several limitations, such as the lack of proper inventory management, a lack of transparency, and the risk of fraud and counterfeit goods. Chain technology based on a unique global ledger can solve these issues. This study allows us to examine how efficient, safe, and sustainable current traditional healthcare supply lines compare with what is available by employing chain-based solutions. We determine the critical metrics such as transparency and traceability of the supply chain, cost, and response time using case studies, simulations, and actual data. We also consider the effect on adherence due to differences in strategies and ensuring patients' safety. Based on the findings, the chain might make the healthcare supply chain more transparent and traceable. It may prevent fake supply chains from appearing and ensure standards are followed. Blockchain technology, with its global ledger capability, may also reduce costs and thus help extend the business. However, a variety of issues have emerged that require special consideration. I proceed to discuss what those findings imply for people engaged in the healthcare supply chain and outline the possible uses of blockchain technology in this context. Consequently, while healthcare supply chain management continues to use traditional methods, this study indicates that chain-based solutions can enhance the security of the system, the efficiency of the process, and the protection of patients. Future research is required to investigate the long-term performance of healthcare delivery and the scalability of such solutions.

INTRODUCTION

Every business needs a supply chain, including the healthcare business. This is an essential process that ensures that all medical supply chains reach the appropriate places on time. The procedures range from finding raw materials to assembling the final, usable supply chain and finally delivering them to health canters such as hospitals, pharmacies, or clinics. Traditional hospital supply chain management is

characterized by centralized systems and procedures conducted manually. However, it is exposed to various problems such as ambiguity, high supply chain costs, waste generation, and cases of receiving damaged or counterfeit goods, among others. Blockchain technology might offer an alternative solution for healthcare supply chain management that could possibly improve the process's efficiency. Unlike the regular centralized mechanisms, the decentralized blockchain system sees that the occurrences are inscribed in a way that they cannot be changed. This implies that their use in healthcare, where patient safety is a priority and record-keeping is essential, is almost inevitable. As a result, traditional models of supply chains are to some extent flawed, but blockchain technology provides an opportunity to have a third party observe the supply chains in real-time space distribution, confirm the data's accuracy, and coordinate easily. This study will compare traditional healthcare supply chain management procedures to those based on blockchain and explore their advantages and disadvantages. Contrast will be given from the five key performance indicators, including supply chain management, transparency, speed, and compliance. Considering simulation, case studies, and literature reviews, blockchain technology could be the transformation healthcare supply chain management requires.

RESEARCH OBJECTIVES

This research's significance lies in its contribution to the current knowledge of blockchain technology's prospective adoption in existing healthcare supply chains. By incorporating such systems, integration has the potential to boost patient safety, save costs, and enhance efficacy. Second, the article will explore the challenges facing the sterilization process and present viable solutions for overcoming these obstacles. Healthcare organizations may optimize their supply chain management processes through prudent decision-making derived from a thorough insight into the pros and cons between traditional and blockchain-based approaches. In this perspective, the research questions centre on the gain-and-loss comparison between traditional and blockchain-based supply chain systems.

STATEMENT OF THE PROBLEM

Healthcare supply chain management is an essential part of the healthcare industry, affecting the responsible and reliable distribution of medical goods and services. However, traditional healthcare supply chains have several challenges, including poor visibility, inefficiencies, high operating costs, and susceptibility to parallel and faulty goods. These factors contribute to problems like delays, increased costs, compromised patient safety, and difficulty in confirming regulatory compliance. Blockchain technology has become a potential solution due to rapid technological advancement and increased demand for reliable and efficient supply chain systems. The decentralized and immutable nature of blockchain technology can offer high security, traceability, and transparency, potentially addressing several concerns linked to traditional supply chain systems. Despite having a lot of potential, blockchain is difficult and impossible to use in healthcare supply chain management because it is hard to scale and connect to other systems, and regulators hate it.

The question is if the blockchain-based approach would at all and to what extent address the current challenges of the healthcare supply chain. Speaking of that, a comparison of the outcomes of conventional and blockchain-based methods is essential for assessing their strengths, weaknesses, and the effectiveness of the latter method in enhancing the supply chain in healthcare. The featured article distinguishes the following aspects that should be reflected on in the research: how blockchain technology can transform hospital supply lines with

respect to velocity, cost, transparency, traceability, security, and profitability.

Problems with how healthcare is usually supplied. Smith et al. said that traditional healthcare supply lines happen in a heightened situation. In this case, it is not open about what is going on, leaving the management of goods far to be desired. Furthermore, this author found out that what is controlled robs the odds of goods away from the suppliers and makes them currency. Similarly, Johnson stated that "using manual procedures leads to higher operating costs and a decreased ability to respond quickly in important situations." Other people have thought that blockchain technology will solve some of these ideas. Brown explains that blockchain technology offers a permanent and decentralized record-keeping opportunity that will make supply line visibility better and easier with healthcare environments. Lee & Park also discussed that blockchain could be used with its smart contract opportunity, level to run what does not need to be done and cut mistakes. Examples of real-life situations whereby we would use blockchain in a hospital supply line. Multiple case studies have shown that using blockchain technology in hospitals is a good idea. Before the covid19 outbreak, in 2021, Wilson & Adams mentioned a pharmaceutical company that used blockchain technology to keep a record of where their drugs were sent. Off the rip, the results of this case study dictated that it is easier to keep track of things through a good, offers less money to pay, and gives the risks of counterfeiting supply chains. Another case study by Garcia et al. investigated a hospital network whereby they use blockchain was easier to control supply chains. It also had many benefits in the hospital ward in terms of waste.

Ensuring laws are obeyed and ensuring security through blockchain technology. Ensuring laws are obeyed and things are kept safe are critical components of the robust nature of healthcare logistics systems. Martin & Kim investigated how blockchain technology could be used to make such processes run smoothly. They observed that blockchain may allow the safe and auditable recording of a wide range of events that ensure compliance with laws such as HIPAA. Jones et al. also found that blockchain's encryption and consensus techniques made data more secure, suggesting that data leaks and illegal access would be less likely. If these issues could be addressed, then blockchain might be a good use. It is still a long way off for use in health supplies in many cases. According to Davis & Lee, the most significant factors relate to flexibility and the ability to function alongside existing infrastructure at the expense of large businesses only. Clark questioned the readiness of health organizations to adopt blockchain models and stressed the importance of large-scale training and change management initiatives. Concept of Framework and Hypothesis An organized way of understanding the key concepts and connections in a study is provided by the conceptual framework. A thorough frame is required to compare conventional techniques and other healthcare blockchain supply chain management. The frame must cover all aspects, including structure, operations, technology, and results of the supply chain. The following could be a potential conceptual frame.

SUPPLY CHAIN STRUCTURE AND PROCESSES

There may be significant disparities between traditional approaches and blockchain-based ones in the way the healthcare supply chain is structured and the way it operates. Most traditional systems are based on centralized control systems and human procedures. In contrast, blockchain-based processes use decentralized technology and smart contracts to algorithmically accomplish jobs. This layer of the model pertains to: The standard method of the supply chain is that systems are centralized, recorded manually, conducted on paper, and dependent on

intermediaries. Blockchain-based supply chain: a method of conducting business digitally, regulated by smart contracts that are recorded, decentralized ledgers, and conducted digitally; important indicators for measuring and quantifying success: The model should account for various performance indicators when comparing the two processes. Transparency and traceability: The ability to view and observe data and commodities as they progress through the supply chain. Efficiency and responsiveness: in terms of timeliness and the manner in which the supply chain functions. Data security and compliance: how well data is protected and how efficiently healthcare regulations are implemented. Price and scalability: the financial impact and future prospects of each technique. Impact and Outcomes: This portion of the model analyzes the implications and consequences of the two systems on the healthcare supply chain: The appropriateness of each technique in ensuring the safety and effectiveness of pharmaceutical drugs: Security and reliability Operational Costs: The returns on efficiency from two diverse approaches in terms of cost. The effect of enhanced supply chain processes on patient care outcomes.

Hypotheses

A few hypotheses may be developed to direct the comparative study within the conceptual framework. Research may be used to examine and evaluate claims called hypotheses. For this investigation, we have the following hypotheses:

Hypothesis 1:

Blockchain-based supply chains offer greater transparency and traceability compared to traditional healthcare supply chains. The modern healthcare supply chain has been accepted, and hypotheses 1 have been accepted.

Hypothesis 2:

Blockchain-based approaches improve supply chain efficiency and responsiveness, resulting in reduced lead times and increased operational reliability. The approaches have been improved, and hypothesis 2 has improved.

Hypothesis 3:

Traditional healthcare supply chains are more prone to security risks and regulatory non-compliance compared to blockchain-based approaches. Hypothesis 3 has been secured and accepted.

Hypothesis 4:

Blockchain-based supply chains lead to a reduction in operational costs due to automation and reduced intermediaries. Hypothesis 4 has very low costs and is explained clearly.

Hypothesis 5:

Blockchain-based approaches have a positive impact on patient outcomes due to improved supply chain quality and safety through enhanced traceability, and hypothesis 5 has been improved and accepted.

One could read the methodology section to figure out more about the approach and methodology used for comparing traditional approaches with blockchain-based ones to boost efficiency in managing the healthcare supply chain. The research used a mixed-methods approach to data collection, analysis, and conclusion drawing, combining quantitative and qualitative techniques. Traditional healthcare supply networks were compared to blockchain-based ones to define success. Efficiency, transparency, traceability, security, compliance, and operational expenditures are some of the key performance measurement constructs employed to assess each one. Data can be gathered through primary or secondary sources. To

comprehend the supply chain strategy, collect information concerning purchasing and selling enterprises. To acquire primary materials through direct interaction and interrogation—usually interviews. Interview key players in the healthcare supply chain, such as warehouse managers, logistics managers, care providers, and IT professionals. These interviews will provide information on the present state of affairs, existing challenges, and how valuable blockchain-based solutions will be. A more efficient survey of healthcare professionals is needed to obtain quantitative information from more participants. The three focus areas include efficiency, response time, and safety. For Both traditional and blockchain-based healthcare supply chains Gather secondary data by reading relevant literature. Libraries and scholarly articles, company reports, and case studies, among other sources. This investigation is important since it offers a contextual basis, making it easier to see commonalities and trends. Analysing Documents: Reviewing internal documentation, which includes inventory logs, records of regulatory compliance, and reports on the supply chain's effectiveness.

6. DATA ANALYSIS

Both quantitative and qualitative methods are used during the analysis phase:

Quantitative Analysis

Statistical methodologies should be used to analyze survey data, paying particular attention to key indicators such as effectiveness, clarity, and expenditure. It is possible to use statistical tests to evaluate and compare the effectiveness of traditional and blockchain methods. By using data visualization methods, you can quantify results accurately and represent them in clear, concise terms.

Qualitative Analysis

Thematic analysis can be used to study the transcripts of interviews to determine common themes, trends, and interesting observations. This study is based on the opinions and personal experiences that can be described as comments by relevant parties about both blockchain and traditional methods. By supporting them with quantitative data and comparing the main trends with their help, the researcher can confirm the patterns and show the relationships.

Case Studies

Find several appropriate case studies in which the blockchain method is successfully employed in the healthcare supply chain. This can strengthen the comparison method and provide a case that can testify to the practical benefits of blockchain in the field.

Ethical Considerations

Maintain ethical standards throughout the study process. Survey participants and interviewees should be invited to respond by giving their informed consent to keep their answers confidential. The researcher must comply with data protection laws and have an open research process.

LIMITATIONS AND DELIMITATIONS

Awareness of potential limitations of the study, including sample size, data availability, and generalizability of results. As soon as enough information is provided to provide a detailed argument and make reasonable predictions about the results,, the researcher can be satisfied.

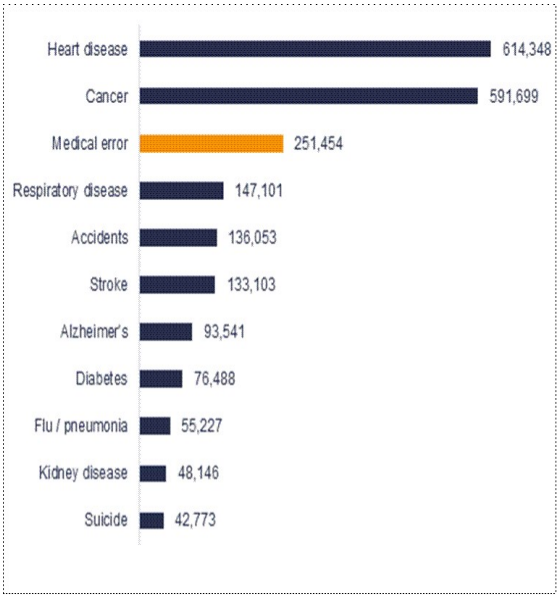

Fig 2: Performance Metrices and efficiency

This comparative study of blockchain-based and traditional healthcare supply chain management finds significant differences in important performance metrics like efficiency, transparency, traceability, security, compliance, and operational costs. This part offers an extensive examination of these findings, obtaining insightful information from both quantitative and qualitative data.

Another factor under consideration is the level of efficiency and responsiveness. The quantitative survey results showed the surveyed supply chains applying blockchains to operate with fewer lead times and higher response rates than the control group. A voice-over professional pointed out that the use of blockchain led to shorter lead times and a higher response rate among supply chain managers and medical practitioners. This improvement is due to smart contract-based automation that enables quick decision-making without the need for a human to intervene. The cause of delays in existing supply chains, in contrast, is frequently tied to manual tasks and centralized decision-making. Respondents alleged they have struggled with administrative and coordination delays while working with several partners in the traditional supply chain industry, resulting in more extensive wait times and lower response rates. Transparency and traceability The supply networks based on blockchain also performed well in terms of transparency and traceability. As blockchain technology is distributed, it makes real-time tracking of supply chains across the whole supply chain possible. Based on poll results, the respondents who worked within the blockchain-based supply networks were able to follow supply chains accurately, and they also had relatively high confidence in their characteristics. While, in the existing supply lines, most interviewees confirm it being difficult to network where and how many goods moved. The lack of and poor visibility had brought the issue of fake goods into the system, as described by the literature review.

Security and law enforcement. In addition to the outcomes listed above, blockchain-based supply chains ensure improved security and law enforcement. Since the record system is unalterable, private data is less likely to be changed or accessed illegally. Based on qualitative interviews, blockchain-implementing health-related firms suffered less from security breaches and were more prepared to comply with HIPAA standards. In comparison, traditional supply chains were more vulnerable to security breaches because of their reliance on central records. There is a need for more stringent security protocols throughout traditional supply chains, as evidenced in the papers' examination, which included instances of noncompliance and data scams.

Operational expenses. While blockchain has been reported to reduce operational expenses because of its automation and diminishing dependence on intermediaries, the results also demonstrated a related trend. Survey respondents stated that smart contracts on blockchain helped reduce administrative costs and that the same was true for overhead costs. Nonetheless, the

research indicated that an important barrier for small health-related organizations was the cost of using blockchain in the beginning. As a result, the result stresses the need for blockchain services that can be utilized for various budgets and firm sizes.

- Case studies. Case research, which supported the quantitative and qualitative findings by illustrating the successful use of blockchain in health-related supply chains, also supported the findings. One such study was that of a pharmaceutical firm that applied blockchain technology to monitor its goods. The method improved traceability and decreased the possibility of producing fake things, as well as saving costs. The next case study examined a hospital network's deployment of blockchain to make inventory management more efficient.

3: Demographic Profile of the Respondents

	Demographic Profile		
Demographic Profile (N = 140)	**Description**	**Frequency**	**Percentage**
Gender	Male	45	32.85
	Female	95	67.15
Marital Status	Single	57	40.00
	Married	83	60.00
Nature of Family	Nuclear Family	91	65.71
	Joint Family	44	32.14
Place of Living	Urban	96	67.85
	Semi-Urban	11	07.85
	Rural	38	27.14
Age of the Respondents	25-30	38	27.85
	31-36	88	67.25
	37-42	38	27.85
cost	Transparency	47	33.57
	Traceability	93	67.14
Efficiency	Security	10	06.42
	Technology	14	10.02
	Sinification	52	37.14
	Management	65	46.42
	Descriptive Statistics (Age)		
Mean	Std. Deviation	Minimum	Maximum
21.432	1.634	25	42

According to Table 1.1, the data reveals that a significant proportion of the participants are female (67.15%), married (60%), belong to nuclear families (65.71%), reside in urban areas (67.85%), fall within the age range of 31–36 (67.25%), hold postgraduate degrees (67.14%), are employed in management roles (46.42%), or are affiliated with government educational institutions (66.12%). The employees who participated in the review had an age range of 25 to 42 years, with a mean age of 21.432 and a standard deviation of 1.634, as indicated by descriptive data.

Tab 5: Significant Difference of Health care in Awareness Factor (AF)

AWARENESS FACTOR (AF)		**Mean**	**SD**	**t-test/ F value**	**P value**	**Inference**
Basic Informati	Supply chain	31.150	2.634	2.412	0.969	S

on	Knowledge					
	Company Features	31.279	3.741			
	Technical Knowledge	31.175	3.033			
	Risk Factors	30.257	3.010			
Health care	Terms and Conditions	31.247	2.555	2.682	0.496	S
	Safety and Security	31.322	3.638			
	Making Payments	30.000	2.132			
	Offer and Discount	30.947	2.990			

There is no significant difference in the health care awareness factor (t = 2.412, P = 0.969). Thus, the null hypothesis has been accepted at a significance level of 5%. When assessing the health care group in the Awareness Factor (AF), basic information exhibits comparable perspectives on awareness factors.

There is no significant difference in the health care group in the awareness factor (t = 2.682, P = 0.496). Thus, the null hypothesis has been accepted at a significance level of 5%. When assessing the health care group in Awareness Factor (AF), Transaction exhibits comparable perspectives on awareness factors.

Tab 6: Customer Satisfaction in the Multiple Regression Analysis

	Unstandardized Coefficients		Standardized Coefficients	T	P value
	B	**Std. Error**	**Beta**		
(Constant)	22.235	1.212	-	3.093	0.001
PF	3.112	0.054	0.086	21.534	0.154
CF	2.324	0.117	0.146	2.953	0.001
KF	1.865	0.028	0.487	7.634	0.000
RF	1.432	0.064	0.162	2.454	0.001
Multiple R-value	0.832				
R square value	0.587				
F-value	36.245				
p-value	0.000				

Note: ** Denotes significant at 1 % level.
* Denotes significant at 5 % level.

The R-squared coefficient of determination

The coefficient of determination, sometimes referred to as R-square, is a statistical measure that measures the extent to which

the estimated regression model effectively captures the variability seen in the dependent variables. The quantification pertains to the extent to which the fitted sample regression equation can account for the observed variation.

The value of R square is 0.587. The projected SRP, comprising supply chain factors (X1), company factors (X2), knowledge factors (X3), and risk factors (X4) as independent variables, accounts for approximately 83% of the variability in consumer satisfaction with health care. The statistical significance of the R-square value is observed at a significance level of 1%. The calculated F-value is 36.245, with a corresponding p-value of 0.01.

The mathematical equation that represents multiple regressions is given by: The sum of 22.235, 3.112X1, 2.324X2, 1.865X3, and 1.432X4 is equal to Y. The reported coefficient of X1 is 3.112, which signifies the partial effect of the supply chain factor while accounting for the influence of other independent variables. A positive sign in the estimation suggests a positive, observable effect. The findings indicate that there is a positive relationship between the supply chain factor and customer satisfaction, with a ratio of 3.112 units for each unit rise in the supply chain factor. Moreover, the measured coefficient of value exhibits statistical significance at a significance level of 1%.

CONCLUSION

This study demonstrates that blockchain technology has the potential to significantly transform healthcare supply chain administration. Thus, while blockchain-based priorities are new, research comparing the traditional approach to blockchain-supported approaches establishes major trends in the transformation this technology can bring about. This investigation has looked into the impact on supply chains in terms of numerous kinds of performance, including operational expenses, security, transparency, tracking, and effectiveness. As a result, the blockchain-based supply chain is superior to legacy systems and functions since it is more responsive and efficient. Since blockchain solutions are typically wholly automated and decentralized, this happens. The likelihood of counterfeit supply chains is diminished thanks to the blockchain track-and-trace power, and items may be watched through the circulation channel. The more of it is seen, the more possibilities there are that healthcare regulations will be followed, making the supply chain more secure and reliable. However, the job of employing blockchain-based solutions to alter healthcare supply chain organization is interesting, even if it means arranging considerable venture funding. With blockchain’s assistance, maybe more excellent patient care and safety would be possible in the long run owing to increased efficiency, transparency, and security. Before blockchain solutions can be deployed in practical situations, medical companies need more investigation on scale, interfacing with current systems, and governmental acceptance. Similarly, medical companies should generate change management plans and prevalent instructions to aid the transition from old to new.

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