Journal of Ecohumanism
2025
Volume: 4, No: 2, pp. 850 – 868
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v4i2.6372

Enhancing Security and Operational Efficiency in Tourisms Sectors through Blockchain Technology: The Role of Trust and Regulatory Environment under Institutional Economics

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Abstract

Purpose: The tourism industry is more and more turning to cutting-edge technologies to tackle issues concerning security, operational effectiveness, and confidence. The decentralized, transparent, and unchangeable characteristics of blockchain technology provide a revolutionary opportunity to improve these areas. This study investigates how blockchain can protect operational processes, secure data, and support service providers and regulators. This research explores the relationship between trust, technology adoption, and regulation by suggesting ways to incorporate blockchain in the tourism industry with a focus on both innovation and responsibility. Design/methodology/approach: The study used quantitative methods to survey 326 professionals in the tourism industry and frequent travelers to explore their interactions with tourism services based on blockchain technology. Data underwent analysis through the utilization of SPSS and SmartPLS 4. This method sought to comprehend the various viewpoints on the advantages and difficulties of incorporating BCT into their activities. Findings: This study Outcomes show the blockchain adoption is perceived. Although some believe that BCT has the potential to improve security and operational efficiency, there are also positive opinions on the matter. Both customers and providers agree on BCT's trustworthiness, however, they have differing opinions on privacy and security improvements. Moreover, the research highlights the crucial importance of regulatory enforcement in promoting blockchain adoption, as blockchain presents valuable chances for ensuring compliance and reducing risks. Implication: This study adds to the current knowledge by offering perspectives from service providers and customers on blockchain technology in the travel sector. It highlights the challenges of integrating new blockchain technologies and urges further research to tackle the raised issues, providing a fresh perspective on utilizing distributed ledger technologies to improve security and operational effectiveness.

Keywords: *Block chain technology adoption, Tourisms security and efficiency, Trust in tourisms platforms, Regulatory environments.*

Introduction

The rise of the Internet has made tourism more interactive, enabling travelers to search for and plan their own trips without relying on a traditional travel agency [1]. This has significantly enhanced the overall experience for tourists. Currently, the travel industry is on the verge of being transformed by blockchain technology, leading to significant changes in the way travel customers experience their journey. In recent years, many big tech companies have greatly changed the way we experience hospitality, travel, and tourism. However, blockchain has been garnering a lot of interest from scholars because of its special characteristics that can enhance security, efficiency, and transparency, making it especially important for the tourism industry [2].

The technology known as blockchain, a specific kind of distributed ledger technology (DLT), was initially incorporated into the bitcoin protocol. Bitcoin, a cryptocurrency, was created by Satoshi Nakamoto in 2009 [3]. Afterwards, it lowered expenses for various economic sectors for both businesses and customers. Moreover, it enhances process effectiveness, enhances trust levels among tourists and in safeguarding

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personal data, and decreases the involvement of middlemen [4][2]. In general, the tourism industry involves various players like hotels, airlines, travel agents, tour operators, insurance companies, fraud, data security, payment inefficiencies, and identity verification problems, which have intricate business connections and fierce competition. In this way, the utilization of BC can address these issues and enhance the level of services provided to customers, as well as provide more secure, efficient, and reliable services to travelers, ultimately improving user experience and operational results [2].

Although blockchain technology has the potential to benefit the tourism industry, it is still in the early stages of adoption and the full effects on security and operational efficiency have not been seen yet [2.5]. Additionally, there has been minimal focus on the importance of trust in blockchain platforms and the impact of regulatory environments on the implementation of blockchain technology. In order to grasp the full potential of blockchain, it is crucial to examine how it influences the tourism sector and recognize the elements that help or hinder its incorporation.

Despite its ability to improve transaction security, decrease fraud, and streamline operations, the tourism industry has not fully adopted blockchain technology. The reason for conducting this research is to address this gap by investigating how blockchain technology can be utilized to enhance security and effectiveness in the tourism industry. This research fills the gaps by presenting evidence on how the use of blockchain improves security and efficiency in tourism by building trust, and it also explores how regulations can help promote blockchain implementation. This study expands the use of the Technology-Organization-Environment framework by showing how blockchain technology adoption can improve security and efficiency with Trust and Regulatory environment as a mediator and moderator.

This research approach comprises these perceptions are visually present in the Figure 1. therefore, the study focusses on the following three research questions (RQs):

RQ1: To what extent does the adoption of blockchain technology influence security and operational efficiency in tourism sectors?

RQ2: Does increased transparency and data immutability provided by blockchain solution enhance user trust in tourisms platforms thereby improving security and efficiency?

RQ3: How does the regulatory environment moderate the relationship among Blockchain technology adoption and its impact on tourism sectors an efficiency?

Research Objectives

1. To examine the impact of blockchain technology adoption on tourism security and efficiency:

2.To investigate the role of trust in tourism platforms as a mediator in the relationship between blockchain adoption and tourism security and efficiency

3. To analyses the moderating role of the regulatory environment on blockchain adoption in tourism

4. To identify the challenges and barriers to blockchain adoption in the tourism sector

5. To provide actionable recommendations for tourism companies and policymakers on leveraging blockchain technology to improve tourism security and efficiency

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Literature Review

Underpinning theory

Technology-Organization-Environment theory

This paper highlights the necessity for a variety of theory-based studies when analyzing the adoption of blockchain in the tourism industry. After thoroughly examining the theoretical foundation and blockchain application in boosting security and efficiency in the tourism industry, we have incorporated a distinctive set of frameworks demonstrating the theories applicable in a blockchain project. This paper explores the potential of using TOE models as theoretical frameworks to achieve positive results when implementing block chain technologies in sustainable development [6,7].

The TOE framework, established in 1990 by Tornatzky and Fleischer, elucidates how companies adopt technology to implement innovation within their environmental setting [8]. Many researchers have looked at the TOE model, which centers on evaluating how technology adjusts to evolving market conditions. It improves operations, interpersonal abilities, and corporate capabilities. It allows companies to synchronize the BCT with their sustainable strategy [9]. It offers a broader view of companies' sustainable strategies and objectives, enabling them to gain a lasting edge in the environmental landscape. Additionally, it motivates businesses to maximize their business advantages by leveraging the technological expertise and standing of their competitors [7].

Block chain technology adoption and Tourisms security and efficiency

Blockchain technology is becoming increasingly popular in different sectors as it has the potential to improve transparency, security, and efficiency. Incorporating blockchain technology includes implementing decentralized ledger systems which enable secure, transparent, and unalterable transactions. This technology is especially advantageous in industries where trust and data integrity are essential [10]. Security and efficiency play a crucial role in providing a positive travel experience for tourists in the tourism sector. Incorporating blockchain technology can greatly improve these elements through a secure and transparent platform for transactions and data management [12]. The TOE framework is an inclusive model that considers internal and external factors impacting an organization's technology adoption decisions.

Different viewpoints on the potential of BCT in the tourism sector are discussed in the literature. Some research focuses on the improved security and confidence that BCT can offer [12], while others highlight the difficulties and costs of using it. Tourism suppliers and consumers experience varying opportunities and challenges in areas such as transaction processing, customer database management, operational cost reduction, cycle time reduction, risk mitigation, generation of new revenue streams, and decreasing capital costs, among other uses [13]. The need to increase our knowledge from both the viewpoint of the customer and the provider, specifically in terms of improving privacy/security, customer experience quality, and trust which are recognized as the primary advantages and obstacles of BCT implementation, is highlighted by this scenario. Thus, the suggested hypothesis is:

H1: Block chain technology adoption has a positive relationship between Tourisms security and efficiency

Block chain technology adoption and Trust in tourisms platforms

Smart Tourism strives to improve the tourist experience by utilizing advanced feedback loops, offering real-time information, and improving customer service to address issues like lost luggage, security concerns, delays, and long queues [14]. Smart Tourism Destinations are expected to offer personalized services such as providing relevant real-time information for trip planning, ensuring access to real-time information for exploring destinations, and facilitating a feedback system for reviewing experiences [14]. Blockchain technology shows great promise in helping Smart Tourism Destinations reach their objectives and offer customized services [24].

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To start, blockchain technology can eliminate intermediaries and empower both providers and consumers of tourism services by fostering trust, enhancing security in information exchange, cutting costs, and promoting transparency. Small companies and local tourism service providers [15], in addition to large tourism businesses, can provide their products and services in Smart Tourism Destinations. Tourists can access real-time information on available tourism services to enhance their experience with authentic travel experiences. Through the utilization of blockchain technology and emphasis on establishing trust, tourism platforms can enhance security, effectiveness, and customer contentment, ultimately resulting in a more dependable and pleasant experience for tourists [25]. Thus, the suggested hypothesis is:

H2: Block chain technology adoption has a positive relationship between Trust in tourisms platforms

Trust in tourisms platforms and Tourisms security and efficiency

This hypothesis reaffirms the concept that the implementation of blockchain technology has an indirect impact on enhancing security and efficiency in tourism platforms by influencing the level of trust. Integrating blockchain into tourism services boosts user trust through its transparent and secure procedures. Tourism providers face difficulties in incorporating BCT because of possible security and privacy issues. Despite BCT's strong security features and improvements in system security, providers still need to comply with diverse data protection laws worldwide [16].

The trust and willingness to use BCT are influenced by customers' perception of privacy protection. Research following the TOE framework, like [17] and [18], has shown that strong commitment from top management positively affects technology adoption. Due to BCT's privacy-focused design and strong encryption methods, customers are likely to see the adoption of BCT in a positive light when it comes to privacy. This trust, in return, boosts acceptance and utilization of the services, ultimately enhancing security and operational efficiency. Hence, trust plays a crucial role in how blockchain adoption leads to beneficial results in the tourism industry [19,20].

H3: Trust in tourisms platforms has a positive relationship between Tourisms security and efficiency

Trust in tourisms platforms mediator

This theory proposes that trust in tourism platforms plays a crucial role in linking blockchain technology adoption to enhancing security and efficiency in the tourism sector. Despite being widely discussed in technology adoption, trust does not have a single definition. Trust in BCT is essential and is connected to their control over its architecture, operation, and auditability [21]. This viewpoint agrees with prior research highlighting the significance of control and transparency for establishing trust in technological systems [22]. BCT's shift from relying on platform providers to relying on algorithms poses questions about its ability to truly establish a more reliable environment while also transferring control from conventional authorities to algorithms [22].

From the viewpoint of customers, technological advancements within the T-O-E framework refer to the technologies available in companies, which are external factors that can impose both limitations and opportunities for technological progress. BCT systems, seen as secure for private data and transparent, have the potential to build trust, possibly transitioning from individual trust to trust in BCT. BCT receives a favorable assessment due to its transparent, tamper-proof, and highly secure data procedures. Increased trust results in higher engagement, customer loyalty, and perceived safety while utilizing these platforms [20]. The influence of trust enhances the effects of blockchain on security and efficiency, indicating that users can only experience the benefits of the technology if they trust it [11].

H4: Trust in tourisms platforms mediates the positive relationship with Block chain technology adoption and Tourisms security and efficiency.

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Regulatory environments as a moderator

The regulatory environment comprises the legal and political factors that impact the rules a company must adhere to. These rules can affect a firm's financial, operational, technological, and legal sides. An important obstacle for blockchain technology is how they will be controlled, considering that it's not the technology itself, but how it's used that may require regulations. The TOE framework is a theoretical method that can be utilized to examine the regulatory landscape in the tourism industry [23].

Governments have a crucial role in overseeing tourism markets. Their duties involve: Setting and upholding regulations and standards, Supervising tourism operations for adherence, providing rewards for eco-friendly behaviors, and carrying out examinations and evaluations [26]. In favorable regulatory environments, the use of blockchain technology can thrive, resulting in enhanced security measures and more efficient operations. Enabling innovation, establishing precise instructions, and guaranteeing data security through regulations can assist organizations in optimizing the potential of blockchain technology [27]. On the other hand, strict rules could hinder usage, restricting the beneficial effects on tourism offerings. This relationship moderates how external legal and policy factors impact technology adoption results [28,2]. This theory suggests that the regulatory framework acts as a mediator in the way blockchain technology influences security and efficiency in the tourism industry.

H5: Regulatory environments moderate the positive relationship with Block chain technology adoption and Tourisms security and efficiency

H6: Regulatory environments moderate the positive relationship with Trust in tourisms platforms and Tourisms security and efficiency

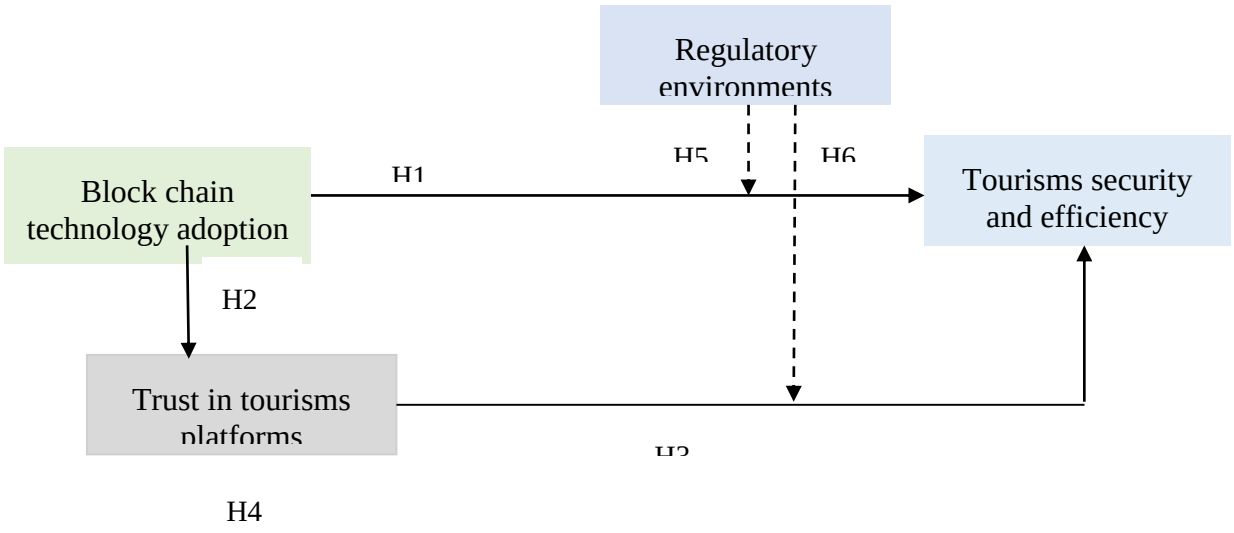

Figure 1 Research framework

Research Methodology

Research Design and Approach

The research design refers to the plan implemented to achieve the research objectives and assess the formulated hypotheses. This study employs a quantitative approach, gathering numerical information from a sample within the tourism sector, which includes professionals such as managers and decision-makers in areas like security and operations, including transportation and travel companies. Regular travellers

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acquainted with digital travel services, who are probable users of blockchain-enabled tourism options, will be assessed via organized questionnaires. The quantitative approach facilitates the systematic collection and analysis of data, enabling researchers to explore relationships between variables and assess proposed hypotheses. This research intends to offer empirical data and statistical analysis of the intricate connection among the implementation of blockchain technology, tourism security and effectiveness, trust in tourism platforms, and the regulatory environment through a quantitative research approach. Structural equation modelling (SEM) will be utilized to assess direct, mediating, and moderating relationships between the variables.

Research Design

The research design describes the overall approach employed to meet the research goals and assess the proposed hypotheses. This research utilizes a quantitative approach by collecting numerical data from industry stakeholders, tourism experts, and senior officials through structured questionnaires. The quantitative method allows researchers to systematically gather and analyze data, facilitating the exploration of relationships between variables and the testing of suggested hypotheses.

By employing a quantitative research approach, this study aims to provide empirical evidence and statistical analysis regarding the complex connection between enhancing security and operational efficiency in the tourism sector through the use of blockchain technology. The quantitative method utilizes a cross-sectional design since data was gathered at one specific moment to examine the relationship. Data was collected through a survey method, enabling the research to evaluate the relationships between these variables and the effects of mediating and moderating factors. To examine the suggested theory, the research employed a deductive methodology with TOE, investigating the relationships among variables through SPSS and Smart PLS4, facilitating the assessment of both direct and indirect effects.

Sampling Procedure and Data Collection

Data was gathered from the focus group of this study, comprised of professionals in the tourism sector (e.g., managers, policymakers) working in fields related to security and operations, including transportation and travel agencies. Frequent travellers who are familiar with digital travel services or platforms and are inclined to engage with blockchain-based tourism services. The information was gathered through an online questionnaire. Online surveys were selected due to their easy accessibility, convenient distribution, and ability to connect with the fast-changing tourism environment.

Prior to performing the official survey, the research team confirmed the questionnaire data's reliability by sending it to participants through Google Forms. Surveys were conducted on the profiles chosen for all professionals in the tourism sector (e.g., managers, policymakers) involved in fields connected to security and operations, such as transportation and travel agencies. Frequent travellers who are knowledgeable about digital travel platforms and tend to use blockchain-based tourism services. The survey contained Likert-scale questions to evaluate the participants' attitudes and experiences. This scale ranged from 1 (strongly disagree) to 5 (strongly agree), allowing for an in-depth understanding of stakeholder viewpoints. The timeframe for gathering data extended from July 2024 to November 2024.

Population and Sample

In this research, the sampling technique consists of deliberately choosing individuals from the intended population. We utilized a purposive sampling method, enabling researchers to intentionally select specific hotels, travel agencies, and restaurants. This guarantees that the sample includes individuals possessing pertinent knowledge and experience concerning the research topic, thereby improving its representativeness and practical significance.

Targeting a sample size of 400 professionals from the tourism industry (such as managers, decision-makers) working in fields concerning security and operations, including transportation and travel agencies, along with frequent travellers familiar with digital travel services or platforms who may be inclined to use

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blockchain-enabled tourism services. A total of 400 surveys were sent out using a simple random sampling technique, leading to 326 valid responses, which results in a response rate of 81%. This is consistent with the suggestion that the smallest adequate sample size ought to be five times the quantity of measurement items. This study necessitates at least 500 participants for accurate analysis, considering the 27 measurement items involved. Consequently, the sample size in this research is considered suitable. Table 1 displays the demographic features of the participants.

Results and Interpretation

Demographics

The age distribution displays a various range of participants, with the majority falling within the 18-25 and 26-35 age. This suggests that the study sample is relatively young, which could influence preferences and behaviours, particularly in areas like technology adoption and travel habits. The gender distribution is skewed towards males (67%) compared to females (33%). This imbalance might affect the generalizability of the findings, as gender can influence preferences and behaviour in travel and technology use. Participants take diverse educational backgrounds, with a significant portion holding Bachelor's (33%) and Master's degrees (27%). Higher education levels often correlate with higher income and more frequent travel, as well as a greater likelihood of using technology for travel planning. The occupation data indicates a mix of students, employed individuals, self-employed, and retired participants. The largest group is employed individuals (36%), followed by self-employed (23%) and retired (22%). Occupation can impact travel frequency and preferences, as well as the importance placed on technology in travel planning. Most participants travel for vacation once a year (40%). This indicates a moderate level of travel activity, which could be influenced by factors such as income, occupation, and personal preferences. Road travel is the most preferred mode (43%), followed by air travel (33%) and sea travel (25%). Preferences for travel modes can be influenced by factors such as cost, convenience, and personal comfort. Travel agents are the most frequently used booking method (44%), followed by mobile apps (19%) and other methods (19%). This indicates a reliance on traditional booking methods, although there is a notable use of digital platforms. This suggests a mixed attitude towards technology in travel planning, which could be influenced by factors such as age, education, and occupation. In summary, the demographic profile provides insights into the characteristics of the study sample, which can help in understanding their preferences and behaviour in travel and technology use. These factors are crucial for tailoring services and marketing strategies to meet the needs of different demographic groups.

Table 1. Demographic Profile

Name	Preference	N		Percentage	
Age	18-25	81	326	25	100
	26-35	95		29	
	36-45	62		19	
	46-55	45		14	
	56 and above	43		13	
Gender	Male	217	326	67	100
	Female	109		33	
Educational Background	High School	61	326	19	100
	Diploma	72		22	
	Bachelor's Degree	106		33	
	Master's Degree	87		27	
Occupation	Student	61	326	19	100
	Employed	118		36	
	Self-employed	76		23	
	Retired	71		22	
Travel frequency for vacation	Once a year	132	326	40	100
	Several times a year	93		29	
	Rarely travel for vacation	64		20	

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	Never travel for vacation.	37		11	
Preferred Mode of Travel:	Air	106	326	33	100
	Road	139		43	
	Sea	81		25	
Most Frequently Used Booking Method	Online Travel Agency Websites	21	326	6	100
	Hotel/Service Provider Websites	35		11	
	Travel Agents	145		44	
	Mobile Apps	63		19	
	Other	62		19	

Descriptive analysis

Descriptive statistics provide a summary of the main features of a dataset. They include measures of central tendency (mean, median), measures of variability (standard deviation), and measures of shape (skewness, kurtosis). The study suggests that all four variables (TSE, BCT, TP, RE) have positive skewness, indicating that most of the values are clustered towards the lower end, with a few higher values stretching the tail to the right. The excess kurtosis values for all variables are positive, indicating that the distributions have heavier tails and sharper peaks compared to a normal distribution. This could imply a higher likelihood of extreme values. In summary, the descriptive statistics provide a snapshot of the data's central tendency, variability, and shape, helping to understand the underlying distribution and characteristics of the study.

Table 2. Descriptive test

	Mean	**Median**	**Observed min**	**Observed max**	**Standard deviation**	**Excess kurtosis**	**Skewness**
Tourisms security and efficiency (TSE)	3.664	3.678	1.0	5.0	0.6979	1.648	0.965
Block chain technology adoption (BCT)	3.647	3.727	1.0	5.0	0.7256	1.721	2.517
Trust in tourisms platforms (TP)	3.624	3.622	1.0	5.0	0.7393	2.181	1.828
Regulatory environments (RE)	3.520	3.831	1.0	5.0	0.7152	2.080	1.988

Reliability and Validity

Reliability and validity are essential ideas in research that guarantee the measurements employed are stable and precisely represent the constructs they aim to assess. Cronbach's Alpha is a measure of internal consistency that shows how closely a group of items are related to each other. A greater value (nearer to 1) indicates that the items assess the same fundamental concept. Typically, a Cronbach's alpha greater than 0.7 is deemed acceptable, greater than 0.8 is regarded as good, and greater than 0.9 is viewed as excellent. Composite Reliability (rho_a and rho_c) assesses the overall dependability of a construct, akin to Cronbach's alpha, yet frequently regarded as more precise in specific situations. Values of composite reliability greater than 0.7 are generally viewed as acceptable.

AVE quantifies the proportion of variance explained by a construct compared to the variance resulting from measurement error. An AVE value greater than 0.5 suggests that the construct accounts for more than 50% of the variance of its indicators, which is deemed acceptable. This research indicates that (BCT, RE, TP, TSE) demonstrate good to excellent reliability, as shown by their Cronbach's alpha and composite reliability metrics. This indicates that the components within each construct are reliably assessing the same fundamental idea. The AVE values suggest that the constructs possess adequate validity, implying they account for a substantial amount of the variance in their indicators. In conclusion, the reliability and validity

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assessments ensure assurance that the constructs employed in the research are both stable and faithfully represent the intended ideas.

Table 3: Reliability and Validity

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Block chain technology adoption	0.862	0.863	0.901	0.647
Regulatory environments	0.887	0.893	0.917	0.689
Trust in tourisms platforms	0.867	0.871	0.904	0.654
Tourisms security and efficiency	0.744	0.767	0.831	0.501

Discriminant Validity Test

Discriminant validity assesses how much a construct is genuinely separate from other constructs. It guarantees that a construct is distinct and reflects phenomena not conveyed by other constructs in the model. Two prevalent approaches to evaluate discriminant validity are the HTMT ratio and the Fornell-Larcker criterion. The HTMT ratio represents a contemporary method for evaluating discriminant validity. It assesses the typical correlations among constructs against the typical correlations within a single construct. A reduced HTMT value signifies enhanced discriminant validity. The Fornell-Larcker criterion is a conventional approach for evaluating discriminant validity. It contrasts the square root of the AVE for each construct with the correlations among the constructs. The square root of the AVE must exceed the correlations involving other constructs. The HTMT ratios presented in Table 4 show that the constructs exhibit moderate correlations among themselves; however, the values are under the 0.85 threshold, indicating strong discriminant validity. The interaction terms (RE x TP and RE x BCT) exhibit lower correlations, reinforcing the evidence for discriminant validity. The Fornell-Larcker criterion presented in Table 5 indicates that the square roots of the AVEs for every construct exceed the correlations with other constructs. This shows that every construct has a greater variance in common with its indicators than with other constructs, thereby confirming discriminant validity.

Table 4. Discriminant validity test - HTMT ratio

	Block chain technology adoption	Regulatory environments	Trust in tourisms platforms	Tourisms security and efficiency	Regulatory environments x Trust in tourisms platforms
Block chain technology adoption					
Regulatory environments	0.558				
Trust in tourisms platforms	0.633	0.757			
Tourisms security and efficiency	0.566	0.612	0.708		

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Regulatory environments x Trust in tourisms platforms	0.154	0.350	0.382	0.309	
Regulatory environments x blockchain technology adoption	0.161	0.201	0.204	0.170	0.593

Table 5. Discriminant validity test - Fornell-Larcker criterion

	Block chain technology adoption	**Regulatory environments**	**Trust in tourisms platforms**	**Tourisms security and efficiency**
Block chain technology adoption	0.805			
Regulatory environments	0.489	0.830		
Trust in tourisms platforms	0.546	0.665	0.809	
Tourisms security and efficiency	0.464	0.508	0.573	0.708

Confirmatory Factor Analysis (CFA)

CFA is a statistical method employed to validate the factor structure of a collection of observed variables. It examines the hypothesis that the connections between measured variables and their underlying latent constructs align with the researcher's comprehension of the essence of those constructs. The CFA findings indicate that the measured variables serve as strong indicators of their associated latent constructs, as shown by the high factor loadings. This indicates that the tools utilized to assess BCT, RE, TP, and TSE are credible and dependable measures of these constructs. The reduced loading for TSE 4 indicates that this item might require revaluation to better match the latent construct it is designed to assess. In conclusion, the CFA indicates that the measurement model fits well with this research, as most items demonstrate robust connections with their corresponding latent constructs.

Table 6. Confirmatory Factor Analysis

Variable	**Item**	**Block chain technology adoption**	**Regulatory environments**	**Trust in tourisms platforms**	**Tourisms security and efficiency**
Block chain technology adoption (BCT)	BCT 1	0.877			
	BCT 2	0.714			
	BCT 3	0.868			
	BCT 4	0.764			
	BCT 5	0.788			
	RE 1		0.820		
Regulatory environments (RE)	RE 2		0.876		
	RE 3		0.870		

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	RE 4		0.825		
	RE 5		0.754		
Trust in tourisms platforms (TP)	TP 1			0.805	
	TP 2			0.865	
	TP 3			0.835	
	TP 4			0.815	
	TP 5			0.715	
Tourisms security and efficiency (TSE)	TSE 1				0.737
	TSE 2				0.737
	TSE 3				0.721
	TSE 4				0.507
	TSE 5				0.801

Regression Analysis

R represents the correlation coefficient that gauges the strength and direction of the linear connection between the predictors (RE, BCT, TP) and the dependent variable (TSE). An R value of 0.782 signifies a robust positive correlation. (R^2) indicates the fraction of variance in the dependent variable that can be forecasted based on the independent variables. An R^2 value of 0.586 indicates that roughly 58.6% of the variation in TSE can be accounted for by RE, BCT, and TP. Adjusted R Square modifies the R^2 value based on the number of predictors in the model, offering a more precise assessment of the goodness of fit. An adjusted R^2 score of 0.584 suggests a strong fit. Standard. The Estimate Error quantifies the average distance between the observed values and the regression line. A smaller value signifies a superior fit.

The results from the regression analysis and ANOVA test indicate that the model, comprising RE, BCT, and TP as independent variables, effectively accounts for the variance in TSE. The elevated R^2 and adjusted R^2 figures suggest that a considerable amount of the variance in TSE is accounted for by the predictors. The considerable F-statistic and small p-value additionally verify that the model holds statistical significance. In conclusion, the regression analysis along with the ANOVA test offers compelling support that RE, BCT, and TP are important predictors of TSE, and the model fits well for this research.

Table 7. Regression Analysis

Model Summary[b]										
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.782[a]	.586	.584	.34588	.586	91.794	3	322	<.001	1.813
a. Predictors: (Constant), Block chain technology adoption, Trust in tourisms platforms, Regulatory environments.										
b. Dependent Variable: Tourisms security and efficiency										

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2025
Volume: 4, No: 2, pp. 850 – 868
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v4i2.6372

Table 8. Regression analysis- ANOVA test

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	46.172	4	11.079	93.874	<.001[b]
	Residual	31.031	222	.314		
	Total	78.284	225			
a. Dependent Variable: Tourisms security and efficiency						
b. Predictors: (Constant), Block chain technology adoption, Trust in tourisms platforms, Regulatory environments.						

Structural Model

In our research, we utilize the Partial Least Squares Structural Equation Modelling (PLS-SEM) method with Smart PLS 4.0 software. Our objective is to create and evaluate a system founded on previous scholarly studies. This examination entails evaluating path coefficients, significance levels, and the coefficient of determination (R^2) associated with each dependent variable. We meticulously analyze the direction and statistical significance of the path coefficients, employing a bootstrapping method with 5000 iterations to confirm the consistency of our findings. The path coefficients are essential in elucidating the magnitude and direction of the relationships among the variables. In our research model, a positive path coefficient indicates a direct connection between constructs, whereas a negative coefficient reflects an inverse connection. The size of the coefficient reflects the strength or degree of this correlation. To determine statistical significance, we depend on the relevant t-values. The bootstrapping method with 5000 repetitions is employed to derive these t-values, confirming the robustness of our results. R^2 measures the proportion of variability in the dependent variables (response variables) that a model explains. Higher R^2 values indicate that the model effectively represents the variations in the dependent variables as affected by the independent variables. It serves as an indicator of the model's fit quality. The Combined Model R^2 reflects the overall fitting quality of the entire model. It considers all the predictors collectively. A higher overall R^2 suggests that the model more effectively explains the observed data. Analyzing R^2 for each variable separately helps to understand how much each predictor contributes to the variation in the dependent variable. Greater individual R^2 values indicate stronger relationships between specific predictors and the outcome. Figure 2 depicts the structural model employed for testing the hypothesis. It outlines the relationships.

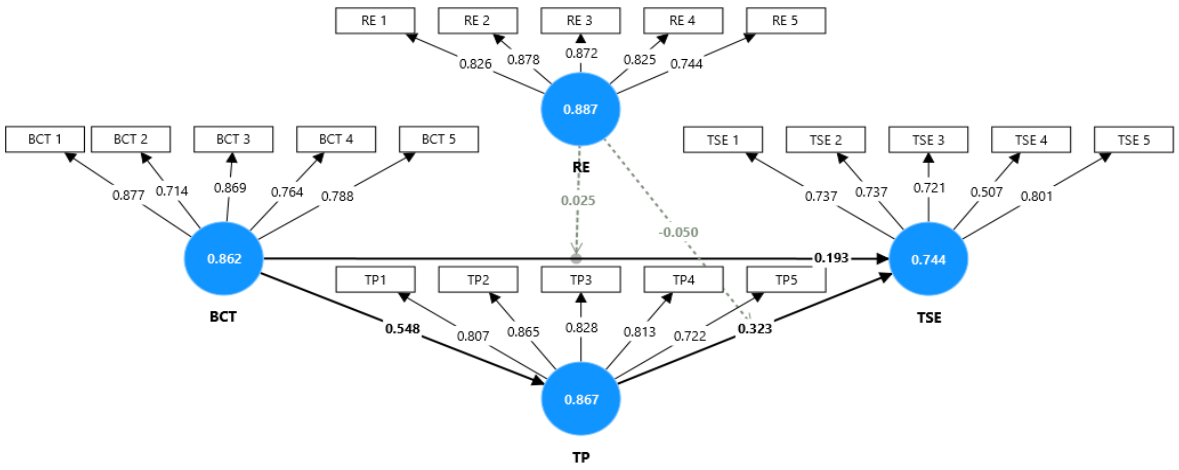

Figure 2 Structural model

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Hypotheses Test

i) Path coefficient

Path coefficients (β) indicate the intensity and direction of the relationship between two variables in a structural equation model. They resemble regression coefficients as they show the extent to which one variable affects another. H1 suggests BCT -> TSE (β = 0.195, SD = 0.065, T value = 2.947, P value = 0.003); this path coefficient reveals a positive association between BCT and TSE. The T value and P value indicate that this connection is statistically significant as well. H2 indicates BCT leading to TP (β = 0.288, SD = 0.063, T value = 4.567, P value = 0.000). This path coefficient reflects a positive correlation between BCT and TP. The T value is elevated while the P value is quite low, showing that this association is statistically significant. h3 suggests TP -> TSE (β = 0.315, SD = 0.095, T value = 3.438, P value = 0.001); this path coefficient reflects a positive connection between TP and TSE. The T value and P value demonstrate that this connection is statistically significant. The path coefficients indicate that BCT has a positive effect on both TP and TSE, while TP also positively affects TSE. This indicates that advancements in BCT may boost TP and total TSE.

Table 9 Path coefficient

Path	β	SD	T value	P value
Block chain technology adoption -> Trust in tourisms platforms	0.288	0.063	4.567	0.000
Block chain technology adoption -> Tourisms security and efficiency	0.195	0.065	2.947	0.003
Trust in tourisms platforms -> Tourisms security and efficiency	0.315	0.095	3.438	0.001

ii) Mediator and Moderator test

Mediator and moderator analyses assist in comprehending the processes by which an independent variable affects a dependent variable (mediator) and how the intensity or nature of this connection varies across different circumstances (moderator). H4 as a mediator suggests that the TP x BCT -> TSE (β = 0.514, SD = 0.073, T value = 7.062, P value = 0.000) interaction between TP and BCT significantly positively influences TSE. The elevated T value and diminished P value indicate that this interaction holds statistical significance. H5 and H6 as moderators RE x TP -> TSE (β = 0.185, SD = 0.078, T value = 2.225, P value = 0.026) suggest that the interaction of RE and TP significantly positively influences TSE, while RE x BCT -> TSE (β = 0.235, SD = 0.076, T value = 2.338, P value = 0.004) demonstrates that the interaction between RE and BCT also has a significant positive effect on TSE. The T statistic and P statistic indicate that this interaction holds statistical significance. The tests for mediation and moderation indicate that the relationships between TP and BCT, RE and TP, and RE and BCT have a significant impact on TSE. This suggests that the joint influence of these factors is crucial in shaping TSE. In conclusion, these findings emphasize the significance of considering both direct and interactive influences of different factors on service experience.

Table 10 Mediator and Moderator test

Path	β	SD	T value	P value
Trust in tourisms platforms x Block chain technology	0.514	0.073	7.062	0.000

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DOI: https://doi.org/10.62754/joe.v4i2.6372

adoption -> Tourisms security and efficiency				
Regulatory environments x Trust in tourisms platforms -> Tourisms security and efficiency	0.185	0.078	2.225	0.026
Regulatory environments x Block chain technology adoption -> Tourisms security and efficiency	0.235	0.076	2.338	0.004

A simple slope test was plotted for the moderating effect of Regulatory environment. Figure 3 and Figure 4 illustrate the levels of Regulatory environment.

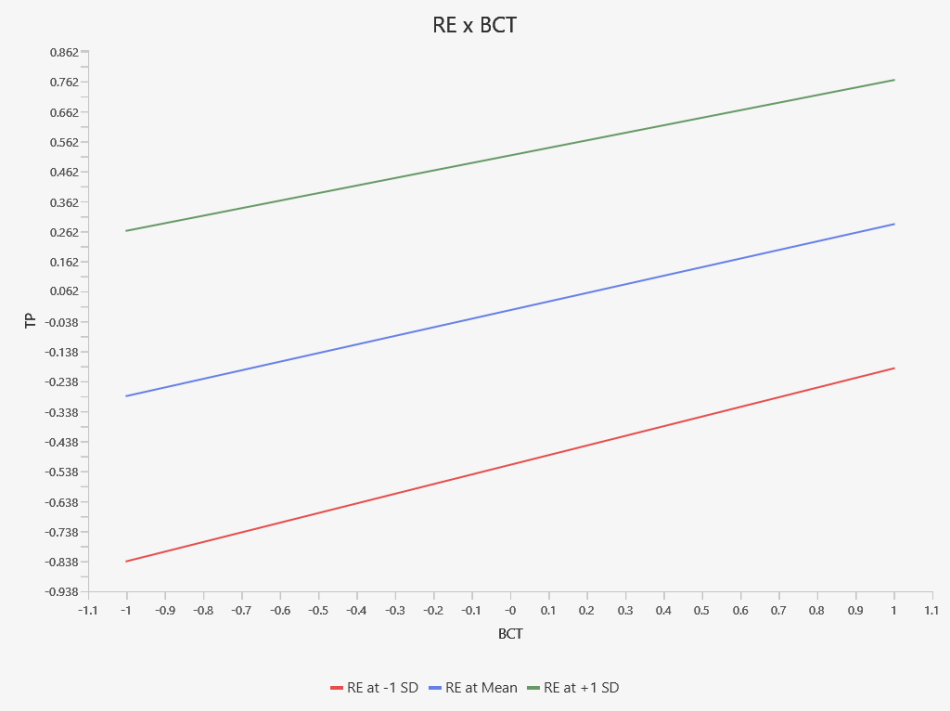

Figure 3 Interaction of Regulatory environment moderates the blockchain technology and Tourism Security and Efficiency

Journal of Ecohumanism
2025
Volume: 4, No: 2, pp. 850 – 868
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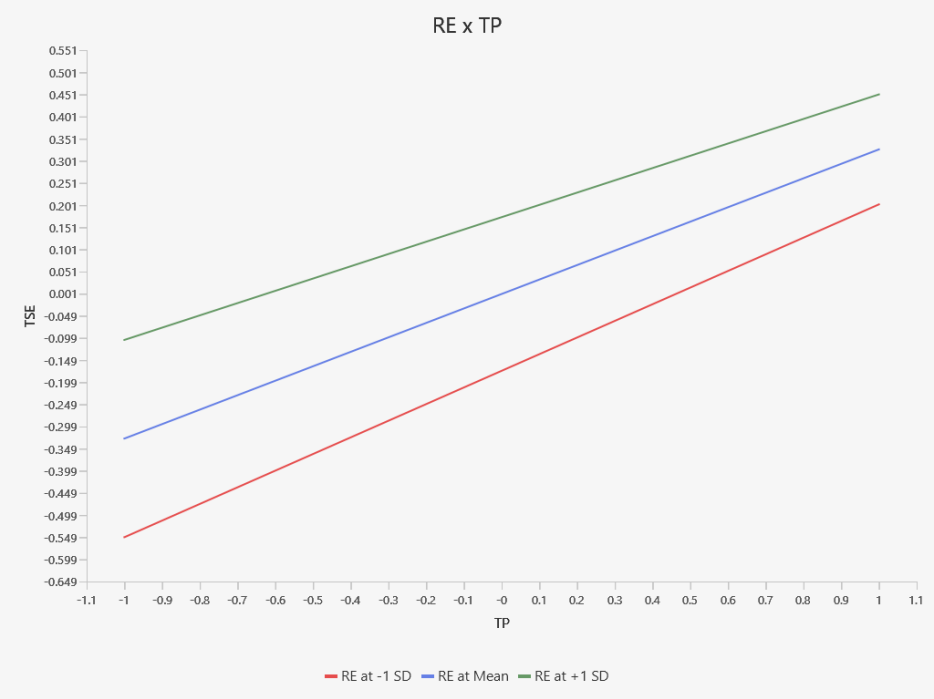

Figure 4 Interaction of Regulatory environment moderates the Trust in tourisms platforms and Tourism Security and Efficiency

Discussion

In this adoption of blockchain technology in tourisms industry hold an immense potential to enhance security and operational efficiency these successful implementations of blockchain technology depends on overcoming technological and regulatory barriers, as well as addressing organisation readiness to embrace this transformative technology [2]. This research explores blockchain can streamed operation safeguard, sensitive data and foster service providers and regulators [19,36]. Also utilizes the qualitative method using SmartPLS and SPSS to investigates how blockchain can protect operational processes, secure data, and support service providers and regulators to explores the relationship between trust, technology adoption, and regulation by suggesting ways to incorporate blockchain in the tourism industry with a focus on both innovation and responsibility. The number of studies [33,2,4] prove that there is a lack of research regarding block chain implementation in the tourism sector and low awareness among the stakeholders.

The Finding of this research illustrates the adoption of blockchain technology generally has a positive relationship with tourism security and efficiency ($\beta = 0.288$, $t = 4.567$, $p < 0.000$), Some research focuses on the improved security and confidence that BCT can offer [12], as it provides a transparent, immutable, and secure ledger system for recording transactions and data related to travel, thereby reducing fraud, increasing trust, and streamlining processes across the tourism industry. This finding is in line with the literature of [37]; [20]. Also, BCT reduces the commission fees from the host destination perspective, thereby lowering overall operating costs [25]. [38] Blockchain technology has emerged as a pivotal innovation for enhancing security and operational efficiency in tourisms sectors it is ability to provide transparent, decentralized and temper proof records address the critical challenge scalability issues, lack of technical maturity, interoperability concerns, privacy issues, potential for complexity in implementation, and the need for widespread adoption across the tourism ecosystem by leveraging smart contracts, block chain eliminates intermediates and reduce operational cost, and benefiting both service providers and travellers [31] [15].

And trust is fundamental in the tourisms sectors, blockchain technology adoption generally has a positive relationship with trust in tourism platforms ($\beta = 0.195$, $t = 2.947$, $p < 0.003$) are statically significant, as the decentralized and transparent nature of blockchain helps to eliminate intermediaries, reduce fraud, and

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provide verifiable data, ultimately increasing user confidence in the platform and its transactions. [39] Trust in tourism platforms refers to the level of confidence a traveller has in online platforms used to book travel arrangements, like hotels, flights, and tours., which is heavily influenced by factors like platform security, transparent information, credible reviews, and efficient booking processes, ultimately impacting the traveller's perception of safety and overall experience at their chosen destination; essentially, a secure and efficient platform builds trust, encouraging more people to use it for their travel bookings [31]. Thus, the Trust in tourisms platforms has a positive relationship between Tourisms security and efficiency ($\beta = 0.315$, $t = 3.438$, $p < 0.001$) According to [33], the growing importance of sustainable practices in the tourism industry is due to its positive influence on the customer's trust and the intention to pay extra [34]. Drawing on [40] and [41], this study explored the dual perspectives of service providers and customer expectations on the potential of BCT in tourism services, focusing on trust (reliability, transaction, and information trust), customer experience quality, and security and privacy issues. Trust is established through transparent and secure processes block chain adoption leads to better collaboration among stakeholders. The mediation effect ($\beta = 0.514$, $t = 7.062$, $p < 0.000$) underscores the importance of designing user centric blockchain system that address both technological capabilities and physiological factors [42].

Regulatory environment plays a critical role in moderator the relationship between blockchain technology adoption and its impact on security and efficiency in tourisms. This moderation result reveals the simple slope test of Regulatory environment. Figure 3,4 illustrates the levels of Regulatory environment (i.e., +1SD above the mean, at the mean and -1SD below the mean). Regulatory environments moderate the positive relationship with Block chain technology adoption and Tourisms security and efficiency [43]. The results confirmed this hypothesis with a significant moderating ($\beta = 0.185$, $t = 2.225$, $p < 0.026$) also in (Figure 3). On the other hand, Regulatory environments moderate the positive relationship with Trust in tourisms platforms and Tourisms security and efficiency [49]. The results provided support for this hypothesis as well, ($\beta = 0.235$, $t = 2.338$, $p < 0.004$). As depicted in figure 4, Regulation ensure compliance with data protection laws, financial standards, which are essential for blockchain border implementation. [44] also maintained that resistance to change is another important dependent challenge, which is consistent with our findings. This moderation highlights the necessity for policy makers to balance innovation with regulation for blockchain driven transformation in tourisms.

Conclusion

Theoretical and practical implication

From a theoretical standpoint, utilizing the TOE framework for blockchain adoption in tourism enhances the comprehension of how technology influences service sectors that depend significantly on customer trust and smooth operations. The TOE framework emphasizes three essential contexts that affect technology adoption. In the event of adopting blockchain technology. In the context of adopting blockchain technology, the critical characteristics of blockchain are highlighted. These characteristics render blockchain a compelling choice for the tourism sector. The adoption of BCT in tourism shows different viewpoints within hospitality sectors. Finance focuses on security and openness, whereas hospitality encounters obstacles in execution and building trust. IT literature emphasizes technological factors essential for widespread acceptance. This complex characteristic requires customized approaches for every sector. In practical terms, the adoption of BCT in tourism signifies changes in operations, improving both transparency and security. It establishes customer confidence via verifiable transactions and assessments, simplifies financial processes, and diminishes dependence on intermediaries. This establishes a more dependable tourism network, advantageous for both companies and visitors. BCT tackles sector-related challenges such as fraud prevention, minimizing intermediaries, and managing foreign currency risks. It enhances operational effectiveness and customer contentment by unifying the tourism value chain. Introducing clear booking systems and bolstering security measures can greatly increase confidence in the system. Effective BCT implementation in tourism necessitates educating stakeholders, initiating with pilot projects, and confirming adherence to regulations. This method may result in a more efficient, safe, and user-friendly tourism sector.

Journal of Ecohumanism
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Limitation and future work

The article examines scholarly research related to the application of BC technology in the tourism industry, drawing conclusions from the findings of the specified studies. While the research provides important insights, certain limitations must be tackled in upcoming studies. Although the existing sample size is adequate for the statistical techniques used, a bigger sample would produce results that are more widely applicable. Experts in this area concur on the beneficial effects of BC adoption in tourism: enhancing operational processes, the quality of products/services provided, data management and security, alongside the overall economy of the nation. Nonetheless, [29,30] several researchers in different disciplines contend that BC technology is plagued by various security concerns. Consequently, upcoming studies should explore the significant obstacles of blockchain technology and examine their impact on the tourism industry [2]. Furthermore, the research mainly emphasizes the theoretical benefits of blockchain, such as transparency and security, while not adequately considering its technical constraints. Future investigations could delve into the technical challenges of blockchain, including its ability to manage high volumes of transactions in tourism and possible scalability solutions like more energy-efficient consensus mechanisms.

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