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Identifying Critical Factors for Blockchain Technology Adoption in Indonesian E-Commerce

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ABSTRACT

This study examines the adoption of blockchain technology in Indonesian e-commerce by employing the Technology Acceptance Model (TAM) to identify key influencing factors. The research focuses on four blockchain characteristics: Time Saving, Cost Saving, Data Privacy Security, and Traceability. The findings indicate that Time Saving and Traceability significantly enhance Perceived Usefulness, while Cost Saving and Data Privacy Security do not have a notable effect. The study confirms that Perceived Usefulness significantly impacts Adoption Intention, mediated by Perceived Ease of Use. Despite the insights provided, the study acknowledges limitations, such as the focus solely on individual users and the use of only four blockchain characteristics. Future research should explore additional factors, such as efficiency and government support, and consider organizational users, like SMEs, to offer a comprehensive understanding of blockchain adoption. Overall, this study offers valuable insights into the critical determinants influencing blockchain adoption in Indonesian e-commerce, emphasizing the importance of perceived benefits in shaping user intentions.

Keyword: Blockchain technology, e-commerce, technology acceptance model

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1. INTRODUCTION

The rapid advancement of digital transformation within organizations is crucial for supporting business operations and selecting the right technologies to solve the problems and challenges they face. Currently, a variety of technologies such as blockchain, cloud computing, Artificial Intelligence (AI), and the Internet of Things (IoT) have emerged, offering a wide array of capabilities for different applications and contexts (Ahram et al., 2017). Among these next-generation technologies, blockchain has garnered increasing attention from both academics and practitioners for its numerous benefits, including cost optimization, effective tracking and traceability, verifiable record-keeping, transparency, and ease of collaboration for companies (Sarkis et al., 2021). The business sector is rapidly adopting these transformative technologies to seize opportunities, gain competitive advantages, and enhance performance across various industries (Saberi et al., 2019). Despite blockchain technology being discussed for nearly a decade, there is still limited evidence regarding the factors influencing the intention to adopt blockchain in the e-commerce sector (Clohessy & Acton, 2019; Hughes et al., 2019; Kumar Bhardwaj et al., 2021).

The adoption of blockchain technology offers a shared database distinguished by transparency and traceability, enabling users to record and access information accurately and promptly (Kaaniche & Laurent, 2017; Milani et al., 2021). Information in the blockchain is transmitted anonymously and with high

encryption, allowing it to be traced back through production and transportation processes, logistics, and supply chain information (Casino et al., 2019). Implementing blockchain technology in e-commerce can create a safer, more efficient, and cost-effective trading environment (Esfahbodi et al., 2022). Consequently, this opens up opportunities for various stakeholders, including companies, business owners, and consumers, to analyze the determining factors influencing the intention to adopt blockchain technology.

Numerous studies suggest that the implementation of blockchain can enhance various business processes and industries, including supply chains, logistics, agricultural finance, and healthcare, and could even trigger a new disruptive technological revolution (Ali et al., 2020; Chang et al., 2019; Dhagarra et al., 2019; Gurtu & Johny, 2019). This highlights the importance of exploring practical blockchain applications across various fields, such as e-commerce. Blockchain has been theoretically proven to have significant potential benefits for e-commerce. The interrelationship between blockchain and e-commerce provides a strong theoretical foundation. Blockchain-based electronic markets offer numerous advantages over conventional electronic markets, including efficient buyer-seller matching, protection of customer information privacy, and reliable transaction tracking (Subramanian, 2017). The Technology Acceptance Model (TAM) is used to analyze the impact of blockchain's benefits on user adoption intentions in the supply chain and construction industries (Chaveesuk et al., 2020; Kamble et al., 2019). Analysis of the TAM model reveals that blockchain's advantages can drive the acceptance of blockchain technology and positively influence factors related to e-commerce. Indonesia is chosen as the study demographic due to its status as a developing country in the implementation of blockchain technology.

This research is among the early empirical studies that examine the determinants influencing individual users' adoption of blockchain technology in e-commerce in Indonesia. The study aims to identify the factors that determine blockchain technology adoption and assess whether the benefits of blockchain features can positively influence consumers' intention to adopt blockchain technology. This study contributes to the existing literature by providing insights into the factors influencing consumers' intention to adopt blockchain technology in the e-commerce sector. Furthermore, it highlights that existing literature predominantly focuses on the determinants of blockchain technology adoption at the organizational level rather than on individual user behavior (Clohessy & Acton, 2019). The most effective method for analyzing the acceptance of new technologies and explaining how users are likely to accept and implement them is the Technology Acceptance Model (TAM) (Davis, 1989).

2. LITERATURE REVIEW, HYPOTHESES, AND METHODS

2.1 Literature Review

Previous studies on the factors influencing the adoption of blockchain technology have primarily focused on developed countries and organizations (Clohessy & Acton, 2019; Esfahbodi et al., 2022; Sarkis et al., 2021; Saurabh & Dey, 2021). In contrast, this study provides a deeper analysis of the determinants driving individual users to adopt blockchain technology in e-commerce. E-commerce users are closely associated with blockchain technology, particularly in key areas such as transaction security, transparency and accountability, supply chain tracking and management, reducing transaction costs, token use and payments, and data ownership. Blockchain technology allows users to have greater control over their personal data by enabling secure digital identities and better privacy settings. Consequently, blockchain holds substantial potential to improve security, efficiency, and transparency in e-commerce, offering users increased trust and control over their transactions and data (Guntara et al., 2023).

2.2 Hypotheses and Methods

Blockchain development in Indonesia is advancing at a micro-level, which can be divided into two key phases: (1) the Blockchain 1.0 Era, focusing primarily on cryptocurrencies, and (2) the post-Blockchain 1.0 Era. Blockchain 1.0 had already been established in Indonesia and received considerable attention in media and public discussions (Ramadhan & Putri, 2018). For instance, in the banking industry, BCA has implemented blockchain technology internally to accelerate payment transactions and reduce back-office

complexities (OnlinePajak, 2018). Additionally, the global economy is intricately linked to e-commerce, one of its major advantages being the effective reduction of trade-related costs, which enhances cross-border business appeal and fosters international economic growth (Gomez-Herrera et al., 2014; Lendle et al., 2016). E-commerce also serves as a trade facilitator by eliminating geographical barriers and reducing information friction in online markets (Leamer, 2007). Recent technological advancements, including blockchain, have shown promise and play a pivotal role in driving e-commerce growth. Blockchain technology first emerged in 2008 as a peer-to-peer encrypted electronic cash system designed to record transactions and enable network members in different locations to exchange information (Nakamoto, 2008). Although blockchain technology was initially developed for cryptocurrencies such as Bitcoin, it has since expanded into the e-commerce sector (Treiblmaier & Sillaber, 2021). Studies from prior research have generally agreed that blockchain technology can significantly reduce costs for consumers (Chang et al., 2019; Xiong et al., 2020). With blockchain, e-commerce platforms can provide immutable access to relevant information based on sellers' requirements, allowing each node to list prices, products, and previous customer reviews, which are then distributed across the Internet. Thus, each seller is responsible for their product information (Z. Liu & Li, 2020).

Furthermore, the Technology Acceptance Model (TAM), developed by Davis (1987), is one of the most effective frameworks for analyzing new technology acceptance levels and explaining user tendencies toward adopting these technologies. Technology acceptance refers to the willingness of users or organizations to adopt new technologies. According to the TAM model, user adoption intentions are influenced by three main factors: (1) perceived usefulness, (2) perceived ease of use, and (3) attitude towards using the technology. Despite recent advancements in the TAM model, existing research provides limited insights into societal influences on technology adoption, necessitating further exploration (Chtourou & Souiden, 2010; Huang & Liao, 2015). Additionally, since the classic TAM model does not account for internal factors, its application is primarily confined to customer environments where users adopt new technologies to meet emotional needs (Taherdoost, 2018), which calls for further investigation. This study aims to bridge these research gaps by integrating core features of blockchain technology into the TAM model to explore its impact on user acceptance, which is not yet addressed in the current literature (Saberi et al., 2019).

In technology acceptance literature, perceived usefulness and ease of use are recognized as key individual determinants influencing the intention to adopt technology (Fosso Wamba et al., 2020). These factors have been identified as significant drivers that positively motivate the intention to adopt new technologies (Raza et al., 2017). When customers believe that blockchain technology is beneficial and enhances their performance in electronic commerce, they are more likely to rate it favorably. Existing literature indicates that perceived ease of use positively affects users' attitudes and behavioral intentions toward adopting new technologies (Sohaib et al., 2020).

Perceived usefulness and perceived ease of use are widely recognized as two primary values perceived by users, which are significant factors in analyzing customer acceptance of blockchain (Grover et al., 2019). Customers are more inclined to find blockchain technology beneficial when it is user-friendly, leading to a positive attitude toward blockchain adoption. Based on this premise, the following hypotheses are proposed:

H1: Perceived usefulness will positively influence users' intention to adopt blockchain technology in e-commerce.
H2: Perceived ease of use will positively influence users' intention to adopt blockchain technology in e-commerce.
H3: Perceived ease of use will positively influence users' perception of blockchain's usefulness.

Today, e-commerce search engines process millions of customer requests daily, requiring efficient search-matching mechanisms to reduce user search costs (S. Liu et al., 2017). Blockchain technology provides an innovative solution to this challenge. As a publicly shared database, blockchain allows nodes within the network to access information anytime and anywhere. Technologically, blockchain ensures

transparency and openness of information while promising data security and reliability (Yiannas, 2018). As a result, customers can benefit from cost and time savings, influencing their perceived usefulness of blockchain in terms of economic and time value.

H4: Cost savings will positively influence users' intention to use blockchain technology in e-commerce.

This study further transforms perceived value into economic and time value to identify extrinsic motivational factors. Consumers recognize economic value when purchasing products or services at a lower price than other options. In this study, alternatives are defined as purchases from offline stores or other online marketplaces. Economic and time values are crucial to consumers, and purchase intentions are perceived positively when benefits outweigh sacrifices. Thus, economic and time values have a positive impact on consumers' product choices across purchasing channels.

H5: Time savings will positively influence users' intention to use blockchain technology in e-commerce.

With a unique timestamp that records information creation times, blockchain supports real-time data recording and investigation, building an immutable and tamper-proof database where transactions can be traced back to their origins through the chain structure (Pierro, 2017). Saurabh & Dey (2021) developed a theoretical framework based on the TAM model to explore factors influencing blockchain adoption in the wine supply chain. They propose that blockchain's traceability enhances users' perceived usefulness and adoption of blockchain technology, especially as consumers increasingly seek information about their food and prioritize food safety. From this viewpoint, this research aims to expand the TAM model by integrating traceability to assess its impact on intentions to use blockchain and proposes hypotheses based on these insights.

H6: Traceability will positively impact users' intention to use blockchain technology in e-commerce.

For e-commerce users, concerns about how online businesses use and process their personal information persist (Udo, 2001). Understandably, consumers' personal and financial information is exposed to e-commerce retailers in almost every transaction, leading them to expect strict data protection (Limbu et al., 2011). Blockchain enables peer-to-peer user interactions, reducing third-party access to customer information, and blockchain users can remain anonymous (Liang et al., 2019). This ensures substantial online privacy protection, allowing consumers to manage and share their information deliberately while maintaining personal data integrity (Guan et al., 2020).

H7: Data privacy security will positively influence users' intention to use blockchain technology in e-commerce.

Figure 1 illustrates the proposed hypotheses. In summary, previous research by Esfahbodi et al. (2022) examined blockchain user intentions, focusing primarily on e-commerce users in China, including variables such as cost savings, traceability, and personal data security. Given the rise of e-commerce, it is crucial for scholars to explore blockchain applications in this field. This study focuses on the individual user's perspective, examining factors influencing blockchain adoption intentions in e-commerce. The research also seeks to explore and identify determinants of user intentions in WeDeals, an Indonesian e-commerce platform that has implemented blockchain.

For this study, a validated scale from existing literature was adopted. This included latent constructs related to blockchain characteristics such as Time Saving, Cost Saving, Traceability, and Data Privacy Security, alongside established TAM constructs: Perceived Usefulness (PU), Perceived Ease of Use (PEU), and Adoption Intention (AI) towards e-commerce, aiming to extend the existing TAM model within this research context. The items measuring attitude were recorded using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

The questionnaire was developed as a survey instrument targeting individuals aged 18 and older. Due to the technical nature of the study, both students and professionals were the primary focus. Traceability and Data Privacy Security have substantial impacts within e-commerce and across various industries. E-commerce users or respondents can track the origin of products transparently, which enhances trust in brands and products. Consumers are more likely to trust products that can be traced from start to finish in the supply chain. Educated individuals can better simplify and understand technical information (Chan, 2001). The questionnaire administered in Indonesia included 22 statements. Respondents were assured that their responses would solely be used for academic research. Considering potential gaps in blockchain knowledge, the survey included a brief explanation of blockchain technology to provide respondents with foundational knowledge before responding to the questions. Purposive sampling was used to select participants from the population. The research instrument was distributed via various social media platforms to reach respondents. Out of 210 questionnaires distributed, 108 were fully completed, resulting in a 51% response rate, which was deemed sufficient for analysis.

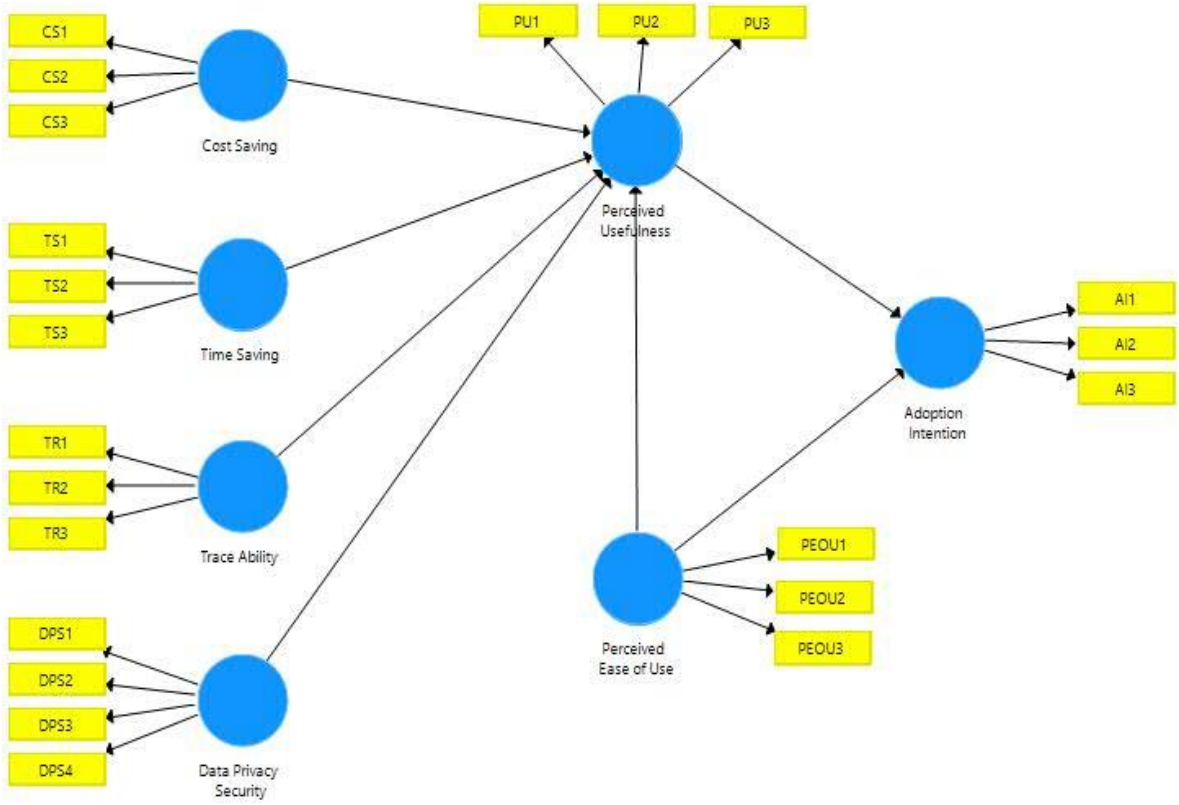

Figure 1. The conceptual framework

3. RESULTS AND DISCUSSION

3.1 Assessment of Measurement Model

Before testing the structural relationships among constructs, it is essential to assess the reliability and validity of each item. Internal consistency among items is measured using composite reliability (CR). As indicated in Table 2, the CR values for Cost Saving (CS), Time Saving (TS), Data Privacy Security (DPS), Traceability (TR), Perceived Ease of Use (PEOU), Perceived Usefulness (PU), and Adoption Intention (AI) are all above 0.7, confirming their reliability. The Average Variance Extracted (AVE) for all latent constructs—AI, ATT, PEU, PSP, PU, and TRT—far exceed the 0.5 threshold. Additionally, the square root of AVE ($\sqrt{AVE}$), presented on the diagonal, surpasses the off-diagonal values in the correlation matrix, providing evidence of both convergent and discriminant validity. Figure 2 shows that all item loadings exceed 0.7, indicating strong indicator reliability.

The questionnaire items, designed to capture the research model's indicators, were translated into Indonesian to enhance respondent comprehension. To further facilitate understanding, particularly for respondents aged 18–24, a brief overview of blockchain technology was provided prior to completing the questionnaire. This overview included definitions, basic concepts, security and reliability, primary applications, and the potential benefits of blockchain. The construction of questionnaire items was informed by prior research by Esfahbodi et al. (2022). This study also considers gender, age, and education as variables, recognizing that these characteristics significantly influence decisions to adopt information technology. Table 1 illustrates the demographic profile of the respondents.

Table 1. Demographic profile

Characteristic	Frequency	Percentage (%)
Gender		
Male	56	51.9
Female	52	48.1
Age		
18-24	64	59.3
25-30	21	19.4
31-35	10	9.3
36-40	9	8.3
Greater than 40	4	3.7
Education		
Junior High School	1	0.9
Senior High School	32	29.6
Bachelor's Degree	70	64.8
Master's Degree	4	3.7
PhD	1	0.9

3.2 Assessment of Structural Model

Non-parametric bootstrapping was employed to evaluate the hypothesized relationships, with the results illustrated in Figure 2. Significant path coefficients serve as critical metrics for assessing causal relationships in the structural model. The findings from this study provide robust empirical evidence supporting the proposed relationships.

The fundamental TAM variables, Perceived Usefulness (PU) and Perceived Ease of Use (PEOU), significantly affect individual attitudes toward blockchain technology, supporting H1 ($\beta = 0.284$, $t = 2.411$) and H2 ($\beta = 0.462$, $t = 3.263$). Perceived Ease of Use (PEOU) relative to Perceived Usefulness (PU) emerges as a strong predictor of individuals' intentions to adopt blockchain in e-commerce in Indonesia, confirming H3 ($\beta = 0.265$, $t = 2.626$). Additionally, Cost Saving (CS) and Perceived Usefulness (PU) were integrated to better predict adoption intentions within Indonesian e-commerce. Cost Saving (CS) positively influences Perceived Usefulness (PU), as evidenced by H4 ($\beta = 0.114$, $t = 1.087$). Furthermore, Time Saving (TS) has a substantial positive effect on Perceived Usefulness (PU), followed by Traceability (TR) and Data Privacy Security (DPS), supporting H5 ($\beta = 0.262$, $t = 3.321$), H6 ($\beta = 0.269$, $t = 2.563$), and H7 ($\beta = 0.111$, $t = 1.096$). The R^2 value assesses the predictive capability of the model, indicating the extent of variance in the dependent variable explained by the independent variables.

The R^2 values were evaluated against suggested benchmarks of 0.19, 0.33, and 0.67, which correspond to weak, moderate, and strong effects, respectively. The structural model's predictors reveal a strong influence on Perceived Usefulness (PU) ($R^2 = 0.741$) and the intention to adopt blockchain in Indonesian e-commerce ($R^2 = 0.503$). Furthermore, the validated hypotheses demonstrate that predictor variables significantly impact outcome variables. The six independent variables—CS, TS, TR, DPS, PEOU, and PU—exhibit positive associations with user intention toward blockchain applications in Indonesian e-commerce.

User intention is a pivotal determinant of behavior, influencing subsequent actions. The six predictors exhibit a strong influence in predicting adoption intention. Through cost savings, efficient time management, data privacy security, traceability, ease of use, and usefulness, innovations can foster individuals' readiness to embrace blockchain-based solutions. According to the demographic profile detailed in Table 2, 56 (51.9%) respondents were male, and 52 (48.1%) were female. The majority of respondents held a bachelor's degree (64.8%), followed by high school graduates (29.6%), postgraduates (3.7%), doctoral graduates (0.9%), and junior high school graduates (0.9%). Common method bias was addressed through a comprehensive collinearity test, revealing Variance Inflation Factor (VIF) values below 5 for all latent constructs, indicating no multicollinearity issues.

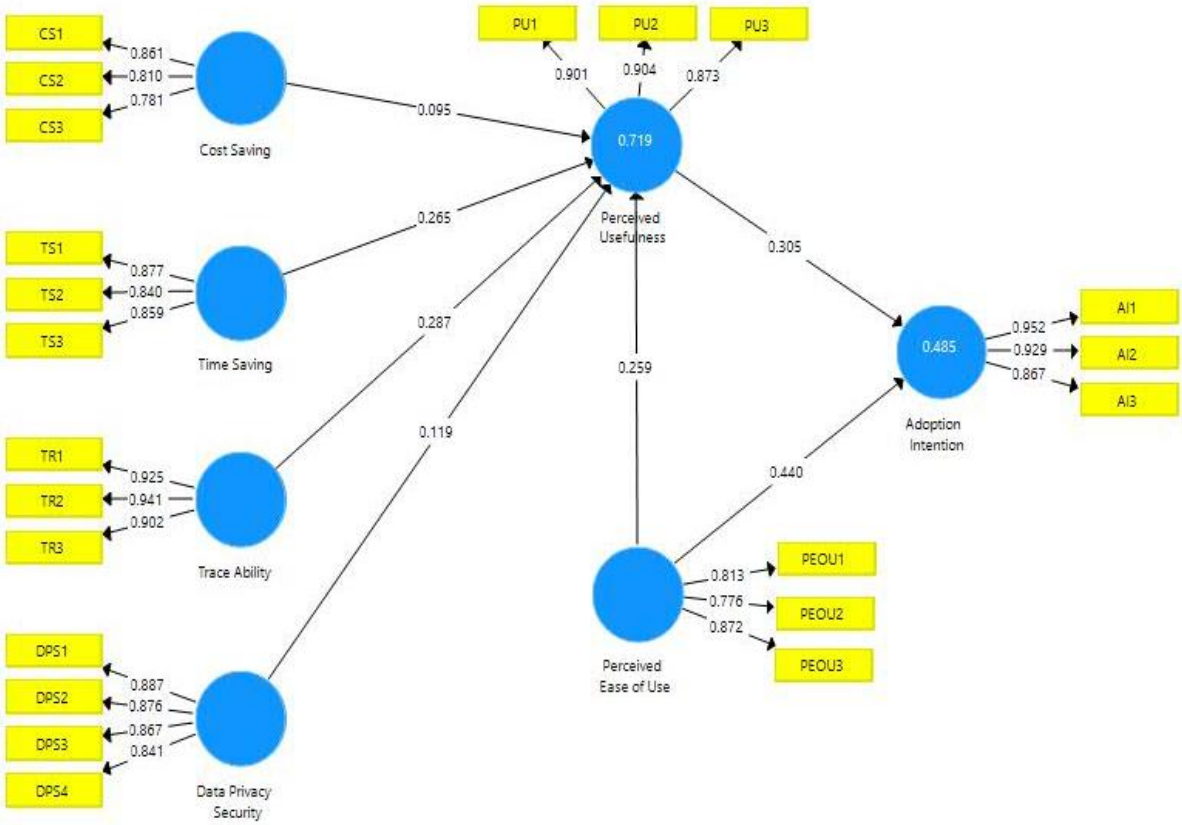

Figure 2. Structural model

Data processing with SMARTPLS3 software shows that the research model fulfills the requirements for convergent validity, with loading factor values for each variable ranging from 0.7 to 0.9, thus exceeding the 0.7 threshold (Figure 2). Moreover, discriminant validity is confirmed by each indicator's diagonal values surpassing all other values. Reliability analysis indicates that all variables have Cronbach's alpha and composite reliability values above 0.7, establishing the model's suitability for further evaluation. Construct reliability was evaluated by measuring the reliability of latent variable constructs, with reliable values expected to exceed 0.70. Construct reliability aligns with Cronbach's alpha. Details can be found in Table 2.

In the subsequent phase, the relationships between constructs were tested, with the significance values determining hypothesis validation, following the standard criterion (p-value < 0.05). According to Table 3, Perceived Ease of Use and Perceived Usefulness significantly impact blockchain technology adoption in e-commerce, as evidenced by p-values below 0.05 and t-statistics above 1.96, indicating a positive influence. Users who experience ease in certain activities are more likely to adopt tools that simplify these tasks. In this study, the focus is on adopting blockchain technology in e-commerce. The findings confirm that perceived usefulness and ease of use significantly influence the intention to use, meaning that the greater the perceived benefits, the higher the intention to use. In contrast, Data Privacy Security and

Cost Saving variables do not significantly impact Perceived Usefulness or blockchain technology adoption. Therefore, Hypotheses 1, 2, 3, 5, and 6 are accepted, while Hypotheses 4 and 7 are rejected.

Table 2. Results of construct reliability and validity

Variable	Cronbach's Alpha (CA)	rho_A	Composite Reliability (CR)	Average Variance Extracted (AVE)
Cost Saving	0.755	0.768	0.858	0.669
Time Saving	0.822	0.827	0.894	0.738
Traceability	0.913	0.914	0.945	0.852
Data Privacy Security	0.891	0.891	0.924	0.753
Perceived Usefulness	0.873	0.874	0.922	0.797
Perceived Ease of Use	0.759	0.766	0.861	0.674
Adoption Intention	0.905	0.917	0.941	0.841

Table 3. Results of path coefficient test

Path	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	Conclusion
Perceived Usefulness → Adoption Intention	0.305	0.280	0.121	2.517	0.012	Accept H1
Perceived Ease of Use → Adoption Intention	0.440	0.463	0.132	3.336	0.001	Accept H2
Perceived Ease of Use → Perceived Usefulness	0.259	0.253	0.101	2.564	0.011	Accept H3
Cost Saving → Perceived Usefulness	0.095	0.122	0.091	1.047	0.296	Reject H4
Time Saving → Perceived Usefulness	0.265	0.257	0.083	3.215	0.001	Accept H5
Traceability → Perceived Usefulness	0.287	0.284	0.112	2.550	0.011	Accept H6
Data Privacy Security → Perceived Usefulness	0.119	0.106	0.096	1.235	0.217	Reject H7

4. CONCLUSION

This study utilizes a theoretical approach grounded in the Technology Acceptance Model (TAM) to analyze key factors influencing blockchain technology adoption in e-commerce within Indonesia. The study focuses on four primary blockchain features: Time Saving, Cost Saving, Data Privacy Security, and Traceability. The findings reveal that Time Saving and Traceability significantly influence Perceived Usefulness. The research model underscores that Perceived Usefulness has a strong impact on Adoption

Intention, indicating that the more consumers perceive the benefits (as measured by perceived usefulness and ease of use), the higher their intention to use the technology. Of the four core characteristics of blockchain, Time Saving and Traceability positively and significantly impact Perceived Usefulness, with the corresponding hypotheses being accepted. This impact is further amplified through the mediating effect of Perceived Ease of Use. In contrast, Cost Saving and Data Privacy Security do not significantly affect Perceived Usefulness or Adoption Intention. Our empirical evidence suggests that Data Privacy Security does not impact perceived usefulness. The model confirms that perceived usefulness strongly affects Adoption Intention, and Perceived Ease of Use influences Perceived Usefulness. This influence is enhanced by the mediation of Perceived Usefulness. Despite these contributions, the study has several limitations that future research could address.

The study has several limitations. Firstly, while various models can measure blockchain user intentions, this study only incorporates four blockchain characteristics to explain user adoption. Future studies might consider adopting alternative models, such as the Diffusion of Innovation (DOI) framework, and include other relevant blockchain characteristics, such as efficiency and government support, offering a more comprehensive understanding of the factors driving blockchain adoption. Secondly, this study examines individual user intentions to adopt blockchain technology. However, the adoption of new technologies involves not only individual users but also organizational users, such as small and medium-sized enterprises. Future research should consider exploring different user types to provide a more holistic view of adoption dynamics. Additionally, blockchain should not be viewed as a standalone technology; it relies heavily on big data collection and analysis.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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