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Blockchained project management: Exploring potential advancements

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ABSTRACT

This study aims to explore the impact of blockchain technology on project management practices. It also examines the moderating role of blockchain literacy in enhancing project management benefits derived from blockchain features. A quantitative research method was used drawing on data from project managers using blockchain across various industries from February to April 2024. An online questionnaire was sent through LinkedIn to the targeted respondents who use blockchain technology in their fields to ensure that they have enough knowledge about the research topic, therefore, guaranteeing the reliability of responses. 277 questionnaires were received, and then the data were analyzed through Smart-PLS 4.0. The results revealed a significant and positive relationship between blockchain features and improved project management practices. The results also showed that while blockchain literacy has enhanced the benefits achieved from blockchain adoption in projects, it has no impact on the ability to benefit from security, tracking and control. This study contributes to the knowledge base on blockchain in project management by providing empirical evidence of its beneficial impacts without and through the moderating role of blockchain literacy. The study offers insights into the distinct impacts of blockchain features, recommending areas where blockchain can provide the most value to project management.

Contribution/Originality: This study uniquely examines the moderating role of blockchain literacy in project management, bridging the gap between theoretical potential and real-world adoption. By providing empirical evidence across industries, it emphasizes the distinct impacts of blockchain features, offering strategic insights for stakeholders seeking to optimize project management outcomes and enhance performance.

1. INTRODUCTION

Project management provides an effective methodology to drive organizational change and create stakeholder value (Sharari, 2023). Through coordinating efforts, it helps organizations fulfil complex tasks and meet fast-changing market needs (Fashina, Fakunle, & Opiti, 2020). This requires the use of modern approaches to manage organizational resources. Keeping up with recent technological updates enables stakeholders to realize better project outcomes (Tereso, Ribeiro, Fernandes, Loureiro, & Ferreira, 2019). From these updates, blockchain technology has a potential in advancing project management practices (Casey & Vigna, 2018). Blockchain technology is a decentralized, digital ledger that records transactions across a network of computers (Casey &

Vigna, 2018; Swan, 2015). Beyond being the underlying technology behind cryptocurrencies such as Bitcoin and Ethereum, blockchain has other uses that can change the way projects are managed (Al-Dmour, Al-Dmour, Al-Dmour, & Al-Adwan, 2024; Anwar, 2020). The integration of blockchain into project management represents a critical shift in how projects are initiated, planned, executed, monitored, and controlled (Casey & Vigna, 2018). It offers a model for greater project efficiency, transparency, and accountability, leading to better stakeholder collaboration (Deloitte, 2018). By enabling secure and immutable records of project transactions, it streamlines processes and minimizes the risks of fraud and miscommunication. This innovative model fosters trust among stakeholders and allows for real-time tracking of project transactions, milestones and deliverables (Hargaden, Papakostas, Newell, Khavia, & Scanlon, 2019). Blockchain literacy is essential for blockchain adoption. In some regions, technology adoption in project management remains low due to limited awareness of its benefits (Abu Yousef, AlKhazali, Qawasmeh, & Alshamayleh, 2023; Jarrar, Barrena, Foncubierta, & Al-Hyari, 2024). This is also referred to other challenges such as complexity, scalability, and integration with existing systems. Literature indicates a major gap in research works focusing on the various developments that blockchain systems may introduce to project management (Sonmez, Sönmez, & Ahmadisheykhsarmast, 2023). It lacks a clear understanding of the project management areas that may be enhanced by blockchain technology, and how blockchain literacy can affect this relationship (Giuliano et al., 2023). This paper explores the potential advancements blockchain can bring to projects management and stakeholders. The paper also explores how blockchain literacy can facilitate these advancements. Delving into project-related applications of blockchain, it becomes clear that this technology can redefine the standards of project execution and governance.

2. LITERATURE REVIEW

2.1. Technology in Project Management

Project management has passed through four distinct periods from basic administration to the age of technology. The first period held the theme of "craft system to human relation administration" where the development of telecommunications and automobiles reduced project schedules (Steyn, 2018). The second period witnessed the application of management science (Azzopardi, 2018) with computer technology starting to partially assist in managing projects. In the third period, project managers started to develop novel attitudes to manage project risks with the information management sector which helped to facilitate project planning and controlling (Dalcher, 2017). The fourth and current period is focusing on the development of a new business environment through the large domination of technological innovations (Jeremiah & Kabeyi, 2019).

Project management approaches are used to provide credible ways of planning and implementing projects based on their unique context and nature. The development of cloud-based software and modern physical technologies is greatly changing the way project management is conceived and performed (Tech, 2018). Such technological advances have become instrumental in offering the best project management tools and techniques that contribute to the success of projects and their businesses objectives.

Project management technologies and tools are now making it much easier to undertake and track project tasks and activities (Cawley, 2021). These technologies have enhanced the performance of project professionals by promoting interdependencies and collaboration (Joshi & Kalyandugrmath, 2021). Various types of collaborative technologies enable project teams to be more efficient by increasing the ability to comfortably share their thoughts and opinions (Abousweilem, 2024). Another advantage of such technologies in project management is offering instant communication (Jacob et al., 2021) which allows project stakeholders to make smoother and optimized decisions. Blockchain is one of these novel technologies that can advance project management by enabling workflow automation, information security and risk and data management among other benefits.

2.2. Blockchain and Project Management

Blockchain technology is a decentralized digital record-keeping that breaks down as a record of all transactions on a network of computers (Casey & Vigna, 2018; Swan, 2015). It consists of a series of blocks, each of which contains a list of the various transactions that make up that block. These are simple digital transactions, the movement of some form of money or other specified digital asset from one location to another. Each block is linked to the previous one through a cryptographic hash, creating a chain of blocks that is resistant to tampering and revision (Narayanan, Bonneau, Felten, Miller, & Goldfeder, 2016; Ullah et al., 2024).

Blockchain has emerged as a promising technology that enhances project management practices through different applications (Kim et al., 2020). These applications include the smart contracts that enable the automatic execution of contract clauses without intermediate intervention (Zheng, Xie, Dai, Chen, & Wang, 2017). Blockchain is challenging traditional project processes that rely on trusted third parties (Casino, Dasaklis, & Patsakis, 2019). This does not only reduce costs and increase confidentiality and efficiency in a project but also optimize stakeholder engagement and cooperation which enhances project structure (Rokooei, Shojaei, Alvanchi, & Azad, 2022). Blockchain allows holding data simultaneously on all peer-to-peer networks of computers or nodes, ensuring project security. This eliminates a single point of failure by allowing a distributed storage of the ledger through cryptographic proof. Another application of blockchain is recording project transactions across the peer-to-peer network of nodes (Sonmez et al., 2023). These transactions are added to and executed by the blockchain with no need for a central stakeholder or authority (Bagetta, 2021). This promotes flexibility by allowing fast, secure and risk-free transactions supported by a decentralized setup.

Within large and complex projects, rewards and compensations can be very difficult to govern, causing harmful effects on project environments (Smajgl & Schweik, 2022). The decentralized network setup of a project blockchain with equal access to data increases trust in the fairness of incentives among stakeholders which enhances their harmony and collaboration (Esmaeilzadeh & Mirzaei, 2023). Tracking and control is another benefit of adopting blockchain in projects. Project stakeholders through the automatic accessibility to project information are continuously updated on project information (Elghaish, Abrishami, & Hosseini, 2020) allowing the project manager and decision-makers within the project network to efficiently monitor and control the project progress (Buterin, 2015). Blockchain can be considered a revolutionary technology that may optimize project work and stakeholder relationships with all these potential benefits in mind.

2.3. Blockchain Literacy

In project management, blockchain literacy is defined as the "level of awareness of blockchain stakeholders concerning both the technology and the potential benefit of its applications" (Jarrar et al., 2024). Blockchain literacy represents the pre-requisites for harnessing blockchain advancements, including knowledge about the technology, incentives to use it, and organizational training and support for adopting it Kumari et al. (2023). These prerequisites can shape the way blockchain applications are perceived and utilized (Mattke, Maier, Reis, & Weitzel, 2021). It also influences the type of advantages that project stakeholders can recognize from adopting blockchain (Raddatz, Coyne, Menard, & Crossler, 2023). Blockchain literacy could be the main factor for driving such advancements which still lack exploration and understanding despite the high potential of blockchain to advance the project management field (Jarrar et al., 2024; Kumari, Bala, & Chakraborty, 2023).

2.4. Theoretical Background and Hypotheses Development

Blockchain provides new technology for advancing business paradigms in numerous domains (e.g., project management). Many industries are scrambling to adopt the use of blockchain to optimize the workflow of project processes (Amoah & Oh, 2021). This paper explores the areas in which blockchain supports project management processes and stakeholders using stakeholder theory (Giuliano et al., 2023) with a look to the moderating role of

blockchain literacy (see Figure 1). These areas include maintaining digital records, establishing reputational systems, reinforcing high-performance levels and exchanging digital assets (Sonmez, Güler, & Kara, 2021). As time moves past the adoption of blockchain, more and more projects are embracing the technology to coordinate their operations (Giffen, 2019) which triggers the need to explore its potential advancements.

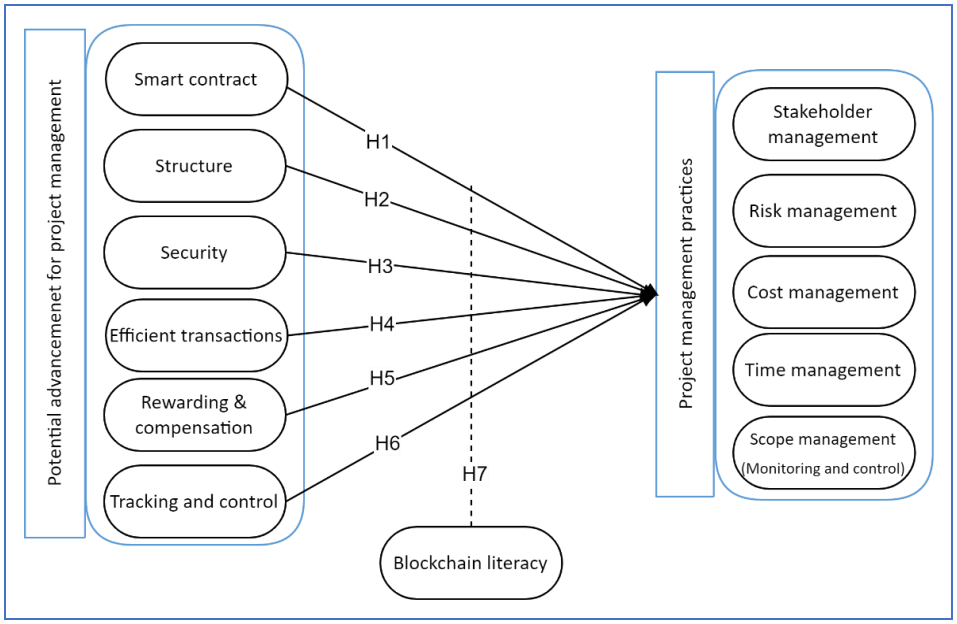

Figure 1. Theoretical framework.

H_1: Smart contracts have a positive effect on project management practices.

Advancements in blockchain technology have facilitated the innovation of smart project contracts. Smart project contracts are described as a computerized protocol with a warranted implementation through a decentralized blockchain code (Rokooei et al., 2022). A smart project contract allows contract clauses to be automatically executed without intermediaries (Snow, 2018). This unique capacity of blockchain can disrupt traditional project management paradigms that rely on centralized processes that need the existence of third parties (Lawrence, 2020). Smart contracts offer great potential to redesign traditional project management processes by effectively reducing service and administration costs and increasing efficiency and stakeholder trust by offering an automated trustless system.

H_2: Structure has a positive effect on project management practices.

Using blockchain changes the way of delineating, running and managing project work packages. Although project stakeholders and their structural positions remain similar, the practice of their roles will be changed (Rokooei et al., 2022). Using blockchain technology allows various points of entry to the project (e.g., data, thoughts, and solutions) that flatten the top-down project structure and allow transparency and timely engagement. It triggers the participation of all project stakeholders in the visioning of the project idea and promotes cooperation. The inputs and actions of each project stakeholder can be recorded and tracked which stands against any potential issues of evaluation and control. The top management support of wider engagement in a project blockchain is invaluable to achieve such benefits.

H_3: Security has a positive effect on project management practices.

As clarified in the previous hypothesis, participants in a project blockchain can introduce their inputs and contributions as much as they are allowed by the project manager or the top management (e.g., PMO). No other outsiders can enter the project blockchain to view or make any changes to project plans and documentations. This provides a fully secure context or environment for exchanging confidential information (e.g., evaluation results and

financial status) that is supported by highly safe and robust cloud storage systems. Therefore, project managers are more capable of identifying and addressing any information spill or security-related issues or risks, keeping projects more focused and secured.

H_4: Efficient transactions have a positive effect on project management practices.

Blockchain technology ensures fast, safe and identity-protected transactions through a decentralized setup. It documents transactions on peer-to-peer computer networks and is ideal for dealing with financial and non-financial transactions such as warranting completion of tasks, handling payments and sharing project information (Bagetta, 2021). A blockchain notes transactions on a distributed ledger where they are made highly secure through a cryptographic proof (Hewavitharana, Perera, Jin, Seneviratne, & Bamdad, 2024). New transactions are logged to the blockchain after a decentralized consensus. This protocol allows simultaneous storage of data on all nodes, which reduces the need for central stakeholder authority (Renwick & Tierney, 2020).

H_5: Reward and compensation have a positive effect on project management practices.

Blockchain rewards and compensations can enhance accountability, transparency, and motivation leading to better project management outcomes. Offering project rewards and compensations through blockchain reduces trust issues which encourages knowledge sharing among stakeholders and optimizes their performance (Esmaeilzadeh & Mirzaei, 2023). This triggers more engagement, commitment, and compliance, thus contributing to higher efficiency in fulfilling project needs and requirements (Garg et al., 2021). Blockchain-based incentives can additionally help manage complex projects and maintain sustainable project practices by rewarding ethical behaviors and fostering stakeholder extrinsic and intrinsic motivation (Ahmad, Abdulhamid, Wahab, Pervaiz, & Imtiaz, 2022; Malek, Sarin, & Haon, 2020).

H_6: Tracking and control have a positive effect on project management practices.

The continually accessible project blockchain on which information is automatically available provides all project stakeholders with a direct update about any adjustments to the project scope (e.g., ideas, needs, requirements, specifications and milestones). This reduces the complex process of distributing the updated project information which is concurrently flowing through the different project channels, leaving no room for fuzzy operations (Elghaish et al., 2020). It also reduces the time spent on distributing these updates as well as other unnecessary conversations about less related project matters (Buterin, 2015). This offers the project manager a holistic project view which allows efficient tracking of project progress and timely decision-making.

H_7: Blockchain literacy moderates the relationship between blockchain's features (H7.1: Smart contract, H7.2: Structure, H7.3: Security, H7.4: Efficient transactions, H7.5: Rewarding and compensation, H7.6: Tracking and control) and project management practices.

Project stakeholders with high blockchain literacy are better positioned to leverage or utilize the above explained blockchain features to enhance productivity. This allows stakeholders to make confident project decisions powered by better collaboration and more diverse information (Sonmez et al., 2021). High blockchain knowledge among stakeholders can leverage technological updates which helps cope with dynamic environments resulting in relevant project outcomes (Pan, Pan, Song, Ai, & Ming, 2020). This all generally reinforces the idea that blockchain literacy is critical to derive the optimal outputs of using blockchain within projects.

3. METHODOLOGY

3.1. Data Collection

Data collection spanned three months, from February to April 2024, giving the researchers enough time to reach project management professionals who are participating in recent blockchain implementations as well as to reach the expected sample size for conducting the analysis. Participants were invited to complete an online questionnaire administered through Google Forms. Data was collected from surveying a targeted sample through LinkedIn of project management professionals who use blockchain technology in their fields. Targeting people

with experience in project management and blockchain to fill out the questionnaire aimed at collecting quality responses as they can articulate when responding to the questionnaire items. Additionally, a referral method was employed to efficiently target relevant participants. Responses were gathered from 277 industry professionals, exceeding the minimum sample size threshold recommended for partial least squares structural equation modeling (PLS-SEM) (Hair, Hult, Ringle, & Sarstedt, 2022).

The selection of variables was adapted from previous empirical studies i.e., Akcora, Gel, and Kantarcioglu (2017); Bashir (2023); Trautman and Molesky (2019); Kerzner (2017) and Project Management Institute (2021). Based on these studies, the questionnaire items were adjusted to fit the context of this study.

Moreover, the questionnaire consisted of two parts: the first part was about demographic information, and the second part contained items to evaluate the variables of the study's model. A five-point Likert scale was used to measure responses. After receiving the responses, the analysis was executed through using PLS-SEM by the program Smart-PLS 4.0. The researchers use PLS-SEM for its suitability in analyzing complex models that have small-to-medium sample sizes. Similarly, PLS-SEM has less restriction regarding the normality assumptions of the data (Hair et al., 2022).

3.2. Data Analysis

The respondents' demographic profile in Table 1 provides a detailed overview of the study sample in categories like age, position, gender, education, experience, and country. The majority of respondents fall within the 30-39 age group (48.7%) followed by those aged 40-49 (29.2%). The sample is predominantly male with 90.3% identifying as such, and most hold a master's degree or equivalent (53.8%). In terms of professional roles, 41.5% of participants are categorized as "other" which may include a range of unspecified positions while 33.9% are team members. The project managers make up 19.5% of the sample, and PMO members constitute the smallest group at 5.1%.

Table 1. Respondents' profile.

Age group	Below 25	7	2.5%	Experience	1 to 3	41	14.8%
	25-29	27	9.7%		4 to 6	20	7.2%
	30-39	135	48.7%		7 to 9	54	19.5%
	40-49	81	29.2%		10 to 12	34	12.3%
	50 years and above	27	9.7%		Over 12	128	46.2%
Position	Team member	94	33.9%	Country	India	92	33.2%
	Project manager	54	19.5%		UAE	75	27.1%
	PMO	14	5.1%		Saudi Arabia	61	22.0%
	Other	115	41.5%		Jordan	14	5.1%
Gender	Male	250	90.3%		Egypt	9	3.2%
	Female	27	9.7%		Kuwait	5	1.8%
Education	Technical qualification	26	9.4%		United Kingdom	4	1.4%
	Undergraduate degree	41	14.8%		Zimbabwe	4	1.4%
	Master's degree or equivalent	149	53.8%		Australia	7	2.5%
	PhD	61	22.0%		Hungary	6	2.2%

Regarding experience and geographical distribution, nearly half of the participants (46.2%) have above 12 years of experience. Another significant portion has 7 to 9 years of experience (19.5%). Geographically, the sample is most represented by participants from India (33.2%) and UAE (27.1%) followed by Saudi Arabia (22.0%). Other countries are represented to a lesser extent with Jordan at 5.1%, and smaller representations from Egypt, Kuwait, the United Kingdom, Zimbabwe, Australia, and Hungary.

3.3. Measurement Model

Table 2 demonstrates strong internal consistency across all factors with Cronbach's alpha values ranging from 0.80 to 0.91, surpassing the commonly accepted threshold of 0.70 which indicates adequate reliability (Nunnally, 1978). The composite reliability (CR) values for all constructs are well above the recommended threshold of 0.70

ranging from 0.88 to 0.94 further validating the reliability of the constructs (Hair, Black, Babin, & Anderson, 2019). The average variance extracted (AVE) values for all factors exceed the threshold of 0.50 which indicates that each construct explains more than half of the variance in its indicators (Fornell & Larcker, 1981). Furthermore, all factor loadings exceed 0.80 which as stated by Hair et al. (2019) must be above 0.70 to determine that the items are good indicators of the construct.

Table 2. Convergent validity.

Factors	Items	Loadings	A	CR (rho_c)	AVE	(STDEV)	Mean
Rewarding and compensation	Comp1	0.825	0.80	0.88	0.71	1.089	3.057
	Comp2	0.853					
	Comp3	0.852					
Smart contract	Cont1	0.84	0.81	0.89	0.73	1.100	2.987
	Cont2	0.858					
	Cont3	0.861					
Cost management	Cst1	0.888	0.91	0.94	0.79	1.047	3.011
	Cst2	0.905					
	Cst3	0.87					
	Cst4	0.895					
Blockchain literacy	Litr1	0.857	0.90	0.93	0.78	1.048	2.982
	Litr2	0.898					
	Litr3	0.907					
	Litr4	0.866					
Risk management	Rsk1	0.851	0.89	0.93	0.76	1.107	2.970
	Rsk2	0.871					
	Rsk3	0.88					
	Rsk4	0.882					
Scope management	Scop1	0.866	0.90	0.93	0.78	1.073	3.042
	Scop2	0.896					
	Scop3	0.872					
	Scop4	0.895					
Security	Sec1	0.882	0.87	0.92	0.80	1.068	3.004
	Sec2	0.897					
	Sec3	0.898					
Stakeholder management	Stk1	0.861	0.90	0.93	0.76	1.032	3.087
	Stk2	0.885					
	Stk3	0.882					
	Stk4	0.871					
Structure	Strc1	0.909	0.91	0.94	0.79	1.042	3.052
	Strc2	0.877					
	Strc3	0.887					
	Strc4	0.887					
Time management	Tim1	0.889	0.90	0.93	0.78	1.034	2.955
	Tim2	0.89					
	Tim3	0.894					
	Tim4	0.856					
Efficient transactions	Tran1	0.816	0.84	0.89	0.68	1.032	3.083
	Tran2	0.817					
	Tran3	0.807					
	Tran4	0.846					
Tracking and control	Trk1	0.887	0.90	0.93	0.77	1.066	2.904
	Trk2	0.899					
	Trk3	0.86					
	Trk4	0.871					

Table 3 presents the results of Fornell and Larcker's (1981) criterion and the Heterotrait-Monotrait (HTMT) ratio. The Fornell-Larcker criterion for discriminant validity is met as each construct's square root of AVE (diagonal value) exceeds its correlations with other constructs (off-diagonal values), confirming discriminant validity (Fornell & Larcker, 1981). Furthermore, the values above the diagonal represent the HTMT ratio. All HTMT values are below 0.90 supporting discriminant validity (Henseler, Ringle, & Sarstedt, 2015).

Table 3. Fornell-Larcker & HTMT.

Factors	1	2	3	4	5	6	7	8	9	10	11	12
1. Blockchain literacy	***0.88***	0.75	0.34	0.33	0.80	0.76	0.78	0.46	0.76	0.84	0.79	0.88
2. Cost management	0.68	***0.89***	0.42	0.45	0.76	0.78	0.75	0.48	0.68	0.77	0.73	0.77
3. Efficient transactions	0.30	0.37	***0.82***	0.54	0.35	0.39	0.41	0.44	0.40	0.37	0.40	0.34
4. Rewarding and compensation	0.28	0.39	0.44	***0.84***	0.44	0.48	0.48	0.45	0.36	0.39	0.39	0.34
5. Risk management	0.72	0.69	0.31	0.37	***0.87***	0.78	0.86	0.47	0.72	0.80	0.74	0.78
6. Scope management	0.69	0.71	0.35	0.41	0.70	***0.88***	0.78	0.55	0.70	0.77	0.77	0.75
7. Security	0.70	0.67	0.35	0.40	0.76	0.70	***0.89***	0.50	0.73	0.76	0.72	0.75
8. Smart contract	0.40	0.41	0.37	0.37	0.40	0.47	0.42	***0.85***	0.46	0.47	0.39	0.45
9. Stakeholder management	0.68	0.62	0.35	0.30	0.64	0.63	0.65	0.40	***0.87***	0.73	0.77	0.75
10. Structure	0.77	0.71	0.33	0.33	0.72	0.70	0.68	0.40	0.66	***0.89***	0.79	0.83
11. Time management	0.72	0.67	0.36	0.33	0.66	0.69	0.64	0.33	0.69	0.71	***0.88***	0.78
12. Tracking and control	0.79	0.70	0.30	0.29	0.70	0.68	0.66	0.38	0.67	0.75	0.71	***0.88***

Note: Numbers in bold italic are the square root. Numbers below the square root represent Fornell and Larcker's (1981) criterion, numbers above the square root represents the HTMT ratio.

3.4. Structural Model

Table 4 and Figure 2 present the results of hypothesis testing for the impact of blockchain sub factors on project management practices. The variance inflation factor (VIF) values for all variables ranged from 1.54 to 3.43 which are below the threshold of 5.0 (Hair et al., 2019). Thus, it is concluded that there is no multicollinearity between variables. Additionally, the model explains 87% of the variance of project management practices.

Hypothesis testing results showed that all variables have significant and positive effects on project management practices with p-values below 0.05; therefore, hypotheses (H1 to H6) were accepted. The effect of security on project management practices (H3) has the strongest effect with a β value of 0.193 and an effect size (f^2) of 0.11. According to Cohen (2013) this indicates a medium effect size, suggesting that security plays a substantial role in influencing project management practices. Structure (H2) and tracking and control (H6) also have notable effects with β values of 0.153 and 0.152, respectively, and corresponding f^2 values of 0.05 each, indicating small but meaningful effects. Efficient transactions (H4), rewarding and compensation (H5), and smart contract (H1) have slightly smaller effects with β values ranging from 0.078 to 0.097 and f^2 values between 0.03 and 0.04 consistent with a small effect size (Cohen, 2013). The results revealed that each potential of blockchain contributes to project management practices in its own right. Security's largest effect emphasizes that a secure environment is not just an add-on but a core element. The roles of structure and tracking and control, though slightly less impactful than security, still show that a well-organized framework and consistent oversight are important for keeping projects aligned with their objectives. Meanwhile, efficient transactions, rewarding and compensating and smart contracts while exhibiting smaller effects individually, they add value by enhancing operational efficiency and motivating team performance.

Table 4. Hypotheses testing.

No.	Path	VIF	f^2	β	Confidence intervals		STDEV	T-value	P- value	Result
1	Smart contract → PMP	1.71	0.03	0.078	0.009	0.140	0.033	2.348	0.019	Accepted
2	Structure → PMP	3.35	0.05	0.153	0.072	0.232	0.041	3.754	0.000	Accepted
3	Security → PMP	2.64	0.11	0.193	0.118	0.267	0.038	5.015	0.000	Accepted
4	Efficient transactions → PMP	1.54	0.04	0.092	0.035	0.149	0.029	3.152	0.002	Accepted
5	Rewarding and compensation → PMP	1.65	0.04	0.097	0.032	0.159	0.032	2.989	0.003	Accepted
6	Tracking and control → PMP	3.43	0.05	0.152	0.065	0.239	0.045	3.413	0.001	Accepted

Note: PMP: Project management practices.

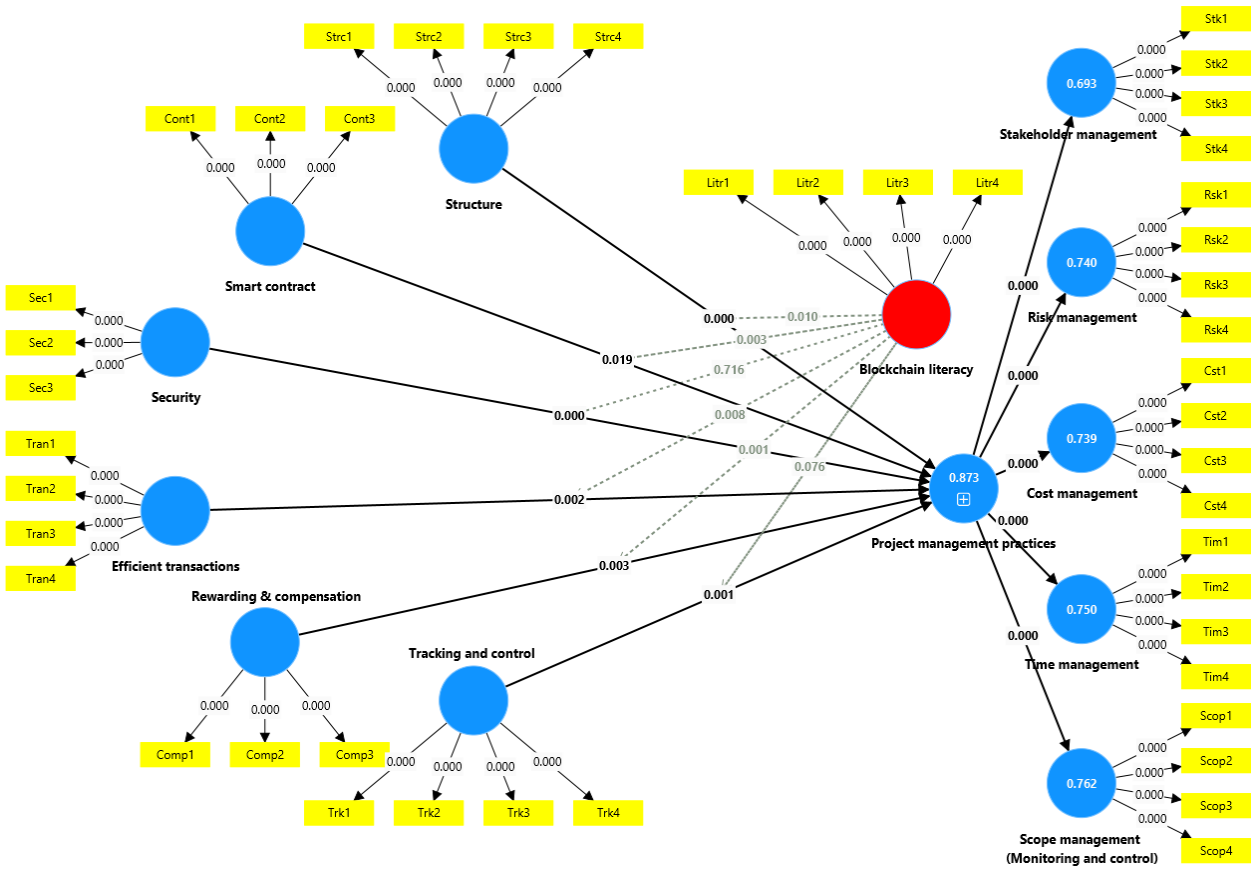

Figure 2. Structural model.

Table 5 presents the results of the moderation hypotheses testing, focusing on whether blockchain literacy moderates the relationships between various factors and project management practices. The effect sizes (f^2) for the accepted moderation hypotheses (H7.1, H7.2, H7.4, and H7.5) ranged from 0.03 to 0.04 indicating small but meaningful moderating effects (Cohen, 2013) where f^2 values above 0.02 represent small effects.

Table 5. Moderation hypotheses.

	Path	f^2	β	Confidence intervals		STDEV	T value	P value	Result
7.1	Blockchain literacy x smart contract → PMP	0.03	0.072	0.117	0.021	0.024	2.964	0.003	Accepted
7.2	Blockchain literacy x structure → PMP	0.03	0.134	0.029	0.232	0.052	2.572	0.010	Accepted
7.3	Blockchain literacy x security → PMP	0.00	0.021	-0.137	0.089	0.057	0.364	0.716	Rejected
7.4	Blockchain literacy x efficient transactions → PMP	0.03	0.077	0.138	0.023	0.029	2.648	0.008	Accepted
7.5	Blockchain literacy x rewarding and compensation → PMP	0.04	0.098	0.158	0.039	0.030	3.223	0.001	Accepted
7.6	Blockchain literacy x tracking and control → PMP	0.01	0.098	-0.009	0.204	0.055	1.777	0.076	Rejected

Note: PMP: Project management practices.

Blockchain literacy significantly moderates the impact of smart contract (H7.1), structure (H7.2), efficient transactions (H7.4), and rewarding and compensation (H7.5) on project management practices. The most substantial moderation effect is observed in the relationship between blockchain literacy and structure (H7.2) with a β of 0.134 and a t-value of 2.572 ($p = 0.010$) indicating that blockchain literacy enhances the positive impact of structure on project management practices. Similarly, blockchain literacy positively influences the effects of smart

contract (β = 0.072, p = 0.003), efficient transactions (β = 0.077, p = 0.008), and rewarding and compensation (β = 0.098, p = 0.001). In other words, organizations with higher levels of blockchain understanding are better equipped to leverage these innovative tools for improving their project management practices.

However, the moderation effects of blockchain literacy on the relationships between security (H7.3) and tracking and control (H7.6) with project management practices are not significant. The non-significant p-values (p = 0.716 for H7.3 and p = 0.076 for H7.6) and low f^2 values (0.00 for H7.3 and 0.01 for H7.6) indicate that blockchain literacy does not moderate these relationships.

4. DISCUSSION

This study reveals a strong relationship between blockchain technology (smart contracts, structure, security, efficient transactions, rewards and compensation, and tracking and control) and the efficiency of project management practices. The results of the study suggest that blockchain can enhance different aspects of project management due to its decentralized and secure nature. Such results were outlined in Renwick and Tierney's (2020) study as they found that blockchain could greatly enhance performance across transparency, control, dynamic status updating, incentives, and trust. The study emphasized that blockchain is to be considered as the technological foundation for the next generation of project management approaches. Those findings also aligned with the study of Al-Faouri, Al-Bazaiah, Alnsour, Abuanzeh, and Alshurideh (2023) as the authors highlighted how decentralized digital infrastructures can enhance collaboration, operational transparency, and cost efficiency in project environments.

The results confirm that using smart contracts improve project outcomes by automating the enforcement of shareholder agreement without the need for intermediaries, thus speeding the workflows at a lower cost. This result came in agreement with the study of Xu, Chong, and Chi (2021) that found smart contracts optimize manual processes and help manage complex projects. The study also found that the decentralized blockchain structure improves project governance by enhancing flexibility and reducing reliance on hierarchical decision-making. This study highlights how blockchain fosters more inclusive decision-making and rapid stakeholder alignment, offering empirical support for decentralized governance models proposed in earlier studies and reaffirmed in recent empirical work by reducing the hierarchical constraints (Wehbe & Popescu, 2022). It also allows stakeholder to cooperate and manage and engagement, and enhances project tracking in a timely manner.

In addition, the study results found that blockchain security has the strongest effect on project management practices. Security is critical to ensure a safe context for exchanging confidential information among stakeholders. This explains prior works that results in blockchain significantly improves quality in project management, enhancing data traceability, reliability, and security (Alkhudary & Gardiner, 2024). This finding was consistent with the study by Lohmer, Ribeiro da Silva, and Lasch (2022) which explained that security mechanisms prevent unauthorized access or misuse of information.

Efficient transactions had a slightly smaller effect but still maintained a positive impact on project management. The decentralized setup ensured fast, secure, and identity-protected transactions and it also reduced project risks and delays. The results support arguments regarding blockchain's capacity to reduce transaction costs and expedite processes by Casino et al. (2019).

Another finding indicated that blockchain-based reward and compensation systems enhance project motivation and transparency while also increasing stakeholder compliance. This system ensures a fair and transparent distribution of rewards and compensations based on predefined criteria in the system. These results are consistent with those of Zheng et al. (2017) indicating that blockchain compensation reduces disputes and triggers better team morale by automatically rewarding team members when specific milestones are reached. It also aligned with A. Kumari et al. (2023) indicating that automated incentive mechanisms can alleviate common coordination and motivation challenges in complex projects.

Blockchain tracking and control had a notable effect on project management keeping immutable records valuable for monitoring and controlling project progress and ensuring that all activities are logged accurately. This study supports the notion that blockchain improves complex projects with multiple phases of accountability by providing an unchangeable audit trail (Tapscott & Tapscott, 2016).

The moderation analysis of blockchain literacy provided several valuable insights. Blockchain literacy strongly increased the positive impact of decentralized structures on project management practices, allowing project managers to realize the structural advantages of blockchain. However, it did not affect the impact of security and tracking and control which means that these features work independently of user expertise. This could be interpreted as a sign that the blockchain's security mechanisms and tracking tools have their base robust and intuitive to technological design rather than being dependent on a user's proficiency level (Saberi, Kouhizadeh, Sarkis, & Shen, 2019).

On the other hand, it was found that blockchain literacy influenced only a part of smart contracts, efficient transactions, and automatized rewards and compensations. In fact, it indicated that even though user knowledge may improve its application, those features do not strongly revolutionize project management outcomes. Therefore, these findings are consistent with other previous works (El Khatib, Beshwari, Beshwari, & Beshwari, 2021) that emphasized how certain blockchain-related functions are more sensitive to user experience than others, hence requiring focused training and educational interventions in organizational settings. At the same time, the results also showed that in blockchain, security and tracking functions are designed in ways that are user-friendly and hence do not require very high levels of literacy to be effectively put into action (Tapscott & Tapscott, 2016).

5. CONCLUSION

This research used a feature-based analysis to identify the potential benefits of blockchain in enhancing project management practices. The results show that security had the highest impact on project management practices, while structure and tracking and control showed significant impacts. Efficient transactions, reward and compensation systems, and smart contracts had a minor impact on project management practices.

Furthermore, the moderation of blockchain literacy denied the influence of security and tracking and control on project management due to no effect from the moderator. On the other hand, the moderator overly influenced structure, which in turn overemphasizes its influence on project management practices. These findings give further emphasis to gradients at which blockchain influences project management practices based on both its core elements and blockchain literacy as a moderating factor.

One of the key contributions of this study is the focus on blockchain literacy which demonstrates that greater blockchain literacy significantly strengthens the effect of structure on project management practices. However, the results indicate that blockchain literacy does not moderate the effects of security and tracking and control, suggesting that these features operate independently of user knowledge.

Overall, the results encourage further research into blockchain's role in project management, particularly focusing on the importance of education and training to optimize its structural advantages and enhance its adoption in relevant project areas.

The findings encourage project managers to take advantage of blockchain's decentralized structure since this greatly improves project transparency and enhances efficiency in project execution. Moreover, blockchain literacy plays a very important role in amplifying the effect of the decentralized structure. Thus, it is recommended that organizations should equally invest in training programs for effective adoption. On the contrary, though the highest impact was imposed by security on project management, its strength remained independent of user expertise, showing that built-in security mechanisms within blockchain are inherently strong and do not depend on advanced literacy for implementation. These findings showed the partial effect of blockchain's influence on project management, as a function of its core capabilities and the moderating role of blockchain literacy.

In the future, more research should be conducted to build upon these findings, particularly by examining how blockchain literacy enhances the use of decentralized structures in project management. Further research could also be underpinned by a comparative approach that could consider how blockchain influences traditional, hybrid, and agile project settings as a means to provide a wider perspective on its adaptability and effectiveness at improving project structures.

5.1. Practical Implications for Organizations

Organizations can enhance their blockchain adoption strategies by focusing on areas that will bring maximum benefits in project management. For example, investment in blockchain literacy training is necessary to meet the needs of decentralized structures that enable project managers to fully exploit blockchain in enhancing collaboration, transparency, and workflow efficiency. This should be followed by the use of blockchain to foster decentralized collaboration through seamless communication and decision-making across teams that are geographically dispersed to reduce dependence on hierarchical structures.

As the highest impact was on the security of project management practices but not influenced by blockchain literacy, organizations should put more emphasis on automated blockchain security solutions rather than extensive training. Blockchain-based tracking and control systems can be applied to further develop project monitoring and transparency, though keeping such a system user-friendly so that staff can benefit without advanced technical knowledge. Lastly, organizations should approach blockchain adoption strategically, focusing on structural advantages over minor-impact features such as smart contracts and efficient transactions. This will be furthered by integrating blockchain into areas where the organizations can see the most tangible benefits, enhancing governance, workflow efficiency, and stakeholder trust in project execution.

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