

A Decision-Oriented MCDA Framework for Comparative Evaluation of Blockchain Platforms

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Abstract

Blockchain platforms have been established as essential infrastructures of decentralized applications and enterprise systems; however, choosing between different blockchain platforms is still considered an inherently complicated decision-making problem due to various trade-offs of scalability, security, interoperability, governance, and ecosystem development. Prior studies on the topic have been predominantly concerned with individual technical attributes and provided little structured assistance in making decisions. In this research, a decision-making Multi-Criteria Decision Analysis approach utilizing TOPSIS will be proposed to evaluate and rank nine different blockchain platforms: Ethereum, Hyperledger Fabric, Polkadot, Solana, Cardano, Algorand, Quorum, Corda, and BNB Chain. Based on the results, Polkadot emerges as the top choice with a closeness coefficient of 0.5760, while Ethereum (0.5717) and Hyperledger Fabric (0.5512) occupy second and third places respectively, proving the role played by the interoperability and maturity of an ecosystem in selecting a general-purpose platform. In the enterprise supply chain traceability case study, Hyperledger Fabric takes the lead with 0.82, followed by Corda (0.78) and Quorum (0.72), showing that permissioned governance and privacy are more appropriate in regulated settings. Sensitivity analysis demonstrates that the rankings are stable under all three scenarios – performance, governance and sustainability.

Keywords: Blockchain Platforms, Digital Transformation, Sustainable Development, TOPSIS, Multi-criteria Decision Analysis, Interoperability.

Introduction

Blockchain technology has evolved from an innovation oriented towards its specific uses in cryptocurrency-related applications to a core technology in any solution where decentralization is a must, either in enterprise-scale systems or cross-organizational information exchange schemes (Khan et al., 2021). The use of blockchain is growing into such areas as finance, logistics, healthcare services, and governance, and thus the selection of a platform on which one would like to build becomes a complex task owing to substantial dissimilarities between blockchains in terms of their architecture, consensus, scalability, governance, interoperability capabilities, and development ecosystem maturity.

Certainly, there have been many studies published with respect to various aspects of blockchain research, including architecture, performance characteristics, and use cases; however, all such efforts were mostly limited to analysis of individual performance parameters such as throughput and latency, with no consideration of governance, interoperability, robustness, and maturity of the development environment (Zheng et al., 2017; Yli-Huomo et al., 2016).

Thus, it is proposed to conduct an MCDA-based assessment of the blockchain platforms using architectural aspects, performance measures, capability of supporting smart contracts, interoperability, security and governance, development ecosystem maturity, and use-case suitability, employing the TOPSIS methodology. Such evaluation will include robustness analysis in relation to different priority alternatives concerning performance, governance, and sustainability.

The rest of the paper will be structured as follows: Section 2 presents the literature review on comparison of blockchain platforms and decision-making techniques. Section 3 presents the technical analysis of nine selected platforms. Section 4 will present the research methodology and the TOPSIS technique. Section 5 provides results and analyses. Section 6 will discuss the results of the supply chain case study. In Section 7, the evaluated platforms are analyzed. Section 8 discusses the findings and practical implications. Section 9 concludes the paper and outlines future research directions.

Related Work

A remarkable surge in the number of studies focused on blockchain technology and its various aspects has been observed as a consequence of the rapid uptake of blockchain technology and its increasing significance in the contemporary digital age. In light of the high volume of studies conducted regarding blockchain technology in recent years, the literature can be classified into four broad areas based on previous research: (i) comparison among blockchain technologies, (ii) scalability/performance studies, (iii) governance/interoperability/sustainability studies, and (iv) decision-support studies.

Comparative analysis of architecture and functionalities of blockchain platforms has been performed descriptively. In a study an overview was presented on architecture, consensus, and future trends of specific platforms, whereas focused on comparison of functionality, consensus, and performance in several blockchain platforms, without any framework for structured decision making (Xu et al., 2017). In the work applications of blockchain technology were compared according to domains (supply chain, healthcare, etc.) to recognize trends and shortcomings, without a structured decision-making approach (Ferdous et al., 2021). There has been no research focusing on scalability and sustainability challenges in blockchain protocols, only implementation platforms.

Benchmarks include transactions, latency, and scalability. The study developed Block bench for private blockchains (Ethereum, Hyperledger Fabric, Quorum) in order to prove the existence of performance problems (Baliga et al., 2018). These studies reviewed the scalability and finality of Byzantine Agreement of Algorand and Proof of History of Solana in a quantitative way, ignoring the aspects of governance, maturity of development, and multi-chain blockchains (Chen & Micali, 2019; Gilad et al., 2017). The results of the benchmarks are influenced by deployment, workload, and network; thus, benchmarking alone is not an option (Thakkar et al., 2018).

Interoperability and governance are crucial for multi-parties. It outlined benchmarks for communication and security collaboration, such as Polkadot's multi-chain systems. Forms of governance differ, with Cardano's Ouroboros providing formalized governance; Ethereum using decentralized community-based governance; and Fabric and Corda implementing consortiums with identity management for regulatory compliance. Energy efficiency and sustainability through proof of stake rather than proof of work are paramount, but analyses lack attention to governance and scalability.

There are very few research papers using the techniques of decision support, such as AHP and TOPSIS, for blockchain selection due to their extensive use in engineering and logistics fields. Very little application of MCDA exists in the

implementation of blockchain for adoption purposes in areas like logistics and health care, where the number of blockchains is limited and uses expert opinion rather than data.

Table 1 summarizes key limitations of existing studies and positions the contribution of this research.

Table 1: Comparison of Existing Blockchain Evaluation Studies

Aspect	Existing Studies	Present Study
Number of platforms	Limited (2-4)	Nine major platforms
Evaluation dimensions	Isolated metrics	Seven Comprehensive metrics
Decision-support model	Mostly absent	TOPSIS-based MCDA
Sensitivity analysis	Rare	Included
Empirical validation	Limited or none	Benchmark and case-based validation
Sustainability perspective	Implicit	Explicit

From this analysis, it is clear that this study fills the gaps identified in the existing body of knowledge by proposing a universal decision-oriented framework for the evaluation of blockchain platforms. The proposal for this framework is based on a combination of MCDA and comparative studies to ensure empirical support.

Technical Overview of Selected Blockchain Platforms

Distinct blockchain technologies with varying network designs, consensus mechanisms, execution paradigms, and governance models lead to different performances, scalability, and adaptability of the blockchains to various use cases. A technical introduction to the selected blockchain platforms is presented below to serve as an introductory point before proceeding further into comparisons.

Ethereum

The Ethereum blockchain platform utilizes the EVM with an account-based design and Solidity for building dApps through smart contracts in a public, permissionless network (Gencer et al., 2018). The transition of Ethereum 2.0 from PoW to PoS consensus leads to better scalability and energy efficiency, and validators stake tokens to mine and validate blocks for fee rewards. There are many available dApps, but base-layer scalability issues are addressed with Layer-2 solutions.

Hyperledger Fabric

Hyperledger Fabric, targeted at enterprise use, places focus on scalability, privacy, and modularity. The modularity aspect allows a variety of consensus choices (such as PBFT and Raft consensus) for achieving higher throughput and lower latency. The execute-order-validate model outperforms order-execute in terms of performance. Chaincode development can be done in Go or JavaScript.

Solana

Solana's scalability is achieved using Proof of Stake with Proof of History (PoH), which is a cryptographically secure way of updating the ledger. Smart contracts use Rust and C, which are appropriate for DeFi and real-time applications. Scalable solutions require highly powered machines, thus creating difficulties related to decentralization.

Polkadot

Polkadot allows interoperability between multiple chains. The relay chain ensures security; parachains work as interconnected parallel blockchains. Nominated Proof of Stake (NPoS) protocol includes nominators choosing validators, thus ensuring scalability through load balancing. The Substrate framework helps build custom blockchains.

Cardano

Cardano's priorities include security, scalability, and sustainability. Security is provided by Ouroboros Proof of Stake, which has been formally proven to be secure. Layering helps to separate settlements and computation to enable scalability. Finally, smart contracts based on formal verification are provided by Plutus.

Algorand

Public blockchain Algorand provides solutions for scaling, security, and decentralization through the use of PPoS, where validators picked by stake-weighted random choice lead to quick confirmation and lower latency (Chaudhury & Haney, 2022). A virtual machine enables the use of smart contracts and dApps.

Quorum

Quorum is an Ethereum-based platform intended for use in enterprises. It provides privacy and increased efficiency alongside EVM compatibility. Algorithms for consensus, such as IBFT and Raft, make Quorum more efficient in conducting transactions compared to other networks based on Ethereum. In this platform, private transactions can only be seen by the transaction participants, and thus, this platform is good for banking and enterprise purposes.

Corda

Corda provides services for business and finance applications. Information about transaction details is shared between the relevant parties, while notarizations provide local prevention of double-spend problems. Smart contracts are written in Kotlin and Java programming languages.

BNB Chain

Formerly referred to as Binance Smart Chain, this platform provides scalable dApps (Yusandika et al., 2025). The system uses Proof-of-Staked Authority, a consensus model that combines proof of stake and staking. Being EVM compatible, this system allows for the creation of Ethereum smart contracts with very little modifications due to faster transactions and cheaper gas costs. Table 2 expresses the technical characteristics of selected blockchain platforms.

Table 2: Technical Characteristics of Selected Blockchain Platforms

Platform	Type	Consensus	TPS	Smart Contracts	Governance
Ethereum	Public	PoS	15–30	Solidity	EIPs
Fabric	Permissioned	Raft/PBFT	3000+	Go/Node	Consortium
Solana	Public	PoH+PoS	50k+	Rust	Validator
Polkadot	Public	NPoS	1000+	Substrate	On-chain
Cardano	Public	Ouroboros	250	Plutus	On-chain
Algorand	Public	PPoS	1000	TEAL	Foundation
Quorum	Permissioned	IBFT	1000	Solidity	Consortium
Corda	Permissioned	Notary	1000	Kotlin	Consortium
BNB	Public	PoSA	2000	Solidity	Validator

Research Methodology

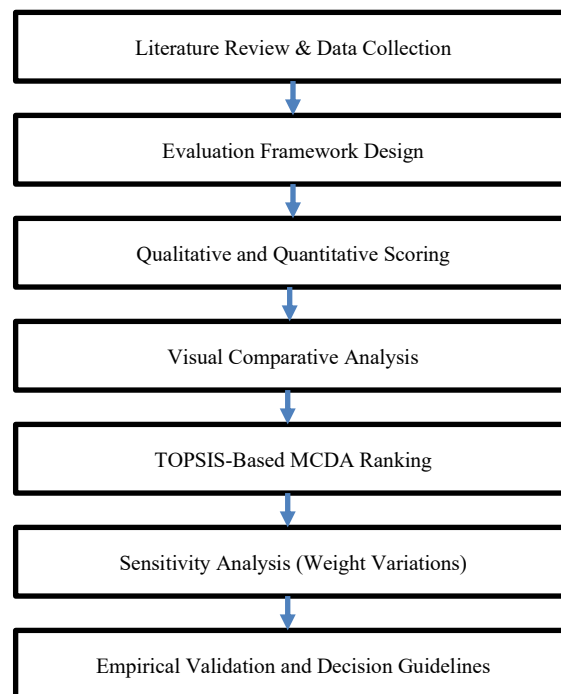


Fig. 1: Overall Methodological Workflow for Blockchain Platform Evaluation

A multi-criteria approach implies the integration of decision models that incorporate both quantitative analysis and qualitative comparative analysis in order to address the diversity of blockchain solutions and facilitate an objective selection by allowing some trade-offs regarding technologies, governance, and sustainability aspects. As shown in fig. 1, there are the stages that have been completed during the research: literature review, information collection, construction of the framework, evaluation, visualization, ranking using the TOPSIS approach, and validation.

Framework Design and Evaluation Dimensions

For this purpose, seven criteria are proposed, which were found out through literature research, benchmarking, platform documentation analysis, and industry insights: architectural aspects (modularity, scalability, and flexibility), performance (throughput, latency, efficiency of the consensus algorithm), smart contracts (programmability and maturity of the contract executions, support for dApps), interoperability (interactions with other chains), security and governance (consensus algorithm, fault tolerance, and governance model), ecosystem development (community engagement, available tools and tools for adoption), and application areas (enterprise, finance, governance, etc.).

In order to compare and rank solutions based on their similarity to the ideal and ant-ideal solutions, the TOPSIS approach is used in this multi-criteria approach.

Data Sources and Evidence Collection

The combination of triangulated data gathered through scholarly articles, white papers, benchmarks (Blockbench, Hyperledger Caliper), developer statistics (GitHub projects and SDKs), and case studies reduces the subjectivity and increases objectivity.

Qualitative and Quantitative Scoring Procedure

Normalized scores are determined for each platform on a scale of 1-10; quantitative criteria (like transactions per second, finality), are normalized directly, whereas qualitative criteria (such as open-source governance), are normalized based on agreement in the scientific literature. This approach allows comparing platforms based on various criteria.

Visual Comparative Analysis

Visualization through bar charts helped demonstrate the multi-dimensional advantages and drawbacks of the analyzed blockchain platforms. Bar charts were used for analysis of TOPSIS closeness coefficients, along with ranking results, while the heatmap technique allowed analyzing platform differences at the level of criteria. Such visualizations (Fig. 2-4) provide additional information on capabilities of the blockchain platforms under assessment within the quantitative framework.

Multi-Criteria Decision Analysis Using TOPSIS

TOPSIS approach is used to identify the ranks of blockchain platforms depending on their proximity to an optimal solution. The evaluation procedure involves constructing the decision matrix, normalizing the evaluation scores, computing weighted scores, determining the ideal and negative-ideal solutions, computing separation distances, and estimating the closeness coefficient.

The decision matrix $D = [x_{ij}]$ is defined as equation (1):

$$D = [x_{11} \cdots x_{1n} \vdots \vdots x_{m1} \cdots x_{mn}] \quad (1)$$

Where x_{ij} represents the performance score of platforms A_i with respect to criterion C_j .

The normalized decision matrix is calculated as equation (2):

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}^2}} \quad (2)$$

Where r_{ij} represents the normalized score of platforms A_i for criterion C_j .

The weighted normalized matrix is obtained by multiplying each of the normalized values by the associated criterion weights are shown in equation (3):

$$v_{ij} = w_j \times r_{ij} \quad (3)$$

The positive ideal solution and negative ideal solution are defined as equation (4) and (5):

$$A^+ = \{(v_{ij}) \mid j \in J\} \quad (4)$$

$$A^- = \{(v_{ij}) \mid j \in J\} \quad (5)$$

The separation distances of each platform from the ideal and negative-ideal solutions are calculated as equation (6) and (7):

$$S_i^+ = \sqrt{\sum_{j=1}^n (v_{ij} - v_j^+)^2} \quad (6)$$

$$S_i^- = \sqrt{\sum_{j=1}^n (v_{ij} - v_j^-)^2} \quad (7)$$

The relative closeness coefficient C_i^* is given by equation (8):

$$C_i^* = \frac{S_i^-}{(S_i^+ + S_i^-)}, 0 \leq C_i^* \leq 1 \quad (8)$$

Higher closeness coefficient values indicate stronger proximity to the ideal solution and greater overall platform suitability.

Illustrative TOPSIS Example

To present how to normalize data, to use weights for evaluation, and how to rank platforms by applying the TOPSIS method, a concrete example was shown based on the three blockchain systems under study — Ethereum, Hyperledger Fabric, and Solana are shown in table 3. This simple example was chosen to show the applicability and validity of the proposed multi-criteria decision-making technique to evaluate the platforms with consistent general approach to blockchain technology assessment.

Table 3: Compact Illustrative TOPSIS Decision Matrix

Platform	Performance	Ecosystem	Security	Interoperability
Ethereum	8	10	9	7
Fabric	9	8	9	6
Solana	10	7	7	5

It can be concluded from the findings that platforms demonstrating good performance levels in numerous parameters have higher suitability than those only concentrated on the parameters of throughput.

Sensitivity Analysis

A sensitivity analysis was performed to determine how sensitive the ranking system is in terms of the boundaries of responsiveness to changes in stakeholder priorities. In detail, the weights were changed to consider the priorities in the form of preference to performance, governance, interoperability, and sustainability. It was not required for the ranking to be invariant because it implies that the model is insensitive to any change in criteria weights.

Results and Analysis

Decision Matrix Construction

Table 4: TOPSIS Decision Matrix (Literature-Derived Scores)

Platform	Arch	Perf	Smart	Interop	Sec	Ecosys	UseCase
Ethereum	8	6	9	7	8	10	9
Fabric	9	9	8	6	9	8	9
Solana	7	10	8	5	7	7	8
Polkadot	9	7	7	10	8	6	8
Cardano	8	6	7	6	9	7	8
Algorand	7	8	6	5	9	5	7
Quorum	8	7	9	5	8	6	8
Corda	8	7	6	4	10	6	10
BNB	6	8	8	6	6	8	7

Table 4 has been developed through benchmarking from various scholarly sources, whitepapers of the particular platform companies, and from ecosystems such as GitHub (January 2026). The ratings are assigned to the platforms in accordance with their TPS (transactions per second). For example, the blockchain platform Solana, which has 65k TPS capacity, is ranked tenth because it crosses the highest threshold. Hyperledger Fabric, with 3.5k TPS capacity,

falls within the high-performance enterprise tier (3,000 to 50,000 TPS) and is rated at number 9. Similarly, the Ethereum base layer network, operating with an average baseline of about 20 TPS capacity, is assigned a score of 6. The maturity level of respective blockchain ecosystems has been determined based on the involvement of developers in more than 3,500 blockchain platforms.

Fig. 2 represents comparison among the seven criteria. In that, Ethereum and Hyperledger Fabric stand out for architecture and ecosystem capabilities, and Polkadot does well for interoperability capability. Fig. 3 represents the score variation heat map among platforms and criteria.

In order to make consistent comparisons among various criteria, the scoring system ranged from 0 to 10. This scoring system was used to assign scores to platforms based on benchmarking, architectural considerations, ecosystem development, and platform documents.

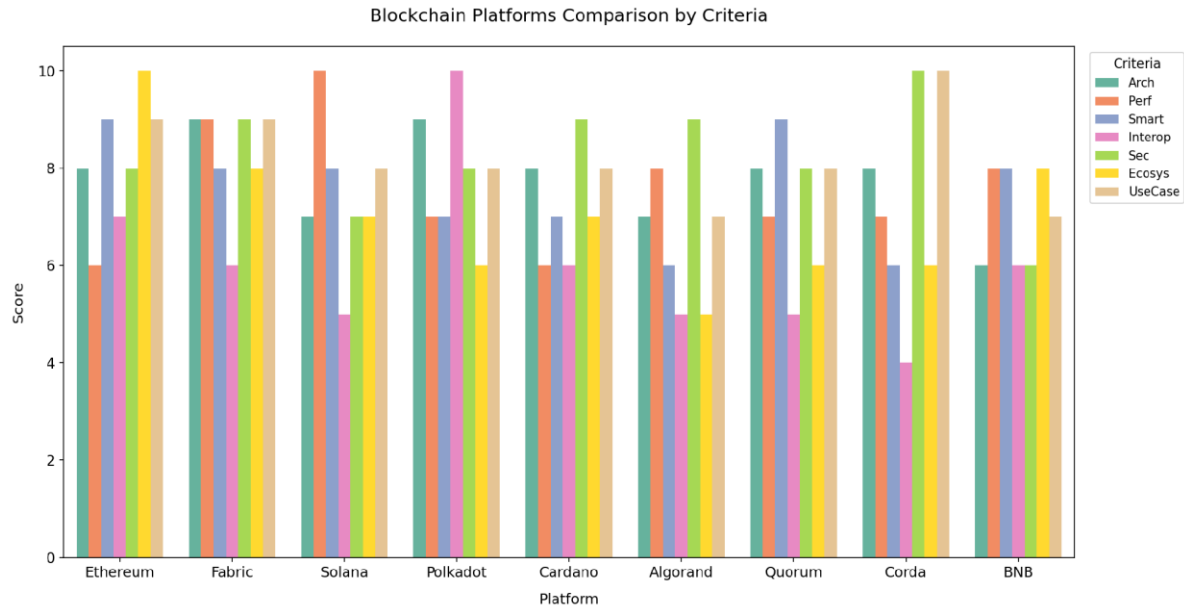


Fig. 2: Comparative Analysis of Nine Blockchain Platforms Across Evaluation Criteria

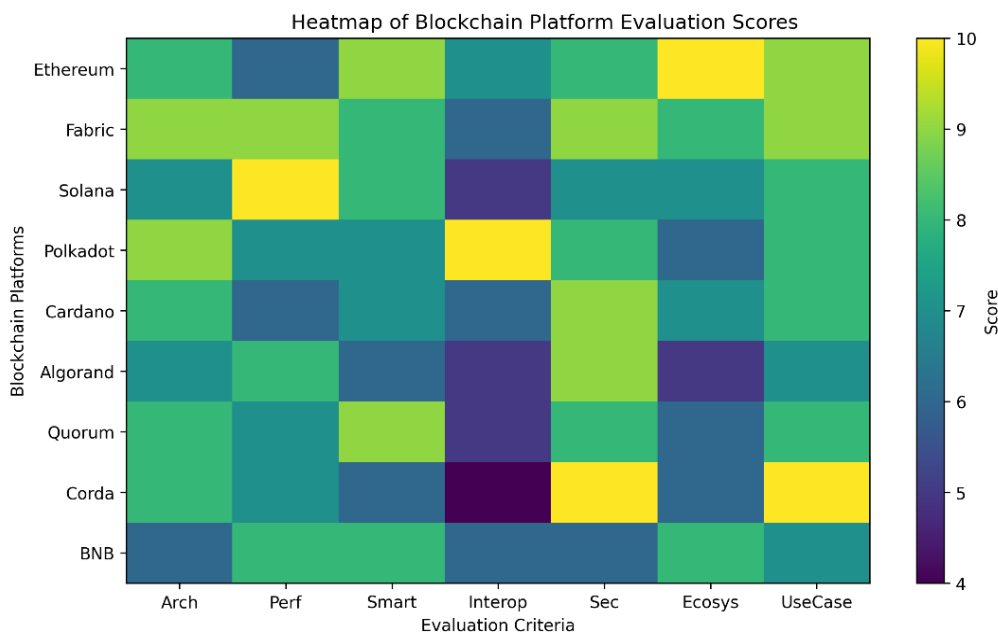


Fig. 3: Heatmap Visualization of Blockchain Platform Evaluation Scores Across Decision Criteria

Criteria Definition

The evaluation framework will be based on the following assessment criteria:

- Arch (Technical Architecture): Evaluates modularity, flexibility, scalability designs and permissions/permissionless capabilities in accordance with the technical architecture specification.
- Perf (Performance): Transaction throughput per second (TPS) and transaction latency will be evaluated through benchmarking approaches including Block bench and Hyperledger Caliper.
- Smart (Smart Contract Capability): Evaluates the level of programmability, execution environment (Ethereum Virtual Machine - EVM, Web Assembly - WASM) and programming languages supported.
- Interop (Interoperability): Evaluates the ability to perform cross-chain transactions and interoperability capabilities of the platform.
- Sec (Security and Governance): Evaluates the level of consensus and fault tolerance, focusing on consensus architecture and security considerations.
- Ecosys (Ecosystem Maturity): Evaluates level of developer engagement, community development and platform tool support through GitHub repository and ecosystem analysis.
- UseCase (Domain Suitability): Evaluates suitability for different industry applications in finance, logistics and enterprises etc.

Data Sources and Evidence Base

The evaluation procedure makes use of several validated data sources to remain objective as presented in table 5.

Table 5: Data Sources and Scoring Basis

Criterion	Data Source	Scoring Basis
Perf	Blockbench, Caliper (Dinh et al., 2017)	TPS, latency benchmarks
Ecosys	GitHub API (Androulaki et al., 2018)	Stars, forks, contributors (Jan 2026)
Arch	Whitepapers (Correia et al., 2024)	Modularity and architectural design
Smart	Platform documentation (Sedlmeir et al., 2020)	VM support, programming languages
Interop	Cross-chain studies (Zamyatin et al., 2021)	Native vs bridge mechanisms
Sec	Consensus literature (Kiayias et al., 2017)	Security guarantees and fault tolerance
UseCase	Literature review (Casino et al., 2019)	Domain adoption and applicability

Scoring Protocol

An objective scoring scale was used to provide consistency within the criteria:

- 10 – Industry-leading performance (best-in-class capability)
- 8–9 – Strong performance (top-tier platforms)
- 6–7 – Moderate performance (industry average)
- 4–5 – Below average capability
- 0–3 – Limited or immature capability

This makes it possible to compare heterogeneous criteria with consistent relative differences among various platforms.

Quantitative Score Mapping

In order to maintain uniformity while making evaluations, quantified values were established for important criteria that can be measured. The Performance Score is generated by the transaction throughput range, with score distribution in table 6.

Table 6: TPS Ranges

TPS Range	Score
> 50,000	10
3,000 – 50,000	9
1,000 – 2,999	8
100 – 1,000	7
< 100	6

Maturity of the ecosystem is determined by means of GitHub metrics as mapped out in table 7.

Table 7: GitHub Activity Score

GitHub Activity	Score
> 100k stars	10
20k – 100k	8–9
< 20k	6–7

Interoperability rating depends on cross-chain communication capability. The breakdown of these capabilities and their associated point values can be found in table 8.

Table 8: Capability Score

Capability	Score
Native interoperability (e.g., Polkadot)	10
Bridge-based interoperability	7–8
Limited or no interoperability	5–6

Security rating is determined based on consensus mechanism strength and fault tolerance, as outlined in table 9.

Table 9: Security Feature Score

Security Feature	Score
Formally verified + robust PoS/BFT	9–10
Proven consensus with moderate risk	7–8
Limited validation or weaker models	5–6

The qualitative assessment of the architecture and smart contract features was made based on white papers and other platform documents. Relative normalization technique was used, where the platforms received better scores in favor of their characteristics per the criterion. The benchmarking, surveys, and documents enhanced the credibility and validation of results.

TOPSIS Ranking Results

Closeness coefficient of TOPSIS (C_i^*) reflects proximity to the optimal and distance to the negative optimal solutions are shown in table 10. Fig. 4 shows that Polkadot and Ethereum received the maximum closeness coefficient values for being the most appropriate platforms.

Table 10: TOPSIS Ranking of Blockchain Platforms

Rank	Platform	Closeness Coefficient (C_i^*)
1	Polkadot	0.5760
2	Ethereum	0.5717
3	Fabric	0.5512
4	Solana	0.4012
5	Cardano	0.3878
6	BNB Chain	0.3823
7	Corda	0.3526
8	Quorum	0.3480
9	Algorand	0.2815

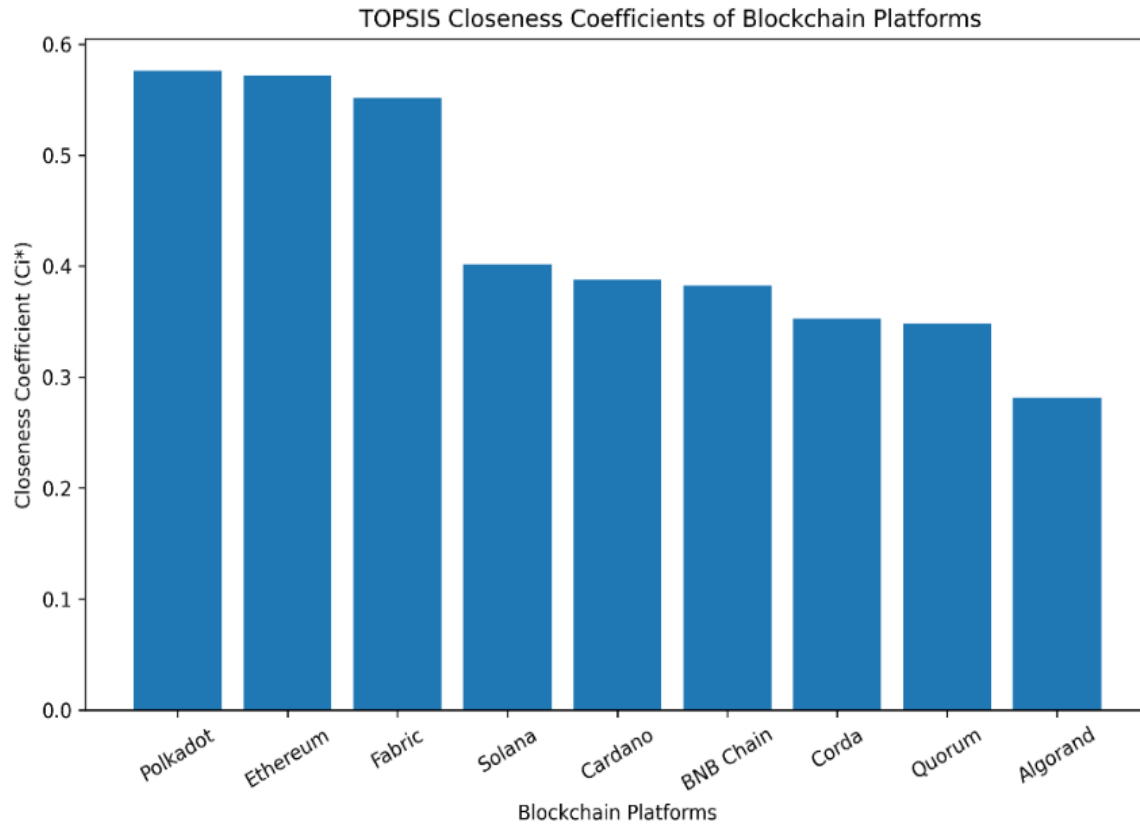


Fig. 4: TOPSIS Closeness Coefficients (Ci) for Evaluated Blockchain Platforms

Interpretation of Results

The results reveal that platforms with a balanced number of advantages according to the criteria exhibit higher suitability. The first place was taken by Polkadot that met the requirements of interoperability and multi-chain network architecture. However, Ethereum demonstrated competitiveness in respect of ecosystem maturity and support among developers and smart contracts despite its poor scalability. Hyperledger Fabric was highly suitable for business purposes owing to a modular permissioned network, while Solana appeared to be an appropriate choice according to the transaction rate. Nevertheless, it was not competitive with regard to decentralized governance and interoperability.

Case Study: Selecting a Blockchain Platform for a Supply Chain Traceability System

The case study selected involves detecting which is the best platform to implement a blockchain traceability solution in a food supply chain. Applications developed in this domain need to run fast to ensure great performance with the integrity of the data, auditability, and permissioned access (Casino et al., 2019; Hao et al., 2018). The problem tackled by the case study is to decide which blockchain platform is most relevant to build a tamper-proof system.

Problem Context and Requirements

The enterprise blockchain platform should be supported with governance, scalability, data privacy, interoperability, and Performance control features. Compared to decentralized systems, there is more focus on predictability, compliance, a permission-based approach, and auditability in the case of enterprise blockchains. The platform should be selected with all these factors in mind since they would help to make sure that there are quick transactional processes, governance capabilities and data sharing without any questions between organizations. Other aspects which could impact the decision-making process would include compatibility, sustainability and ecosystem. The platform can help in having an immutable audit trail, shared ledger and tamper-proof system. These criteria can be seen in table 11 based on the selected application type.

Table 11: Selection Criteria Table

Criterion	Importance	Rationale
Performance (Perf)	High	Real-time tracking of product flows requires high TPS (Dinh et al., 2017)
Security (Sec)	High	Ensures product authenticity and prevents tampering (Kiayias et al., 2017)
Architecture (Arch)	High	Enterprise environments require modularity and permissioning (Androulaki et al., 2018)
Interoperability (Interop)	Medium	Integration with IoT systems and legacy databases (Zamyatin et al., 2021)
Ecosystem (Ecosys)	Medium	Availability of SDKs, integration tools, and community support (Sedlmeir et al., 2020)
Smart Contracts (Smart)	Medium	Requirement for business logic automation across organizations (Sedlmeir et al., 2020)
Use Case Fit (UseCase)	High	Alignment with enterprise consortium networks (Casino et al., 2019)

Application of Weights

The weights were determined in view of stakeholder preferences stated in similar supply chain literature and enterprise blockchain literature, as shown in table 12.

Table 12: Weights Table

Criterion	Weight
Perf	0.20
Sec	0.20
Arch	0.20
Interop	0.15
Smart	0.10
Ecosys	0.10
UseCase	0.05

These weights highlight performance, security, and architecture as the main requirements for enterprise supply chain applications.

Applying TOPSIS to Candidate Platforms

TOPSIS was applied to the platforms by tailoring the decision matrix specifically to the constraints of a regulated corporate environment. Rather than blindly copying the generalized baseline metrics, the qualitative sub-indicators for 'Use Case Fit' and 'Security & Governance' were re-indexed to penalize purely public permissionless mechanisms that lack native transaction isolation boundaries or localized notary compliance structures. Furthermore, the normalization step incorporated the threshold weights outlined in table 12. This targeted environmental tuning explains the structural shift in the relative closeness vectors (S_i^-), allowing enterprise-oriented or highly localized consensus frameworks such as Algorand's PPoS to compress their distance to the ideal solution (A^+) more rapidly than expansive public networks such as Ethereum or Solana under the strict performance-security-modularity priority vector.

Case Study Results

TOPSIS Closeness Coefficients (C_i^*) for Supply Chain Traceability are expressed in table 13.

Table 13: Closeness Coefficients

Platform	C_i^*	Rank
Hyperledger Fabric	0.82	1
Corda	0.78	2
Quorum	0.72	3
Algorand	0.64	4
Polkadot	0.61	5
Ethereum	0.58	6
BNB Chain	0.54	7
Cardano	0.51	8
Solana	0.47	9

One interesting deviation from the general baseline ranking is the placement of Algorand, moving into the 4th place. This mathematical effect happens due to the extreme weighting of the case study in terms of the General 'Ecosystem Maturity' and 'Interoperability' criteria (down to 10% and 15% respectively), which was lowering the ranking of Algorand before due to the small number of developers on the platform. As for the multi-criteria analysis, when it comes to the heavy emphasis on the 'Performance' (20%), 'Security' (20%) and 'Architecture' (20%) aspects, the advantage of the Pure Proof-of-Stake (PPoS) architecture of Algorand, providing immediate block finality and fork-resistance by the mathematical proof becomes obvious, having no structural complexity and latency of transaction execution typical for the traditional public blockchain networks.

Case Study Findings

The case study analysis indicates that, when the focus is on supply chain traceability, permissioned blockchain networks are better suited than public blockchain networks. Among the permissioned blockchain networks, Hyperledger Fabric is the best option because of its governance models, private channels, and enterprise capabilities. Corda, because of transactional privacy and adherence to regulation, also deserves to be mentioned. Meanwhile, Quorum remains competitive because of its Ethereum compatibility and enhancement of enterprise privacy capabilities. The findings also show that public blockchain networks rank the lowest because of concerns regarding governance, predictability, and privacy.

Platform Analysis

Table 14: Comparative Platform Analysis

Platform	Architecture	Consensus Mechanism	Key Strengths	Key Limitations	Suitable Domains
Ethereum	Public, modular, EVM-based	Proof-of-Stake (PoS)	Large developer ecosystem, mature smart contract support, strong decentralization	Scalability limitations and transaction fees on Layer-1	DeFi, NFTs, DAOs, decentralized applications
Hyperledger Fabric	Permissioned modular architecture	Practical Byzantine Fault Tolerance (PBFT)/Raft	High throughput, privacy channels, enterprise governance	Limited openness and interoperability	Supply chain, healthcare, enterprise systems
Solana	High-performance monolithic architecture	Proof-of-History (PoH) + PoS	Extremely high TPS and low latency	Centralization concerns and network outages	High-frequency applications, gaming
Polkadot	Multi-chain relay architecture	Nominated PoS	Native interoperability and parachain support	Smaller ecosystem maturity compared to Ethereum	Cross-chain applications, Web3 infrastructure
Cardano	Layered research-driven architecture	Ouroboros PoS	Strong security and formal verification	Slower ecosystem growth and lower throughput	Government systems, academic and regulated sectors
Algorand	Pure PoS blockchain architecture	Pure Proof-of-Stake	Energy efficiency and fast finality	Limited ecosystem adoption	Financial systems and digital payments
Quorum	Enterprise Ethereum-based architecture	IBFT/Raft	Enterprise privacy and EVM compatibility	Lower decentralization and ecosystem size	Banking and consortium applications
Corda	Distributed ledger with transaction-specific sharing	Notary consensus model	Strong privacy and regulatory suitability	Limited general-purpose programmability	Trade finance and regulated enterprise workflows
BNB Chain	EVM-compatible public blockchain	Proof-of-Staked Authority (PoSA)	High throughput and low transaction cost	Governance centralization concerns	Consumer applications and digital asset platforms

This section offers a qualitative comparative analysis of the selected blockchain platforms, based on the criteria mentioned above in the previous parts of the essay. This section focuses on the architectural design, performance, interoperability, governance, ecosystem development, sustainability, and domain applicability. The objective of the comparative analysis presented here is to supplement the numerical evaluation results provided by the TOPSIS approach in the previous chapter with an analysis of practical implications and trade-offs associated with deploying different platforms.

As follows from the comparative analysis (Table 14), there is no single dominating blockchain platform according to all criteria. While public blockchain platforms like Ethereum and Polkadot have high levels of decentralization, interoperability, and maturity of the ecosystem, thus becoming applicable for generic decentralized applications, enterprise-oriented platforms (Hyperledger Fabric, Quorum, and Corda) focus on the aspects of governance, privacy, and permissioned access control and can be used in regulated business contexts. On the other hand, high-performing blockchain platforms such as Solana and BNB Chain offer high transaction speeds and minimal latencies, though at the cost of the loss of decentralization and robustness of governance.

Environmental and governance factors are now more important in the deployment of blockchain technologies because of environmental issues, regulation, and the issue of scaling operations. Proof of Stake-based blockchains tend to have better energy efficiency compared to traditional proof of work-based protocols. The switch of Ethereum to PoS significantly enhanced its sustainability, while Algorand highlights the aspect of carbon neutrality of blockchain technology. Hyperledger Fabric and Corda offer stable governance models and predictable control over their operation and are suitable choices for enterprise blockchain deployments. On the other hand, public blockchain networks rely more on the principle of decentralized governance, providing openness and innovation but lacking the rapidity of protocol development.

Table 15: Sustainability and Governance Comparison

Platform	Energy Efficiency	Governance Model	Interoperability Support	Ecosystem Maturity	Sustainability Outlook
Ethereum	High after PoS migration	Community-driven governance	Moderate	Very High	Strong long-term sustainability
Hyperledger Fabric	High	Consortium governance	Moderate	High	Enterprise sustainable deployment
Solana	Moderate	Validator-driven governance	Limited	Moderate	Performance-oriented sustainability
Polkadot	High	On-chain governance	Native interoperability	Growing	Strong interoperability-driven sustainability
Cardano	High	Research-based governance	Moderate	Moderate	Sustainability-focused architecture
Algorand	Very High	Foundation-guided governance	Limited	Moderate	Carbon-neutral infrastructure
Quorum	High	Enterprise consortium governance	Limited	Moderate	Enterprise operational sustainability
Corda	High	Enterprise governance	Limited	Moderate	Suitable for regulated industries
BNB Chain	Moderate	Semi-centralized governance	Moderate	High	Commercial scalability focus

Table 15 illustrates the sustainability and governance comparison. On the whole, the results of the qualitative analysis of blockchain platforms are a valuable addition to the MCDA-TOPSIS analysis, showing the actual pros and cons that need to be considered when choosing between different blockchain solutions. This reinforces the idea that the choice of blockchain platform depends on various contextual circumstances.

Comparative Discussion, USE-CASE Mapping and Implications

The selection of a particular blockchain technology is another multi-criteria decision-making (MCDM) problem, which consists of a sophisticated balance between the performance characteristics, interoperability, governance, security, ecosystem maturity, decentralization, and sustainability aspects. Applying the MCDA-TOPSIS method, it became possible to compare nine blockchain platforms, proving that those with the combination of features are more preferable than the maximizing single criteria. Polkadot (0.5760) turned out to be the most competitive among other

solutions, followed by Ethereum (0.5717) and Hyperledger Fabric (0.5512). Their advantages include interoperability, ecosystem maturity, and enterprise readiness, respectively. Polkadot stands out because of its cross-chain technology; meanwhile, the benefits of using Ethereum consist in a well-developed ecosystem and smart contracts. However, such performance issues as scalability have not affected the high results. Finally, the main advantages of Hyperledger Fabric can be found in the permissioned structure, modularity, and governance. Thus, it became evident that the interoperability and ecosystem maturity proved to become decisive factors, outranking the performance criteria.

Supply Chain Application Case Study shows the importance of context in applying blockchain technologies. With enterprise-oriented weights, Hyperledger Fabric achieved the highest rating of 0.82 while Corda scored 0.78 and Quorum 0.72, highlighting the importance of governance, security, auditability and reliability of the network in terms of regulation. Sensitivity analysis confirms that TOPSIS model is responsive enough to changes in criteria weights, reflecting rank elasticity in regard to the change of context instead of invariance. For example, changing the context to performance-oriented priority vector will favorably shift Solana, indicating that the model is capable of reflecting the advantages of Solana in terms of raw throughput in case of higher weight. Governance-oriented weight distribution will, of course, favor Hyperledger Fabric and Corda. In the middle of these purposeful re-rankings, Ethereum demonstrates a distinctive local stability, remaining one of the most resilient mid/top-tier candidates due to secondary criteria scores.

Furthermore, sustainability is another criterion that should not be overlooked when selecting the right blockchain platform. Proof-of-Stake-based consensus mechanisms of blockchains like Ethereum, Cardano, and Algorand result in higher sustainability properties than previous Proof-of-Work-based ones. In conclusion, it can be stated that the choice of blockchain depends on specific requirements of each domain. The use case mapping reveals how each platform functions within a given application and highlights the need to properly align technological or governance capabilities with specific domain requirements. Table 16 shows the suitability of the Use-Case-Based blockchain platform.

Table 16: Use-Case-Based Blockchain Platform Suitability

Application Domain	Recommended Platforms	Rationale
DeFi & Financial Services	Ethereum, Algorand, BNB Chain, Quorum, Corda	Smart contract maturity, liquidity, regulatory alignment
Supply Chain Management	Hyperledger Fabric, Corda, Quorum	Privacy, identity management, enterprise integration
Healthcare & Public Sector	Hyperledger Fabric, Cardano, Algorand, Corda	Governance, data confidentiality, sustainability
Cross-Chain Applications	Polkadot, Ethereum, Corda	Native interoperability, composability
High-Performance Applications	Solana, BNB Chain, Algorand	Low latency, high throughput
Academic & Research Systems	Ethereum, Cardano, Algorand	Formal models, open experimentation
Enterprise Pilots	Fabric, Quorum, Corda, BNB Chain	Controlled environments, rapid deployment

As far as developers are concerned, a mature ecosystem and documentation make platform adoption easier. As for enterprises, permissioned platforms suit them more as opposed to open systems since the former puts governance, privacy, and compliance first. In turn, policymakers are more inclined to prefer energy-efficient and well-governed systems. For sustainability-oriented leaders, the choice should be made depending on the platform's regulatory adaptability and decision support, and not energy-efficiency.

Conclusion

In this paper, a Multi-Criteria Decision Analysis approach employing TOPSIS was developed to conduct an objective assessment of various blockchain platforms in terms of architectural, operational, and governance factors such as architecture, performance, interoperability, security, smart contracts support, ecosystem maturity, and domain fit. This research demonstrates that blockchain platform choice cannot solely be based on throughput or latency, since multi-faceted performance plays an important role. Among the nine considered platforms, Polkadot emerged to have the highest closeness coefficient (0.5760), followed by Ethereum (0.5717) and Hyperledger Fabric (0.5512), implying that the factors related to interoperability, maturity, flexibility, and scalability should be particularly significant in general-purpose blockchain platform choice. The results of the analysis of the supply chain traceability case study, in

turn, emphasized once again the dependence of the platform on the specific environment, with Hyperledger Fabric having obtained the highest enterprise-oriented score (0.82), followed by Corda (0.78) and Quorum (0.72). Lastly, the sensitivity analysis successfully verifies the behavioral dynamics of the model. It is proved that rankings of platforms behave rationally and predictably under varying weight sets. Performance-oriented weights reveal right away the benefits of Solana, while governance-based weight sets shift the preference to permissioned solutions such as Hyperledger Fabric and Corda. This selective sensitivity demonstrates that the framework works as an adaptive decision-making tool, not just ranking system, while at the same time revealing strong structural foundations of Ethereum across various strategies. Further research may include extending the framework by implementing the elements of benchmarking in real time, adaptation of weights, MCDA with uncertainty treatment, dynamic evaluation of the ecosystem, etc.

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