Metrics for Quality Assessment in Blockchain-based Systems: A Systematic Mapping Study

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Agenda

- Introduction
- Research Method
- Results
- Discussion
- Conclusion

Introduction

Context of Blockchain Technology

- **Blockchain** is emerging as a **disruptive technology** comparable to the **early Internet** [1];
- Initially used for **cryptocurrencies**, now applied in **critical sectors**: healthcare, finance, logistics [2];
- Key attributes: **decentralization**, **immutability** and **transparency**;
- **Blockchain's complex architecture** poses new challenges for evaluating software quality.

[1] Simone Porru, Andrea Pinna, Michele Marchesi, and Roberto Tonelli. 2017. Blockchain-oriented software engineering: challenges and new directions. In 2017 IEEE/ACM 39th International Conference on Software Engineering Companion (ICSE-C). IEEE, 169–171.

[2] Jesse Yli-Huumo, Deokyoon Ko, Sujin Choi, Sooyong Park, and Kari Smolander. 2016. Where is current research on blockchain technology?—a systematic review.

Quality Challenges in Blockchain

- **Distributed architecture** and **consensus validation** increase **complexity** [3];
- Interactions with **cryptography** and **heterogeneous environments** hinder **maintenance** [4];
- **Lack of established evaluation models** tailored to blockchain.

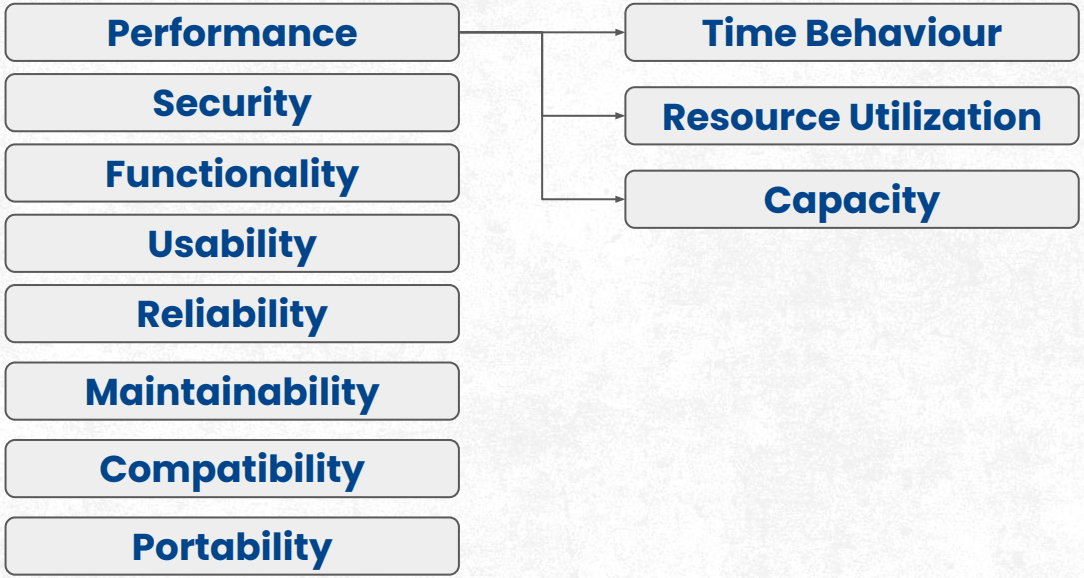
[3] Jesse Yli-Huumo, Deokyoon Ko, Sujin Choi, Sooyong Park, and Kari Smolander. 2016. Where is current research on blockchain technology?—a systematic review.

[4] Xu, X., Weber, I., & Staples, M. (2019). Architecture for Blockchain Applications. Springer International Publishing.

Quality in the Information Systems

- Quality in IS seeks **alignment** between **systems** and **organizational goals**;
- Blockchain challenges **traditional quality models** due to its **autonomous and distributed nature**;
- Need for metrics addressing **interoperability, reliability and performance.**

ISO/IEC 25010 - Quality Model



Gaps in the Scientific Literature

Few studies align metrics with ISO/IEC 25010

Strong focus on performance and security

Limited attention to user-centered aspects such as usability

Study Objective

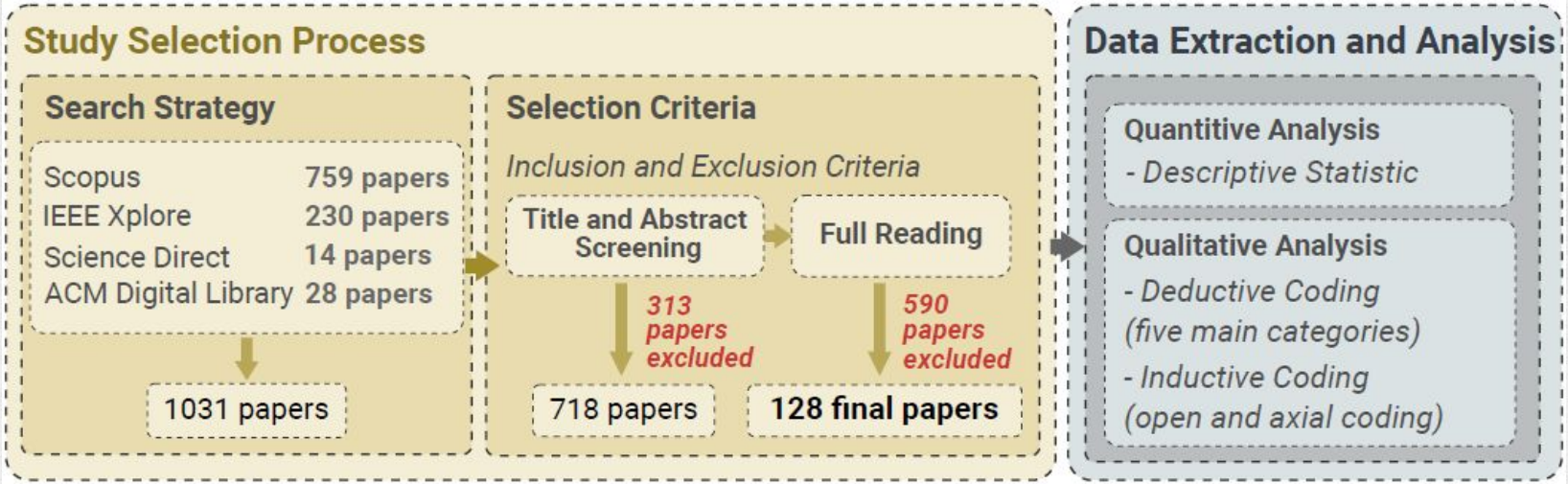
To conduct a **Systematic Mapping** study to **identify, classify, and analyze** software quality metrics used in blockchain-based systems, based on the **ISO/IEC 25010 model**.

Research Contributions

01	**Theoretical Framework for Quality Analysis**	**Structured proposal** for analyzing blockchain quality metrics;
02	**Comprehensive Literature Mapping**	Mapping of **128 primary studies** and over **160 metrics**;
03	**Research Gaps and Future Directions**	Identification of research **gaps** and **future research directions;**
04	**Support for Blockchain Development**	**Support for software engineering** decisions in blockchain systems.

Research Method

Study Selection Process



Search String

(“blockchain") AND (“measurement" OR “software measurement" OR “metrics" OR “software metrics") AND (“functionality" OR “performance" OR “compatibility" OR “usability" OR “reliability" OR “security" OR “maintainability" OR “portability")

Selection Criteria

- **Inclusion Criteria:**
  - Studies that **propose or apply software metrics** to evaluate blockchain-based systems;
  - Publications from **peer-reviewed sources** (journals, conferences);
  - Written in **English** and with **full-text access.**

- **Exclusion Criteria:**
  - Papers **without full text availability;**
  - **Secondary** or **tertiary** papers (systematic reviews, surveys, etc);
  - Papers in **editorial form**.
  - Studies without a **clear use of metrics** or unrelated to **blockchain context;**

Research Questions (RQs)

RQ1
What are the **most commonly used metrics** for quality in blockchain systems?

RQ2
What quality **characteristics are frequently assessed** in blockchain systems?

RQ3
How are blockchain **studies' metrics applied and assessed**?

Data Extraction and Analysis

- Dual-review process for reliability
- **Quantitative:** descriptive statistics (frequencies)
- **Qualitative:** deductive coding and inductive coding
- Dimensions analyzed:

Metric names

ISO classification

Tools Used

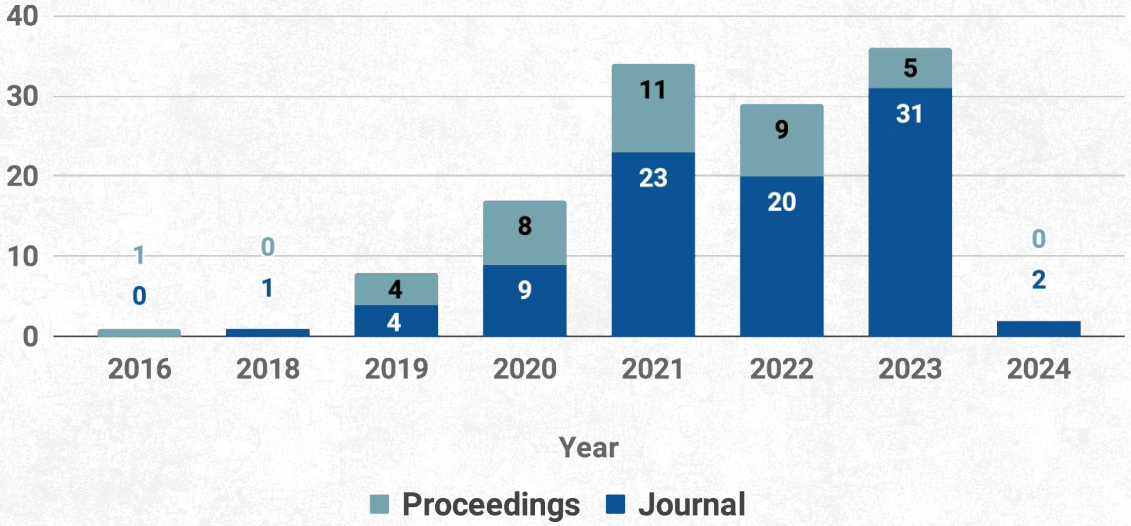
Evaluation Levels

Method Used

Results

Characterization of Primary Studies

- Publications mostly from 2016–2023, with a peak in 2023



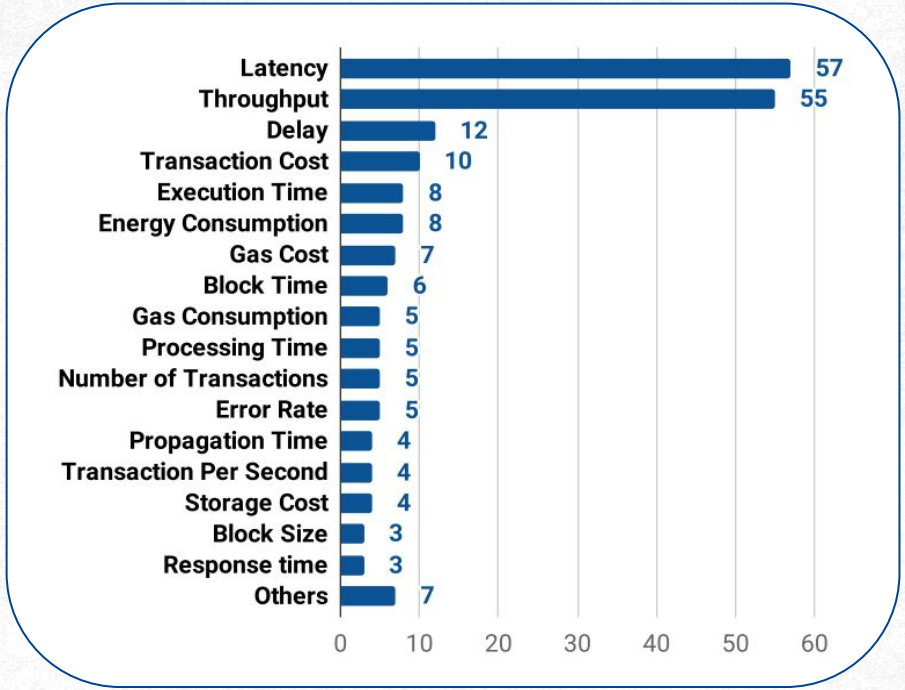
Characterization of Primary Studies

- 70.3% journal articles, 29.7% conference papers
- IEEE and MDPI were leading publishers:
  - **IEEE Xplore: 32,6%;**
  - **MDPI: 21,3%;**
  - ScienceDirect: 19,1%;
  - Springer: 11,2%;
  - Wiley: 4,5%;
  - Other publishers: 11,2%.

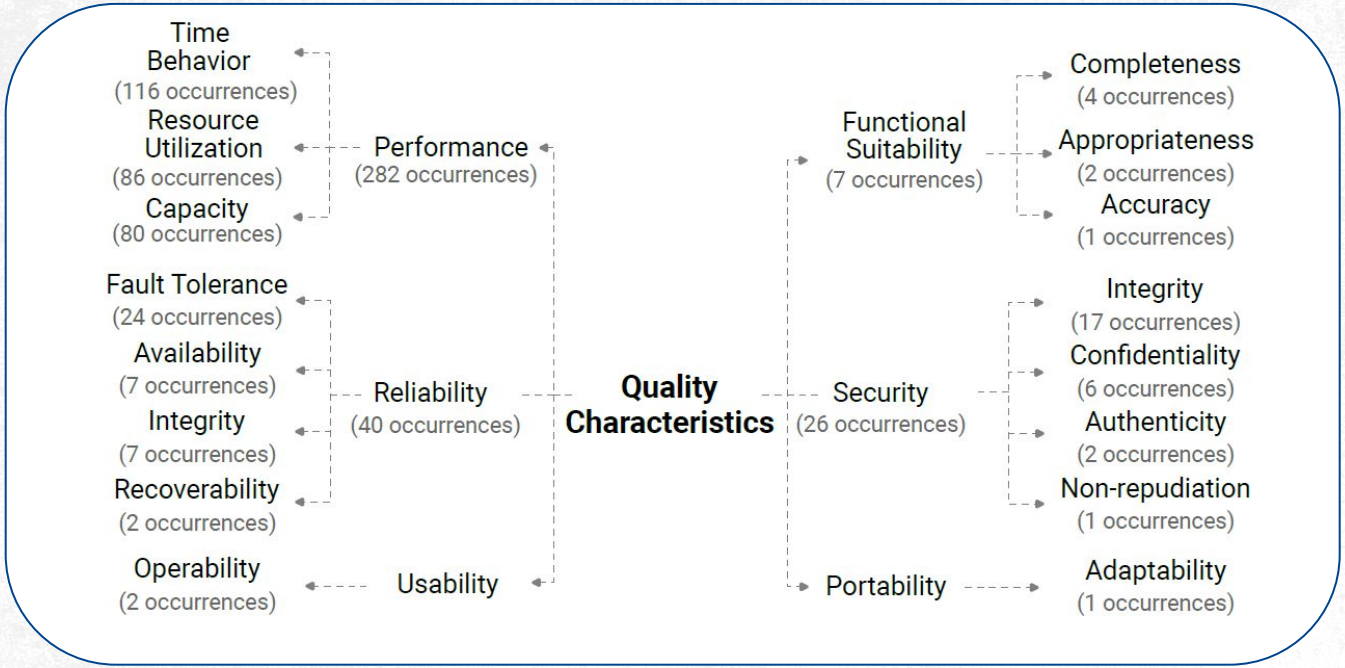
RQ1 – Most Common Metrics

- Most cited metrics:
  - **Latency** (27%), **Throughput** (26.1%)
  - Delay, Transaction Cost, Execution Time, Energy Consumption

- Context-driven use: healthcare, **IoT**, finance



RQ2 – Quality Characteristics



RQ3 – Metric Application and Tools

- Evaluation levels:

- Tools: **Hyperledger Caliper** (most common), **custom scripts** (Python, Java, Go), and **ad hoc tools.**

Discussion

Research Gaps Identified

- Narrow focus on performance
- Smart contracts are rarely evaluated
- Lack of standardized methods
- Heavy use of simulation tools
- User-centered metrics are largely absent

Implications for IS Research

Promotes **theory-based evaluation** of blockchain systems;

Expands **ISO/IEC 25010 application** in decentralized contexts;

Exposes gaps in **user-focused quality attributes**;

Implications for Practitioners

Helps choose **relevant metrics and tools**;

Encourages **broader quality assessment** beyond performance;

Guides development of **user-friendly applications**;

Conclusion

Conclusion

- There is a clear **focus on performance**, while key aspects like **usability and portability** remain overlooked;
- **Smart contract** evaluation is still rare, despite its **importance**;
- Future works should focus on
  - Creating and validating **metrics tailored to blockchain properties;**
  - Assessing **neglected attributes** like usability;
  - **Developing tools** to support real-world quality evaluation**.**

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