Issue 17, 2025

https://doi.org/10.23939/sisn2025.17.130

УДК 004.6

COMPARISON ANALYSIS OF METRICS AND EVALUATION SCALES OF DISTRIBUTED INFORMATION RESOURCES QUALITY PARAMETERS

Yurii Heriak[1], Andrii Berko[2]

Lviv Polytechnic National University,
Department of Information Systems and Networks, Lviv, Ukraine
E-mail[1]: yurii.m.heriak@lpnu.ua, ORCID 0009-0008-3251-2007
E-mail[2]: andrii.y.berko@lpnu.ua, ORCID 0000-0003-2892-9519

The increasing importance of ensuring high-quality distributed information resources in the context of modern technologies necessitates the definition of effective quality assessment systems and measurement scales. This work explores the essential quality criteria for distributed information resources, including reliability, performance, scalability, security, interoperability, usability, management, and monitoring. Various assessment systems, such as ISO/IEC 25010, CMMI, COBIT, ITIL, and NIST, are analyzed for their applicability to different quality parameters. Additionally, the study examines the use of nominal, ordinal, interval, and ratio scales within these systems, highlighting their advantages and limitations. Recommendations are provided for selecting and implementing appropriate quality assessment systems and scales, with particular emphasis on the unique characteristics of distributed information resources. Reviewed some risks, challenges, tasks and advantages of developing a dedicated quality assessment system for distributed resources quality assessment. The conclusions drawn underline the effectiveness of different systems and scales in enhancing resource quality, while also suggesting directions for further research in this domain.

Keywords — Distributed Information Resources, Quality Assessment Systems, Measurement Scales, ISO/IEC 25010, CMMI

Problem Statement

The relevance of ensuring high quality distributed information resources is increasing in the context of modern technologies. As organizations rely more heavily on distributed systems to manage vast amounts of data and support critical operations, the demand for robust quality assurance mechanisms becomes paramount. A distributed information resource refers to a system or collection of data that is spread across multiple locations, often across different physical or geographical boundaries. These resources are managed and accessed through a network, typically involving the use of various technologies and protocols to ensure seamless integration and functionality. Distributed information resources are critical for modern applications due to their ability to handle large-scale data, provide high availability, and support global access. They enable organizations to achieve greater efficiency, flexibility, and resilience in their operations, making them essential for contemporary IT infrastructure.

The definition of effective quality assessment systems and rating scales is critically important to achieve these objectives. By establishing comprehensive and precise evaluation criteria, organizations can systematically measure and enhance the quality of their distributed information resources. This, in turn, supports the overall goal of building resilient, high-performing, and secure systems that can meet the evolving demands of today's technological landscape.

Analysis of Recent Studies and Publications

The quality of distributed information resources is determined by several critical criteria, each addressing different aspects of system performance and user satisfaction. Ensuring high-quality distributed resources is essential for achieving operational efficiency, reliability, and security in today's technologically advanced environments (Kahloun, 2018).

One of the primary criteria is **reliability**, which measures the system's ability to function correctly and consistently over time. In distributed systems, reliability is crucial as it ensures that the resources remain available and operational despite potential failures or disruptions. This involves implementing fault tolerance mechanisms, such as data replication and failover processes, to maintain service continuity.

Performance is another vital criterion, focusing on the system's responsiveness and efficiency. Distributed information resources must handle high volumes of data and transactions with minimal latency and optimal throughput. Performance is assessed through various metrics, including response time, processing speed, and resource utilization, ensuring that the system can meet user demands effectively.

Scalability is equally important, referring to the system's capacity to grow and manage increased workload without compromising performance. In distributed environments, scalability allows for the seamless addition of resources to handle higher demands. This criterion is essential for systems that need to adapt to changing business needs and expanding user bases.

Security is a fundamental criterion that encompasses protecting data and resources from unauthorized access, breaches, and other threats. Distributed systems must implement robust security measures, such as encryption, access controls, and continuous monitoring, to safeguard sensitive information and ensure compliance with regulatory standards.

Interoperability is crucial for the seamless integration of distributed resources with other systems and technologies. It ensures that different components can work together effectively, facilitating data exchange and collaboration across diverse platforms. This criterion is particularly significant in environments where systems from various vendors need to interoperate smoothly (Bahmani, 2021).

Usability focuses on the ease with which users can interact with the system. High usability ensures that the distributed resources are accessible and user-friendly, reducing the learning curve and enhancing user satisfaction. This involves intuitive interfaces, clear documentation, and responsive support.

Effective management and monitoring are also critical quality criteria. These involve overseeing the distributed resources to ensure optimal performance, security, and compliance. Comprehensive monitoring tools and management practices enable timely detection and resolution of issues, maintaining the overall health of the system (Kahloun, 2018).

In conclusion, the quality of distributed information resources is multifaceted, requiring attention to reliability, performance, scalability, security, interoperability, usability, and effective management and monitoring. Addressing these criteria comprehensively ensures that distributed systems can deliver high-quality services, meet user expectations, and adapt to evolving technological demands.

Formulation of the Article's Objective

The aim of the article is to conduct a comparative analysis of existing metrics and evaluation scales for assessing the quality parameters of distributed information resources, with the goal of identifying their advantages, limitations, and the conditions for their effective application in various contexts of information systems.

Main Results

Quality assesment systems. In the rapidly evolving landscape of distributed information systems, maintaining high quality across various parameters is paramount. Different frameworks and standards offer structured methodologies to evaluate and enhance quality. This chapter explores five notable systems—ISO/IEC 25010, CMMI, COBIT, ITIL, and NIST—and provides a comparative analysis to guide organizations in selecting the most appropriate system(s) for their needs.

Let's take a closer look at each of the quality assessment systems and conduct a comparative analysis based on key parameters.

The ISO/IEC 25010 standard provides a comprehensive model for software quality, which is highly applicable to distributed information resources. This model defines a set of quality characteristics and sub-characteristics, including functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability. By applying ISO/IEC 25010, organizations can systematically evaluate the quality of their distributed systems across these dimensions, ensuring that the systems meet user requirements and industry standards (Estdale, 2018).

Capability Maturity Model Integration (CMMI) is another valuable framework for assessing and improving the quality of distributed information resources. CMMI provides a structured approach to process improvement, focusing on enhancing the maturity of organizational processes. For distributed systems, CMMI can help organizations establish and refine processes that ensure reliable, efficient, and secure resource management. The model's maturity levels guide organizations from initial, ad-hoc practices to optimized processes, enhancing the overall quality of distributed resources (Hidayati, 2018).

Control Objectives for Information and Related Technologies (COBIT) offers a governance and management framework for enterprise IT, emphasizing the alignment of IT with business goals. For distributed information resources, COBIT provides a set of control objectives and practices that ensure effective governance, risk management, and compliance. The framework helps organizations implement controls and policies that enhance the quality, security, and performance of distributed systems, aligning IT resources with strategic business objectives (De Haes, 2020).

Information Technology Infrastructure Library (ITIL) is a widely adopted framework for IT service management, focusing on delivering high-quality IT services. ITIL's practices are particularly relevant for managing distributed information resources, as they provide guidance on service design, transition, operation, and continual improvement. By applying ITIL principles, organizations can ensure that their distributed systems deliver reliable, efficient, and user-centered services, meeting the expectations of stakeholders (Rusman, 2022).

National Institute of Standards and Technology (NIST) provides a series of guidelines and standards for ensuring the security and quality of information systems, including distributed environments. NIST's frameworks, such as the NIST Cybersecurity Framework, offer a risk-based approach to managing and securing distributed resources. These guidelines help organizations identify, protect, detect, respond to, and recover from cybersecurity threats, ensuring the integrity and reliability of distributed information resources (Alshar'e, 2023).

Table 1.

Quality assessment systems comparison

Parameter	ISO/IEC 25010	CMMI	COBIT	ITIL	NIST
Focus	Software quality	Process maturity	IT management and control	IT service management	Information system security
Key Characteristics	Product quality model	Five maturity levels	Five principles	Service lifecycle	Security controls and guidance
Application	Software development and assessment	Process management	IT process management	IT service management	Security management
Rating Scale	From 1 to 5	From 1 to 5	From 0 to 5	Implicit, process-focused	No unified scale
Implementation Approach	Formal standard	Gradual improvement	Framework and guidance	Set of best practices	Standards and guidelines
Flexibility	Moderate	High	High	High	High
Tool Support	Limited	Many tools	Many tools	Many tools	Many tools

Each quality assessment system provides a unique approach to evaluating and ensuring the quality of distributed information resources. The choice of system or their combination depends on the specific needs and goals of an organization. For instance, ISO/IEC 25010 is ideal for organizations focused on software quality, while CMMI offers a structured path for process improvement. COBIT is suited for IT governance and alignment with business goals, ITIL excels in IT service management, and NIST is indispensable for organizations prioritizing information security.

Quality rating scales

Quality rating scales can be classified into four main types: nominal, ordinal, interval, and ratio. Each of these scales has its unique characteristics, advantages, and disadvantages, which make them suitable for different quality assessment systems of distributed information resources.

Nominal scales are used for categorizing data into distinct categories without any inherent order. Examples of nominal scales include types of errors, user categories, or types of services. In the **ITIL** system, nominal scales can be used to classify incidents (e.g., "network issues," "software problems," "hardware issues"). In COBIT, nominal scales can be applied to classify control measures (e.g., "data protection," "access management," "audit").

Ordinal scales allow for ranking data in order but do not specify the exact distances between categories. Examples of ordinal scales include levels of importance or priority. In **CMMI**, ordinal scales are used to define process maturity levels (e.g., "Initial," "Managed," "Defined," "Quantitatively Managed," "Optimizing"). In ISO/IEC 25010, ordinal scales can be used to assess reliability or usability (e.g., "low," "medium," "high") (Dalati, 2018).

Interval scales allow for precise measurement of distances between values but do not have an absolute zero. Examples of interval scales include user satisfaction ratings or temperature in degrees. In **NIST**, interval scales can be used to assess the effectiveness of security measures on a scale from 0 to 10. In ISO/IEC 25010, interval scales can be used to measure system performance, where each unit represents a specific level of efficiency.

Ratio scales have an absolute zero and allow for measuring both distances between values and relative proportions. Examples of ratio scales include weight, length, or cost. In COBIT, ratio scales can be applied to assess the costs of implementing control measures relative to the total budget. In ITIL, ratio scales can be used to measure system downtime in hours or percentages (Saneii, 2024).

Systematization of data quality evaluation approaches

The goal of this study is to develop a systematic approach for assessing the quality of distributed information resources by analyzing existing quality assessment frameworks and measurement scales, determining their applicability to various quality attributes, and formulating recommendations for their selection and implementation. In the context of modern technological advancements, ensuring the reliability, performance, scalability, security, interoperability, usability, management, and monitoring of distributed information resources is critical. The increasing complexity of these systems necessitates an in-depth evaluation of their quality parameters to support their effective operation, maintain consistency, and mitigate potential risks. A comprehensive analysis of quality assessment methodologies will provide insights into the most effective strategies for evaluating and enhancing distributed information resources.

To achieve this goal, the study will examine established quality assessment systems, including ISO/IEC 25010, CMMI, COBIT, ITIL, and NIST, assessing their relevance and applicability to distributed information resource quality evaluation. The comparative analysis of these frameworks will allow for the identification of their strengths, limitations, and areas of overlap in addressing key quality attributes. Additionally, the study will investigate various measurement scales, such as nominal, ordinal, interval, and ratio, to determine their suitability for quantifying different quality parameters. This assessment will provide a structured approach to selecting appropriate scales based on the nature of the evaluated criteria and the specific requirements of distributed systems.

Beyond analyzing existing methodologies, the study will explore the risks, challenges, and advantages associated with implementing quality assessment systems for distributed information resources. Special attention will be given to the limitations of current frameworks in adapting to the dynamic and decentralized nature of distributed environments. The study will highlight the necessity of developing a dedicated quality assessment system tailored to the unique characteristics of distributed information resources, addressing the gaps in existing methodologies. Based on the findings, recommendations will be formulated for selecting and applying optimal quality assessment techniques, ensuring their effectiveness in improving the overall quality, security, and efficiency of distributed systems. Furthermore, the study will outline future research directions aimed at refining quality assessment practices, fostering continuous improvement, and advancing the field of distributed information resource evaluation.

When evaluating the quality criteria of distributed information resources, various rating scales can be applied to each criterion to ensure precise and meaningful assessments. Reliability, for instance, can be effectively measured using an interval scale, allowing for the quantification of system uptime in hours or percentage terms, providing a precise metric of reliability performance. Performance and scalability can also benefit from interval or ratio scales, measuring response times, throughput, and resource utilization in specific units, facilitating detailed and comparative analyses. Security assessments often employ ordinal scales to rank the severity of vulnerabilities and nominal scales to categorize different types of threats and controls, enabling structured and comprehensive security evaluations.

Interoperability can be assessed using nominal scales to categorize compatibility with different systems and technologies, while usability is often evaluated with ordinal scales to rank user satisfaction and ease of use based on survey responses. Management and monitoring can leverage interval scales to measure the frequency and effectiveness of monitoring activities, and ratio scales to quantify the allocation of resources towards management tasks. These diverse scales, each tailored to specific quality criteria, ensure that distributed information resources are comprehensively evaluated, supporting robust quality assurance and continuous improvement efforts.

Table 2.

Quality criterion assesment

Quality Criterion	Assessment System	Measurement Scales
Reliability	ISO/IEC 25010	Interval, ratio
Performance	ISO/IEC 25010, CMMI	Interval, ratio
Scalability	COBIT, CMMI	Ordinal, interval
Security	NIST, ISO/IEC 25010	Nominal, interval, ratio
Interoperability	COBIT, ISO/IEC 25010	Ordinal, interval
Usability	ISO/IEC 25010, ITIL	Nominal, ordinal, interval
Management	CMMI, COBIT, ITIL	Ordinal, interval
Monitoring	COBIT, ITIL, NIST	Nominal, interval, ratio

Different types of quality rating scales have their advantages and disadvantages, making them suitable for various aspects of assessing the quality of distributed information resources. The choice of the appropriate scale depends on the specific evaluation goals, available data, and organizational requirements. Combining different scales can provide a more accurate and comprehensive quality analysis, providing a basis for effective managerial decision-making. Another resolution to this problem is developing a dedicated quality assessment system, but this solution has its own tasks, challenges, issues, and advantages that need to be considered.

The primary task is to design a system that can accurately assess the specified quality criteria across diverse and distributed environments. This involves defining precise metrics and benchmarks for each criterion. For example, reliability may require metrics such as uptime or failure rates, while performance might focus on response time or throughput. Additionally, the system must be capable of integrating data from various sources and platforms to provide a comprehensive evaluation of the distributed resources. Another critical task is ensuring that the system can operate in real-time or near real-time to support dynamic environments, enabling timely decision-making and adjustments.

One of the main challenges in developing such a system is the complexity inherent in distributed environments. Distributed resources often vary in architecture, technology stack, and operational context, making it difficult to create a one-size-fits-all assessment model. Ensuring the system is scalable to handle the growth in data volume and resource complexity is another significant challenge. Security is also a crucial concern, as the assessment system itself must be protected against unauthorized access or tampering. Additionally, achieving interoperability across different platforms and standards requires sophisticated integration capabilities.

Key issues include data accuracy and consistency, especially when aggregating information from distributed sources. Discrepancies in data formats, collection methods, or time synchronization can lead to inaccurate assessments. Moreover, the system must address potential trade-offs between conflicting criteria, such as performance and security, where optimizing one might adversely impact the other. Another issue is maintaining the usability of the system, as it must be accessible to both technical and non-technical stakeholders, ensuring that its insights are actionable across the organization.

Despite these challenges, a custom quality assessment system offers significant advantages. It allows for tailored evaluations that align with the organization's specific goals and operational context. Such a system can be designed to focus on the most critical quality criteria, providing deeper insights than generic, off-the-shelf solutions. Additionally, a custom system can be more adaptable to changes in technology or organizational needs, ensuring long-term relevance and effectiveness. By integrating real-time monitoring and feedback mechanisms, organizations can continuously improve their distributed information resources, leading to increased reliability, performance, and overall quality.

In summary, while the development of a custom quality assessment system for distributed information resources involves navigating complex tasks, challenges, and issues, the potential advantages make it a worthwhile endeavor. The ability to create a system tailored to the specific needs and characteristics of the organization's distributed resources can lead to more accurate assessments, better decision-making, and enhanced resource quality over time.

Conclusions

Based on the analysis of various quality assessment systems and scales for distributed information resources, it is evident that no single system is universally applicable. Each system offers a unique set of tools and methodologies that may be more or less effective depending on the specific characteristics of the resource, such as reliability, performance, scalability, security, interoperability, usability, management, and monitoring.

ISO/IEC 25010 is the most comprehensive model, covering a wide range of quality criteria, including reliability, performance, security, and usability. This system is suitable for a thorough evaluation of distributed resources, providing a structured approach to assessing each of the key characteristics.

CMMI, which focuses on process maturity, is well-suited for improving the management and monitoring of distributed resources. Organizations seeking to enhance the efficiency of their management processes and ensure continuous quality improvement can use CMMI to create stable processes and procedures that support reliability and scalability.

COBIT provides an effective methodology for managing IT resources, which is crucial for maintaining interoperability and security in distributed systems. COBIT offers tools for strategic resource management, particularly at the level of corporate governance, allowing organizations to address challenges related to security and management of distributed resources.

ITIL, focused on IT service lifecycle management, is effective in ensuring usability and management of distributed resources. ITIL provides practices that help maintain high service quality, encompassing not only technical aspects but also a user-centric approach.

NIST focuses on security, offering methodologies and standards for protecting distributed information resources. For organizations that prioritize cybersecurity, NIST provides reliable tools for threat identification, risk management, and continuous monitoring.

Recommendations for organizations regarding the selection of a quality assessment system should be based on the specific characteristics of their distributed resources. For comprehensive assessment of resources requiring high levels of reliability, performance, and scalability, ISO/IEC 25010 is the most suitable choice. For managing interoperability and security, COBIT may be the best option, while ITIL is preferable for ensuring usability and management. Organizations with a high priority on security should focus on NIST standards.

Future research directions in this field include the development of integrated approaches that combine the advantages of various assessment systems to create more adaptive and comprehensive models. Additionally, research into automating the quality assessment of distributed resources using machine learning methods and big data analysis is promising, as it would enhance the accuracy and efficiency of assessment processes.

REFERENCES

1. Alshar'e, M. (2023). Cyber security framework selection: Comparision of NIST and ISO27001. *Applied computing Journal*, 245-255.
2. Bahmani, A., Alavi, A., Buergel, T., Upadhyayula, S., Wang, Q., Ananthakrishnan, S. K., ... & Snyder, M. P. (2021). A scalable, secure, and interoperable platform for deep data-driven health management. *Nature communications*, *12*(1), 5757.
3. Dalati, S. (2018). Measurement and Measurement Scales. *Modernizing the Academic Teaching and Research Environment: Methodologies and Cases in Business Research*, 79-96.
4. De Haes, S., Van Grembergen, W., Joshi, A., Huygh, T. (2020). COBIT as a Framework for Enterprise Governance of IT. In: Enterprise Governance of Information Technology. Management for Professionals. Springer, Cham. https://doi.org/10.1007/978-3-030-25918-1_5.
5. Estdale, J., Georgiadou, E. (2018). Applying the ISO/IEC 25010 Quality Models to Software Product. In: Larrucea, X., Santamaria, I., O'Connor, R., Messnarz, R. (eds) Systems, Software and Services Process Improvement. EuroSPI 2018. Communications in Computer and Information Science, vol 896. Springer, Cham. https://doi.org/10.1007/978-3-319-97925-0_42.
6. Hidayati, B. Purwandari, E. K. Budiardjo and I. Solichah, "Global Software Development and Capability Maturity Model Integration: A Systematic Literature Review," *2018 Third International Conference on Informatics and Computing (ICIC)*, Palembang, Indonesia, 2018, pp. 1-6, doi: 10.1109/IAC.2018.8780489.
7. Kahloun, F., Ayachi Ghannouchi, S. (2018). A Classification Algorithm for Assessing the Quality Criteria for Business Process Models. In: Abraham, A., Muhuri, P., Muda, A., Gandhi, N. (eds) Hybrid Intelligent Systems. HIS 2017. Advances in Intelligent Systems and Computing, vol 734. Springer, Cham. https://doi.org/10.1007/978-3-319-76351-4_8
8. Rusman, A., Nadlifatin, R., & Subriadi, A. P. (2022). Information system audit using COBIT and ITIL framework: literature review. *Sinkron: jurnal dan penelitian teknik informatika*, *6*(3), 799-810.
9. Saneii, S. H., & Doosti, H. (2024). Measuring Scales. In *Practical Biostatistics for Medical and Health Sciences* (pp. 1-9). Singapore: Springer Nature Singapore.

ПОРІВНЯЛЬНИЙ АНАЛІЗ МЕТРИК І ШКАЛ ОЦІНЮВАННЯ ПАРАМЕТРІВ ЯКОСТІ РОЗПОДІЛЕНИХ ІНФОРМАЦІЙНИХ РЕСУРСІВ

Юрій Геряк[1], Андрій Берко[2]

Національний університет «Львівська політехніка»,
кафедра інформаційних систем та мереж, Львів, Україна
E-mail[1]: yurii.m.heriak@lpnu.ua, ORCID 0009-0008-3251-2007
E-mail[2]: andrii.y.berko@lpnu.ua, ORCID 0000-0003-2892-9519

Збільшення значення забезпечення високоякісних розподілених інформаційних ресурсів у контексті сучасних технологій вимагає визначення ефективних систем оцінювання якості та шкал вимірювання. У цій роботі розглядаються основні критерії якості для розподілених інформаційних ресурсів, зокрема надійність, продуктивність, масштабованість, безпека, взаємодія, зручність використання, управління та моніторинг. Аналізуються різні системи оцінювання, такі як ISO/IEC 25010, CMMI, COBIT, ITIL і NIST, з огляду на їх застосовність до різних параметрів якості. Крім того, досліджується використання номінальних, порядкових, інтервальних і відносних шкал у цих системах, підкреслюючи їхні переваги та обмеження. Надано рекомендації щодо вибору та впровадження відповідних систем оцінювання якості та шкал, з особливою увагою до унікальних характеристик розподілених інформаційних ресурсів. Оглянуто деякі ризики, виклики, завдання та переваги розроблення спеціалізованої системи оцінювання якості для оцінки якості розподілених ресурсів. У висновках підкреслено ефективність різних систем і шкал у покращенні якості ресурсів, а також запропоновано напрями для подальших досліджень у цій сфері.

Ключові слова — Розподілені інформаційні ресурси, системи оцінювання якості, шкали вимірювання, ISO/IEC 25010, CMMI.