THE ROLE OF SOFTWARE QUALITY IN MODERN LOGISTICS PROCESSES: AN ANALYSIS BASED ON THE ISO/IEC 25010:2023 STANDARD

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Abstract
The rapid digitalization of business processes has placed software quality at the center of operational success, particularly within the complex field of logistics. This paper examines the role of software quality in supporting logistics processes, focusing on the updated international standard ISO/IEC 25010:2023. This standard, part of the Systems and Software Quality Requirements and Evaluation (SQuaRE) series, provides a comprehensive framework for defining, measuring, and evaluating software product quality. The paper demonstrates how the nine quality characteristics – functional suitability, performance efficiency, compatibility, interaction capability, reliability, security, maintainability, flexibility, and safety – address the specific needs of logistics information systems. By applying these characteristics to logistics information systems, such as Warehouse Management Systems and Transport Management Systems, the study illustrates how structured quality evaluation mitigates operational risks and enhances supply chain resilience. The findings suggest that the 2023 update, which separates quality-in-use into ISO/IEC 25019, offers a more precise framework for assessing the technical integrity of Information and Communications Technology products in complex, multi-stakeholder logistics environments.

Keywords: *ISO/IEC 25010:2023, software quality, logistics, SQuaRE, ICT product quality.*
JEL classification: L86, M15, O32

INTRODUCTION

The global logistics sector is experiencing a significant transformation driven by advancements in digital technologies (Verdecchia et al., 2024). The quality of software has become increasingly central to business success, as it ensures that IT products meet user expectations and create value through digitalization (Jereb & Kajba, 2023; Nugraha & Rachman, 2024). In logistics, where real-time data and precision are essential, the quality of information systems—evaluated through characteristics such as Functional Suitability, Reliability, and Performance Efficiency—directly impacts the efficiency of the entire supply chain (Pikh et al., 2025; Rojas et al., 2025).

To navigate this complexity, organizations turn to the SQuaRE (Systems and Software Quality Requirements and Evaluation) series of international standards (ISO/IEC 250xx) (Rojas et al., 2025). These standards provide a comprehensive framework for defining, measuring, and assessing the quality of IT systems and software (Verdecchia et al., 2024). Among this series, ISO/IEC 25010 serves as the foundational standard, defining quality models and establishing the terminology used throughout the series (Król, 2024; Nugraha & Rachman, 2024). The recent 2023 revision has further refined these models, introducing new characteristics such as Interaction Capability and Flexibility to better align with modern ICT requirements (Jereb & Kajba, 2023; Pikh et al., 2025).

In 2023, a new version of ISO/IEC 25010 was released, superseding the 2011 edition (Rojas et al., 2025). This update was essential to reflect better the interconnected nature of modern technologies such as the Internet of Things (IoT) and autonomous systems, which require more robust evaluations of Security and Interaction Capability (El-Hajj & Gebremariam, 2024). This paper examines the application of this updated standard in logistics, where software plays a crucial role in supporting both physical and informational flows, ensuring high levels of Reliability and Performance Efficiency in increasingly complex supply chain environments (Sarwosri et al., 2023).

1. METHODS

The methodology of this research involves a qualitative analysis of the ISO/IEC 25010:2023 standard and its predecessor, augmented by a review of contemporary scientific literature regarding software quality in logistics. This analysis focuses on the "Product Quality Model," which pertains to ICT products, including software, hardware, firmware, and data components. The analysis aims to investigate the transition of the "Quality-in-Use" model from ISO/IEC 25010 to ISO/IEC 25019. This will be followed by a taxonomy analysis, which involves breaking down the nine primary characteristics and forty sub-characteristics outlined in the 2023 edition. Next, we will correlate specific quality characteristics with logistics requirements. Finally, we will conduct a measurement evaluation by identifying potential metrics for each characteristic based on the SQuaRE measurement division (ISO, 2019).

2. RESULTS

The ISO/IEC 25010:2023 standard provides a hierarchical structure that decomposes the abstract concept of "quality" into measurable components. The product quality model now consists of nine main characteristics.

3.1. OVERVIEW OF ISO/IEC 25010:2023

ISO/IEC 25010:2023 represents a significant evolution from its 2011 predecessor, expanding its scope to address modern IT systems beyond traditional software (ISO, 2023).

The 2023 version was specifically developed to accommodate contemporary technologies, including artificial intelligence, IoT devices, and autonomous systems - all of which are increasingly common in logistics operations.

The standard defines a product quality model that includes nine main characteristics, each with multiple subcharacteristics (Figure 1). This hierarchical structure allows organizations to systematically evaluate software quality across various dimensions relevant to their specific operational needs.

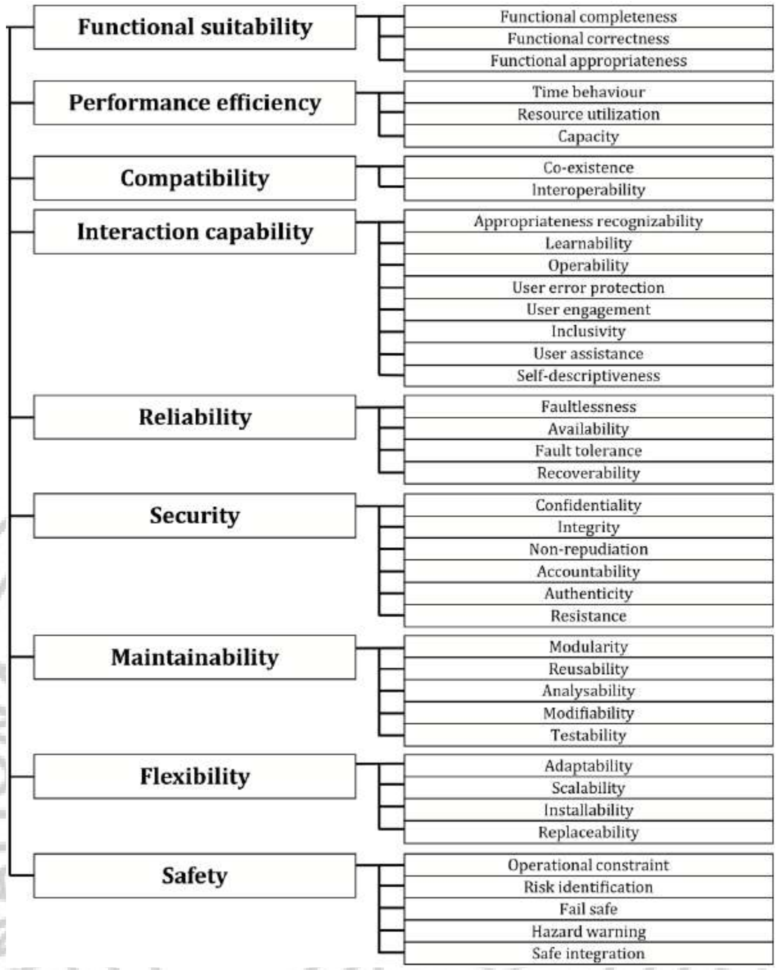

Figure 1: Product quality model structure (ISO, 2023)

3.2. FUNCTIONAL SUITABILITY

Functional suitability is the most critical characteristic for logistics software systems. As logistics operations become increasingly complex and specialized, software must provide the appropriate functionality to handle the diverse tasks required by different stakeholders and processes.

Functional completeness ensures that the system provides all necessary functions for specific logistics tasks, such as route optimization, warehouse management, inventory tracking, and customer notification systems. In the context of logistics, incomplete functionality could mean that certain shipment types are not properly tracked or that special handling requirements (e.g., temperature control) are not addressed.

Functional correctness is especially crucial in logistics, where errors can have immediate financial impacts. For example, a system that incorrectly calculates shipping costs or provides inaccurate delivery time estimates can damage customer relationships and reduce profitability.

Functional appropriateness relates to whether the functions provided facilitate the accomplishment of specified tasks and objectives without unnecessary steps. In logistics, this might mean providing only the information relevant to a particular task rather than overwhelming users with unnecessary data.

3.3. PERFORMANCE EFFICIENCY

Performance efficiency is vital in logistics operations where time sensitivity is often critical (Rojas et al., 2025). Logistics systems must be able to process large volumes of transactions efficiently, respond quickly to changing conditions, and operate reliably under peak loads.

Time behavior directly impacts logistics operations, where delays can have significant consequences. For example, during peak holiday shopping periods, a transportation management system must process thousands of shipping requests without unacceptable delays.

Resource utilization is particularly important for logistics organizations that need to balance system performance with cost constraints. Efficient use of computing resources enables more scalable solutions without unnecessary infrastructure costs.

Capacity relates to the system's ability to handle maximum loads during peak periods. In logistics, this could involve ensuring the system can handle sudden surges in transaction volume, such as when a major retail company experiences a holiday sales spike.

3.3. COMPATIBILITY

As logistics operations become increasingly interconnected, compatibility is fundamental to ensuring seamless operations across diverse systems and environments.

Co-existence refers to a logistics system's ability to operate effectively alongside other systems in the same environment without negatively impacting their performance. For example, a warehouse management system should not interfere with a separate inventory control system running on the same infrastructure.

Interoperability is perhaps even more critical in logistics, where systems often need to communicate with external partners, suppliers, carriers, and customers (Jereb, 2025). This might involve API integrations between a logistics company's transportation management system and its clients' ERP systems.

3.5. INTERACTION CAPABILITY

Interaction capability is particularly important for logistics software that is used by diverse users, including warehouse operators, transportation coordinators, customer service representatives, and clients. The quality of user interaction directly affects operational efficiency and user satisfaction.

Appropriateness recognizability is critical for logistics staff who need to identify appropriate tools for specific tasks quickly. For example, a system should clearly indicate which tools are for managing international shipments versus domestic ones.

Learnability impacts operational efficiency as logistics teams must quickly become proficient with new software. The ability of logistics personnel to learn a system within a specified time frame is essential for minimizing downtime during system implementations.

Operability affects how effectively users can complete their tasks. In logistics operations where time is often critical, a user interface that requires multiple steps to complete common tasks can significantly reduce productivity.

User error protection is especially important in logistics, where human errors can lead to high costs or safety issues. For example, a system should prevent warehouse operators from mistakenly shipping items to incorrect destinations.

3.6. RELIABILITY

Reliability is a critical quality characteristic for logistics systems where downtime or incorrect operation can have serious business consequences.

Faultlessness ensures that the system operates without faults during normal operations. In logistics, this means a route optimization system should consistently provide correct route calculations without unexpected errors.

Availability is especially critical for logistics operations that require 24/7 operation. For example, a global logistics provider must ensure that their transportation management system is available 99.9% of the time to prevent disruption to international shipments.
Fault tolerance is important for ensuring that system failures do not completely halt operations. In logistics, this could mean that if part of a system fails, alternative routes or processes can continue to operate.
Recoverability affects how quickly operations can return to normal after an incident. For example, if a shipment tracking system fails, it should be able to restore the last-known-good state of the tracking information within minutes rather than hours.

3.7. SECURITY

Security is particularly critical for logistics operations that handle sensitive information about shipments, customers, and valuable goods.
Confidentiality is important to protect sensitive logistics data from unauthorized access. This includes shipping details, inventory information, and customer data that could be exploited if leaked. Integrity is essential for ensuring that shipment information remains accurate throughout the logistics process. A system that allows unauthorized modification of shipping documents could pose significant security risks. Non-repudiation is crucial for maintaining accurate records of shipping operations that may be subject to legal disputes. It ensures that parties cannot deny their involvement in particular shipping transactions. Accountability enables logging and tracing of all actions within logistics systems, which is important for both security and regulatory compliance.
Authenticity helps ensure that only legitimate entities can access logistics systems and data, which is particularly important for preventing fraudulent activity. Resistance is vital for protecting logistics systems from various attack vectors. This includes protection against ransomware attacks that can disrupt operations.

3.8. MAINTAINABILITY

The ability to maintain and adapt logistics systems is essential given the changing nature of supply chain operations and regulations.
Modularity allows for system components to be updated independently without affecting other areas of the system. In logistics, this could mean a company can upgrade its route optimization module without disrupting its inventory management functions.
Reusability enables the same components to be used across different logistics applications, reducing development time and cost. For example, a warehouse management system component might be reused in multiple warehouse locations.
Analysability affects how quickly issues can be diagnosed and resolved in logistics operations where downtime is costly.
Modifiability is important for adapting logistics systems to changing business requirements, such as new regulatory requirements for shipping sensitive goods.
Testability ensures that changes to logistics systems can be properly validated before deployment, minimizing the risk of introducing errors into production environments.

3.9. FLEXIBILITY

Flexibility is increasingly important in modern logistics as operations adapt to volatile markets, regulatory changes, and new business models (ISO, 2023).
Adaptability is crucial to ensuring that logistics systems can operate across diverse hardware and software environments, particularly for global logistics companies.
Scalability refers to a logistics system's ability to handle increasing transaction volumes without significant performance degradation.

Installability is important for logistics systems that need to be deployed across multiple locations with varying technical environments.

Replaceability allows organizations to switch between different logistics solutions while maintaining operational continuity.

3.10. SAFETY

Safety is particularly critical in logistics operations involving hazardous materials or where failure could cause harm to people or the environment (Jereb, 2025).

Operational constraints ensure that systems operate within safe parameters, preventing unsafe conditions that could lead to accidents.

Risk identification helps identify potential hazards in logistics operations before they become critical incidents.

Fail-safe functionality is essential for systems that control critical logistics operations, where failure could cause serious harm.

Hazard warnings provide early notice of potential safety issues, enabling timely intervention.

Safe integration ensures that new systems integrate safely with existing operations without compromising overall safety.

3.11. CONTEXTUAL APPLICATION TO LOGISTICS

Logistics software operates within a complex context that requires careful consideration when applying ISO/IEC 25010:2023. As noted in the standard itself, "The priorities assigned to the quality characteristics in each model depend on the context in which the information system is used" (ISO, 2023).

For logistics systems, key contextual factors include:

The types of users and their capabilities (e.g., warehouse staff with limited computer experience vs. IT professionals)

The specific goals of users (e.g., efficient processing of small packages vs. managing critical medical supplies)

The user environment (e.g., warehouse settings, delivery vehicles, or remote offices)

The system context (e.g., technical capabilities of the environment and data sources)

In logistics operations, the functional suitability, performance efficiency, reliability, security, and safety characteristics significantly influence quality-in-use for primary users (logistics staff). These characteristics also affect maintenance tasks and quality-in-use for secondary users (IT staff) who maintain the systems.

4. DISCUSSION

The evolution of the standard acknowledges that software has evolved beyond being a standalone tool; it is now an integral component of a complex "Information System" that encompasses hardware, data, and communication infrastructure. The distinction between Security and Safety is particularly significant in logistics. Security focuses on protecting against intentional threats, such as unauthorized access to shipment databases. At the same time, Safety addresses unintentional failures, like a sensor malfunction in an automated warehouse that could lead to collisions. The 2023 standards approach to treating these aspects as separate categories enables logistics managers to allocate resources more effectively according to varying risk profiles. Recent scientific studies, such as those published in the Software Quality Journal, highlight that high-quality software can significantly reduce "Technical Debt" in logistics systems. By emphasizing "Maintainability" and "Flexibility" during the initial procurement process, companies can avoid the substantial costs of modifying inflexible legacy systems when market conditions shift.

The characteristics of "Interaction Capability" are directly linked to labor productivity; user-friendly systems that minimize errors reduce training time and mistakes. The SQuaRE framework serves not only as a collection of definitions but also as a comprehensive measurement system. For every characteristic outlined, the standard recommends specific metrics. For instance, "Performance Efficiency" can be assessed by measuring response time under peak load, whereas "Reliability" is evaluated using Mean Time Between Failures (MTBF). By employing these quantitative metrics, logistics companies can hold software vendors accountable through Service Level Agreements (SLAs).

CONCLUSION

The ISO/IEC 25010:2023 standard provides a robust, modern framework for ensuring software quality in the demanding field of logistics. By expanding the model to nine characteristics and emphasizing safety and flexibility, the standard addresses the specific challenges of contemporary digital supply chains.

Logistics organizations should adopt this standard to:

Standardize Requirements: Use the 40 sub-characteristics to define what software vendors need clearly.

Evaluate Risk: Use the new "Safety" and "Security" sub-characteristics to protect physical and digital assets.

Ensure Long-term Value: Prioritize flexibility and maintainability to ensure the software can evolve with the business.

As logistics becomes increasingly automated and data-driven, the technical integrity of software will remain the backbone of global commerce. Future research should explore the specific application of the ISO/IEC 25010:2023 model to Artificial Intelligence components within logistics, as the standard's updated definitions provide a much stronger foundation for such evaluations.

LITERATURE

1. El-Hajj, M., & Gebremariam, T. H. (2024). Enhancing Resilience in Digital Twins: ASCON-Based Security Solutions for Industry 4.0. *Network*, *4*(3), 260–294. https://doi.org/10.3390/network4030013
2. ISO. (2019). *ISO/IEC 2502n – Quality Measurement Division*. ISO. https://iso25000.com/index.php/en/iso-25000standards/52-iso-iec-2502n
3. ISO. (2023). *ISO/IEC 25010:2023(en), Systems and software engineering—Systems and software Quality Requirements and Evaluation (SQuaRE)—Product quality model*. ISO. https://www.iso.org/obp/ui/en/#iso:std:iso-iec:25010:ed-2:v1:en
4. Jereb, B. (2025). Digitalizacija – izvajanje. In *Digitalna transformacija v logistiki in managementu oskrbovalnih verig* (pp. 19–38). Univerzitetna založba Univerze v Mariboru. https://doi.org/10.18690/um.fl.2.2025
5. Jereb, B., & Kajba, M. (2023). Logistics Systems Digitalisation And Software Quality: Why It'S Important And How It'S Related To Iso/Iec 25010. *Business Logistics in Modern Management*, *23*, 413–430.
6. Król, K. (2024). Retrospective Analysis of Municipal Geoportal Usability in the Context of the Evolution of Online Data Presentation Techniques. *ISPRS International Journal of Geo-Information*, *13*(9), 307. https://doi.org/10.3390/ijgi13090307
7. Nugraha, U., & Rachman, M. A. N. (2024). *Evaluation of Ixitask Application Quality Based on ISO/IEC 25010:2023 in Marketing Division*. 139–147. https://doi.org/10.2991/978-94-6463-618-5_15
8. Pikh, I., Senkivskyy, V., Sikora, L., Lysa, N., & Kudriashova, A. (2025). Automated System for Evaluating Alternatives for Developing Innovative IT Projects. *Applied Sciences*, *15*(3), 1167. https://doi.org/10.3390/app15031167
9. Rojas, H., Renteria, R., Duran, V. M., Gutiérrez, Y. T., Cabrera, M. J. I., & Aminuddin, A. (2025). Mapping the Evolution and Future Directions of ISO/IEC 25010: A Bibliometric and Thematic Analysis. *Engineering, Technology & Applied Science Research*, *15*(5), 27530–27541. https://doi.org/10.48084/etasr.11772
10. Sarwosri, S., Rochimah, S., Yuhana, U., & Hidayat, S. (2023). Software Quality Measurement for Functional Suitability, Performance Efficiency, and Reliability Characteristics Using Analytical Hierarchy Process. *JOIV : International Journal on Informatics Visualization*, *7*, 2421. https://doi.org/10.62527/joiv.7.4.2441
11. Verdecchia, R., Scommegna, L., Picano, B., Becattini, M., & Vicario, E. (2024). Network Digital Twins: A Systematic Review. *IEEE Access*, *PP*(12), 145400–145416. https://doi.org/10.1109/ACCESS.2024.3453034