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Homepage : https://journal.i-ros.org/index.php/JOCSIS
Email : jocsis@i-ros.org

e-ISSN 3089-7564
Vol.2, No.1, March 2026

Framework Model of Sustainability Reliability Assessment for Clinical Laboratories Equipment in Vertical Hospital Indonesia

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DOI : https://doi.org/10.63230/jocsis.2.1.155

Sections Info

Article history:
Submitted: May 20, 2026
Final Revised: June 4, 2026
Accepted: June 5, 2026
Published: June 10, 2026

Keywords:
Clinical Laboratory Equipment;
Reliability Assessment;
Sustainability;
Vertical Hospitals;
VUCA Framework.

ABSTRACT

Objective: *This study aims to develop a holistic framework for assessing the reliability of clinical laboratory equipment in vertical hospitals in Indonesia. Clinical laboratories play a strategic role in supporting National Health Insurance and achieving the Sustainable Development Goals (SDGs) in economic, social, and environmental aspects. Reliable maintenance systems are crucial to ensure the equipment's reliability, maintainability, availability, and safety.* ***Method:*** *A comprehensive literature review of international journals was conducted to identify existing models and methodologies for reliability assessment. The proposed framework integrates reliability engineering, sustainability principles, and VUCA (volatility, uncertainty, complexity, ambiguity) concepts. The model consists of sub-assessment sections covering pre-analytical, analytical, and post-analytical stages, supporting equipment reliability, logistics and warehousing, and continuous equipment monitoring.* ***Results:*** *The framework provides a structured approach to identify factors influencing the reliability of laboratory equipment, enabling effective assessment and problem-solving in clinical laboratories. It facilitates continuous evaluation, supports maintenance planning, and aligns with safety and quality standards.* ***Novelty:*** *The novelty of this study lies in integrating reliability, sustainability, and VUCA concepts into a single, holistic model for clinical laboratory equipment in vertical hospitals. The framework offers practical guidance for hospital policymakers and managers to ensure accurate testing results, optimize equipment performance, and support sustainable healthcare operations.*

INTRODUCTION

Current healthcare practice requires diagnosis based on data from clinical laboratories (Nayupe et al., 2023). Medical equipment is a critical asset that contributes greatly to the effectiveness and quality improvement of healthcare services (Zamzam et al., 2021; Wang et al., 2021). A comprehensive evaluation and effective monitoring of the entire operational cycle of medical equipment asset maintenance can improve equipment reliability, availability, and safety (Abd Rahman et al., 2023). Asset and facility management is a key element in ensuring the continuity of operations of both primary and support health services (Zio, 2018). The delivery of health services and the fundamental right to safety to the public will be significantly affected if effective management is not implemented (Cesarotti & Di Silvio, 2006). Medical equipment used in supporting various services in the healthcare sector requires maintenance to oversee and care for the assets through a series of maintenance tasks over the life cycle of the equipment. The life cycle of medical equipment is like that of machinery or equipment in general which has a limited-service life and will run out after a certain period (Aridi et al., 2014).

Quality of clinical laboratories needs to be supported by reliable maintenance (Shohet & Lavy, 2004), by considering reliability, maintainability, availability, and safety (Abd Rahman et al., 2023). Reliability is one of the important parameters in determining quality with reliability instruments in the form of the ability to be measured and repeatability of the results obtained (Barker et al., 2022). The reliability system as a parameter needs to be considered from the beginning of the concept prepared (Peraturan Menteri Kesehatan RI