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Risk Management Integrated in Asset Management through ISO 55001 Implementation

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ABSTRACT

This paper presents a practical framework for integrating risk management into an asset management system (AMS) aligned with ISO 55001. Drawing on more than 20 years of experience managing water and wastewater assets and using the Samra WWTP O&M project context as a case study, we outline how risk is treated across ISO 55001 clauses (context, leadership, planning, support, operation, performance evaluation, and improvement). The outcomes include improved reliability, safety, stakeholder confidence, and business continuity. Key tools include risk registers, criticality analysis, management of change (MOC), and KPI/KRI/KCI triads.

A foundational level of knowledge and practical experience in ISO 55001 and asset management is required to fully engage with the concepts presented in this paper.

Keywords: Risk Management Integrated, Risk Management Processes, Wastewater Treatment

Background

Jordan is among the most water-scarce countries, which raises the importance of reliable wastewater treatment and reuse infrastructure. Samra O&M Co. operates under a long-term BOT contract and has implemented ISO 55001 since 2016 in an integrated management environment alongside ISO 9001, ISO 14001, ISO 45001, ISO 50001, and ISO/IEC 17025. Operations involve high field activity and risk management, yet performance demonstrates strong safety records and consistent effluent compliance.

What is Risk?

Risk is the effect of uncertainty on objectives and is a function of likelihood and consequence. In an AMS, risk cannot be avoided but can be managed by removing sources, reducing likelihood or consequences, transferring, or accepting risk within defined tolerances when opportunity exists. Effective Risk management is an iterative and dynamic process [1].

Table 1: Samra O&M project context and performance highlights

Contract model	BOT (30 years)
Population served	≈3.7 million
Treatment capacity	≈380,000 m³/day
Effluent use	100% for irrigation
Power recovery	≈95%

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Workforce and safety	≈140 field techs; multi-million LTI-free hours; strong permit-to-work culture

Risks within an AMS may be categorized as asset risks, operational risks, enterprise risks, project risks, and quality, health, safety, and environmental (QHSE) risks.

- Asset risks include equipment failure, deferred maintenance, and asset degradation.
- Operational risks relate to management of change, human factors, and process control.
- Enterprise risks include contractual, financial, reputational, and force majeure events.
- QHSE risks involve safety incidents, environmental pollution, and regulatory non-compliance.

ISO 55001 AMS Risk Management

Risk is embedded throughout ISO 55001. Asset-related risks arise across the life cycle and must be addressed with alignment, relevance, and balance. The AMS sits at the core of organizational activities; good practice for each clause is summarized below [2].

Context of the Organization

Risk management begins with the clear definition of the organizational context, as well as the scope and boundaries of the Asset Management System (AMS). Any ambiguity at this stage may lead either to the inclusion of unnecessary scope or, more critically, to the omission of essential asset-related activities. Systematic analysis of the external context (including legal, regulatory, social, and environmental factors) and the internal context (such as organizational structure, roles, responsibilities, and policies) together with clearly defined physical boundaries, provides a foundation for effective risk identification and control. Regular review and documentation of this context reduce the likelihood of regulatory non-compliance and associated penalties.

Establishing a clear project context also requires the identification of stakeholder needs, expectations, and risk appetite. As project complexity increases, structured stakeholder communication becomes essential. Maintaining comprehensive stakeholder registers, communication plans, and documented action tracking ensures transparency, alignment, and effective risk mitigation.

Typical risks at this level include contractual risks, regulatory compliance risks, stakeholder dissatisfaction, and financial penalties.

Leadership

A lack of leadership commitment represents one of the most significant risks to effective asset and risk management. Without active involvement from top management and designated leadership roles, critical risks may either be overlooked or inadequately addressed, leading to decisions that are not evidence-based and potentially resulting in severe consequences.

Clearly defined policies, strategies, objectives and well-structured roles, responsibilities, and authorities (commonly established through a Responsibility Assignment Matrix (RACI) are essential to prevent individuals from bypassing critical activities or leaving risk identification and treatment actions unmanaged within organizational "grey zones.". Developed organizations introduce a risk culture among all levels.

Effective leadership also requires continuous oversight of the organization's risk profile, including recognition of changes and emerging risks. To ensure this, a clear risk management governance structure must be established, documented, and communicated. Maintaining multidirectional communication channels and formalized decision-making processes is essential to support timely, consistent, and accountable risk management actions.

A typical risk at this level is unclear accountability, which can lead to delayed emergency response and potentially catastrophic consequences.

Planning

Risks and opportunities must be systematically addressed when establishing and reviewing asset management objectives to eliminate the risk of objectives not being achieved. Objective-related risks may arise from insufficient resources, misalignment with organizational priorities, or exposure to external factors, and therefore must be identified and planned for at the earliest possible stage.

The implementation of structured risk assessment procedures, asset criticality analysis, and business continuity planning across the asset lifecycle supports informed and resilient decision-making. Integrating these practices with total cost of ownership (TCO) analysis, supported by computerized maintenance management system (CMMS) reporting, enhances the effectiveness of asset-related decisions and strengthens organizational readiness for risk control.

While multiple forms of risk registers may be employed to address different organizational needs, alignment across these registers is essential to ensure consistency and traceability. Risk-based maintenance planning is then translated into operational actions through the work order cycle, including preventive, predictive, and corrective activities. The depth and rigor of these activities are proportionate to the level of risk and may incorporate job hazard analysis (JHA), detailed standard operating procedures (SOPs), permit-to-work systems, defined competency requirements, and task-specific instructions.

A typical example is the risk of asset failure, which is mitigated through preventive maintenance programs and redundancy planning.

Support

Key risk inputs at the support level include gaps in resources and competence, insufficient awareness of risk consequences, ineffective communication, and compromised information integrity. Resource-related risks are managed by systematically assessing gaps in human, financial, and technical resources, followed by an iterative process of prioritization and optimization to ensure that asset management objectives can be achieved. Competence risks are addressed by aligning skills with assigned responsibilities through the application of Responsibility Assignment (RACI) matrices and structured skill matrices.

Risk awareness is promoted by ensuring that personnel understand the importance of asset management and the actual or potential consequences associated with unmanaged risks. This awareness is reinforced through training, toolbox talks, and operational briefings.

Effective communication is essential for managing risk and is supported by the establishment of formal communication plans covering progress updates, improvements, reviews, and incident reporting. Designated communication representatives ensure clarity, consistency, and accountability across organizational levels.

Information-related risks are managed by ensuring the availability, accuracy, and integrity of asset information throughout all stages of the AMS. Information handling is based on its asset-related value and associated risk, considering data type, timeliness, required competencies for analysis, and secure methods of transfer. Documented information is maintained and controlled to ensure the effectiveness and reliability of the AMS.

An example of a typical risk at this level is incorrect data transfer, which is mitigated through the use of a computerized maintenance management system (CMMS) supported by targeted training.

Operation

Key operational risk inputs include risks arising from Management of Change (MOC), which may introduce new or unforeseen hazards, and outsourcing risks that require strict alignment with the Asset Management System (AMS).

Operation of the asset management system may require planned or unplanned changes to processes, procedures, or asset configurations. Such changes can introduce new risks or alter existing risk profiles. Consequently, risk assessment and control within the context of managing change represent critical elements of effective AMS operation.

Organizations must define how risks identified during planning and execution are managed and controlled, including the establishment of clear criteria for risk management processes. Both temporary and permanent changes shall be evaluated through formal Management of Change procedures, with consideration given to the potential consequences of modifications. Risk assessments associated with change ensure that new hazards are identified, evaluated, and controlled before implementation.

Outsourcing also represents a significant operational risk, particularly when subcontractors perform critical or safety-related activities. While certain risks may be contractually transferred, accountability for asset performance and compliance cannot be fully delegated. Therefore, outsourced service providers must operate in alignment with the organization's AMS, supported by defined requirements, monitoring, and oversight mechanisms.

An example of an operational risk is subcontractor non-compliance, which is mitigated through contractual risk clauses, qualification requirements, and periodic audits.

Performance Evaluation

Risks could be introduced during performance evaluation stage include data accuracy and integrity, correct interpretation of information, audit competence, and the relevance and alignment of performance indicators.

Risks associated with data management arise during the collection, processing, and transformation of raw data into meaningful information. Inaccurate, incomplete, or poorly interpreted data can lead to ineffective decision-making and delayed risk response. To mitigate these risks, performance evaluation relies on structured internal and external audits conducted by competent personnel capable of identifying nonconformities and systemic weaknesses. Self-assessment tools, such as gap analyses and maturity assessments, further support objective performance evaluation.

Management reviews play a critical role in monitoring corrective and preventive actions, evaluating key performance indicators (KPIs), and assessing changes in the organization's risk and opportunity profile. Good work practice reports and performance dashboards support transparency and traceability of results.

Performance indicators themselves introduce risks related to interpretation consistency, relevance to objectives, completeness, and alignment across organizational levels. Regular validation of indicators and structured management review processes ensure that performance measures remain meaningful and support effective risk control.

An example of a performance evaluation risk is the use of misaligned or misrepresented indicators.

Table 2: Examples of Indicators

Type	Example	Purpose
KPI (Key Performance Indicator)	Critical equipment availability; effluent quality etc.	Performance vs. targets
KRI (Key Risk Indicator)	Emergency drill index; incident frequency	Risk profile change
KCI (Key Control Indicator)	Permit compliance; audit closure rate	Control effectiveness

Improvement

The improvement activities include nonconformities, incidents, and emergency events that necessitate corrective and preventive actions. All improvement initiatives introduce potential changes to the risk profile and therefore must be subject to risk assessment prior to implementation.

Asset-related incidents and emergency situations highlight vulnerabilities within the asset management system and emphasize the importance of effective emergency response and business continuity planning for identified risks. The management of nonconformities and incidents (whether related to health, safety, environmental, or industrial performance) requires evaluation of their consequences and assessment of any resulting impacts on risk identification and risk assessment processes.

Continual improvement is driven through a combination of preventive and predictive actions, supported by nonconformity reports, corrective action programs, audit findings, management of change processes, and ongoing risk assessments. These mechanisms ensure that improvements enhance asset performance, regulatory compliance, and return on investment ROI while reducing the likelihood of recurrence of adverse events.

An example of an improvement-related risk is failure of emergency response, which is mitigated through regular emergency drills, contingency planning, and periodic review of response effectiveness.

Conclusions

Integrating risk management into an ISO 55001–compliant Asset Management System (AMS) enhances organizational resilience and supports sustained regulatory compliance. Each ISO 55001 clause provides a structured entry point for identifying, analyzing, and treating risks across the asset lifecycle. Proactive risk management reduces uncertainty and strengthens the organization's ability to achieve its objectives.

A documented risk management methodology should be applied to identify, evaluate, and treat risks, with clear linkage to business continuity planning. Risk registers supported by escalation mechanisms enable effective oversight, including consideration of low-probability, high-impact events and the organization's capability to monitor and respond to them.

The iterative risk management cycle applied within the AMS, including asset classification, risk identification, likelihood and consequence analysis, risk evaluation, selection of treatment strategies, and continuous monitoring and reassessment. Those iterations repeated till acceptable risk level reached.

Implementation of this integrated approach has resulted in sustained operational performance, extended periods without lost-time injuries, absence of significant asset failures, consistent regulatory compliance, and optimized lifecycle costs. These outcomes demonstrate that structured risk governance enhances environmental protection, reliable agricultural water reuse, and stakeholder confidence.

References

1. ISO 55000/55001/55002: Asset Management-Overview, Requirements, and Guidelines.
2. ISO 31000: Risk Management-Guidelines.