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**THEORETICAL AND METHODOLOGICAL FOUNDATIONS OF
ENVIRONMENTAL MANAGEMENT AND DIRECTIONS FOR ITS
IMPROVEMENT IN ENTERPRISE GOVERNANCE**

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Abstract. *The article examines the content and evolution of environmental management within enterprise governance. It systematizes the transition from conventional end-of-pipe control to pollution prevention, resource efficiency, sustainable development, life-cycle and risk considerations, and digitally enabled results-oriented management. International and national theoretical approaches are compared and interpreted for construction-materials enterprises. Environmental management is defined as an organizational and economic system that links environmental aspects, resource use, compliance obligations, risks and stakeholder requirements with decisions extending from corporate strategy to operational processes. The paper proposes assessing environmental management effectiveness through the combined presence of organizational maturity, measurable environmental outcomes and management response speed. This approach shifts attention from certificates and documentation alone toward process control, reliable evidence, corrective action and repeated measurement. The findings provide a theoretical basis for improving environmental management in resource- and energy-intensive construction industries.*

Keywords: *environmental management, environmental performance, ISO 14001, resource efficiency, cleaner production, sustainable development, construction industry, management responsiveness.*

INTRODUCTION

Environmental problems at industrial enterprises often arise as the combined outcome of technological processes, the choice of raw materials and energy sources, the technical condition of equipment, production discipline, and managerial decisions. Therefore, limiting environmental impact management to filters, treatment facilities, or periodic laboratory monitoring does not fully reflect the managerial nature of the problem. Environmental impact is directly associated with resource losses, costs, production risks, product markets, and stakeholder confidence.

ISO 14001:2026 defines an environmental management system as an international framework that enables an organization to systematically manage its environmental impacts, meet compliance obligations, and continually improve environmental performance [1]. The fourth edition of the standard, issued in 2026, places greater emphasis on aligning environmental protection with business outcomes, leadership, resource efficiency, and contemporary environmental priorities. This requires enterprises to focus not on producing



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more documentation, but on building management processes that generate reliable information and measurable results.

The relevance of this issue to the construction materials industry is explained by the sector's high material and energy intensity, the large number of dust-emission sources, the complexity of water and raw-material flows, and the close relationship between product-quality and environmental indicators. A deviation in dosing, equipment malfunction, or material loss can simultaneously impair product quality, increase resource consumption, and worsen environmental impacts. Environmental management in this sector must therefore translate general standard requirements into specific controls at the level of technological points, work shifts, and responsible personnel.

The purpose of this study is to systematize the theoretical and methodological content and evolution of environmental management, comparatively assess the managerial significance of existing scientific approaches, and substantiate an author-developed, results-oriented concept for construction-industry enterprises. To achieve this purpose, scientific interpretations of environmental management were analyzed; stages of its evolution were compared in terms of the object of management and decision-making frequency; industry-specific features were identified; and a three-condition model of effectiveness was developed.

LITERATURE REVIEW. Scientific perspectives on environmental management demonstrate its gradual transformation from a technical control instrument into a strategic management system. While early approaches focused mainly on keeping waste and emissions within regulatory limits, later approaches placed greater emphasis on reducing impacts at source, improving resource productivity, addressing stakeholder interests, and ensuring long-term sustainability.

The United Nations World Commission on Environment and Development interpreted economic growth, resource use, and the interests of future generations as interrelated issues [2]. UNEP conceptualized cleaner production as an integrated preventive environmental strategy applied to processes, products, and services [3]. The pollution-prevention policy of the U.S. Environmental Protection Agency likewise emphasizes reducing environmental impacts at their source rather than treating them only at the final stage [4]. The European Union's circular-economy approach has further strengthened the goals of keeping resources in the economy for longer, preventing waste generation, and managing product life cycles [5].

From the perspective of strategic management, S. Hart developed the natural-resource-based view of the firm and described pollution prevention, product stewardship, and sustainable-development capabilities as potential sources of competitive advantage [6]. M. Porter and C. van der Linde argued that appropriately designed environmental requirements can stimulate innovation and improve resource productivity [7]. These approaches make it possible to view the relationship between environmental requirements and economic performance not merely as a source of costs, but also as an opportunity for managerial innovation.



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S.A. Melnyk, R.P. Sroufe, and R. Calantone empirically assessed the relationship between environmental management systems and corporate and environmental performance, showing that the effectiveness of such systems depends on the depth of their implementation [8]. O. Boiral noted that certification may, in some cases, become a formal structure detached from day-to-day practice [9]. Accordingly, the existence of a certificate is a necessary but insufficient indicator of system effectiveness.

Among scholars from the CIS, G.S. Feraru interprets environmental management as an activity that coordinates the ecological and economic development of an enterprise through strategic, tactical, and operational objectives [10]. N.V. Pakhomova and co-authors consider environmental economics, environmental costs, incentives, auditing, and corporate-management instruments within a unified institutional framework [11]. I.A. Kostylev and N.N. Yashalova associate the contemporary development of environmental management with low-carbon strategies, the green economy, and information transparency [12].

In the construction and engineering field, R. Horry, C.A. Booth, and A.-M. Mahamadu have examined the benefits and barriers of environmental management systems and their links to sustainable-development objectives [13]. Uzbek scholars A.V. Vakhobov and Sh.Kh. Khajibakiev substantiate the role of aligning resource efficiency and environmental constraints with economic growth in the transition to a green economy [14]. M.T. Askarova, J.J. Jamolov, and Kh.S. Khadjaev systematize the institutional and sectoral mechanisms of Uzbekistan's green transition [15]. However, adapting these approaches to the shift-level operations, technological points, and evidence chains of construction-materials enterprises requires additional methodological development.

Table 1.

Comparative analysis of theoretical approaches to environmental management

Approach	Main focus	Scientific contribution	Significance for enterprise management
Regulatory-control approach	Emission, effluent, and waste standards	Limiting pollution and ensuring compliance	Necessary baseline control; often manages consequences rather than causes
Cleaner production	Reducing impact at source	Integrating prevention and resource efficiency	Reducing losses of raw materials, water, and energy through technological measures
Sustainable development	Balance among enterprise, society, and resources	Long-term, stakeholder-oriented perspective	Joint consideration of investment, territorial impacts, and future resource risks



Approach	Main focus	Scientific contribution	Significance for enterprise management
Natural-resource-based strategy	Environmental capabilities and competitive advantage	Interpreting pollution prevention as a strategic resource	Integrating environmental competence into product, technology, and market strategy
Innovation and competitiveness	Requirements, innovation, and resource productivity	Viewing environmental constraints as an opportunity for efficiency improvement	Meeting requirements through process redesign rather than minimum-cost compliance alone
Systemic and process-based approach	Policy, objectives, processes, auditing, and improvement	Integrating environmental tasks into the management cycle	Bringing responsibility, evidence, measurement, and management review into a unified system
Results-oriented and digital approach	Data quality, rapid deviation detection, and measurable results	Transition from documentation to a data-decision-action chain	Early detection of deviations at shift and technological-point level, action tracking, and re-measurement

Source: compiled by the author based on an analysis of sources [1-15].

RESEARCH METHODOLOGY. The study combines systemic, evolutionary, comparative, and process-based approaches. The systemic approach made it possible to view environmental management as an interconnected set of policy, objectives, responsibilities, resources, processes, information, auditing, and improvement elements. The evolutionary approach was used to identify historical changes in the object of management, the timing of decisions, responsibility, and the measurement of outcomes.

The comparative analysis identified the common and distinctive features of international standards, sustainable development, cleaner production, the natural-resource-based strategic view, and theories of environmental innovation. These approaches were compared using four criteria: the object of management, the timing of decision-making, the type of evidence, and enterprise-level outcomes. Adaptation to the construction materials industry took into account the interrelationships among dust emissions, energy and water use, raw-material losses, equipment condition, and shift-level data.

As a methodological boundary, the article focuses on the theoretical foundations of environmental management and the logic of enterprise-level management. A detailed comparison of ISO 14001 and EMAS, integrated-assessment calculations, and FONOK-



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based operational monitoring are reserved for separate subsequent articles. This delimitation is intended to prevent duplication of the scientific ideas across the four articles.

RESULTS AND DISCUSSION. The development of environmental management is best understood not merely as a sequence of standards and dates, but as a transformation in management logic. Over time, the answers to the questions 'What is managed?', 'When is a decision made?', 'Who is responsible?', and 'How is the result measured?' have changed. On this basis, six stages are distinguished.

At the first stage, priority was given to treating the consequences of final emissions and waste. At the second stage, attention shifted to the source of impact - technological processes, raw materials, and resource consumption. The third stage linked enterprise decisions with the interests of society and future generations. The fourth stage integrated environmental policy, planning, auditing, and management review into a standardized system.

At the fifth stage, risks, opportunities, stakeholders, and the product life cycle became part of strategic decision-making. At the sixth stage, climate change, circularity, data quality, and rapid digital management are becoming priority issues. This stage does not replace earlier engineering and regulatory instruments; rather, it supplements them with prevention, resource efficiency, and evidence-based decision-making.

Table 2.

Management stages in the evolution of environmental management

Stage and period	Object of management	Decision and primary evidence	Manifestation in the construction industry
I. 1960s-1970s	Final emissions, effluents, and waste	After the event; laboratory report and regulatory limit	Filters and treatment facilities; mainly addressing consequences
II. 1980s	Processes, raw materials, energy, and water	Technological cycle; resource balance and prevention	Accurate dosing, enclosed transport, elimination of leaks
III. 1987-1995	Enterprise-society-natural resource relationship	Long-term program; environmental and social information	Joint assessment of territory, population, resource base, and investment
IV. 1996-2014	Policy, objectives, processes, responsibility, and auditing	Planned cycle; documentation, internal audit, management review	Systematizing environmental tasks and linking certification to results



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Stage and period	Object of management	Decision and primary evidence	Manifestation in the construction industry
V. 2015-2025	Context, risk, supply, and life cycle	Project and strategy; risk register and indicators	Aligning environmental requirements from procurement to finished product
VI. From 2026 onward	Climate, circularity, data quality, and rapid deviation detection	Shift and real-time measurement, evidence, and action record	Early detection of deviations, correction, re-measurement, and reliable information

Source: developed by the author based on sources [1-9].

Sector-specific features of environmental management in the construction industry

The first distinctive feature of environmental management in construction-materials production is the dispersed nature of environmental-impact sources. Dust can arise not only from the main production unit, but also from transport routes, open storage areas, loading and unloading operations, conveyor transfer points, and wind action. For this reason, an aggregate emissions indicator is insufficient for identifying the cause of a problem; evidence is required by technological point and time interval.

The second feature is the two-way relationship between product quality and environmental performance. Incorrect dosing or an inappropriate moisture regime can deteriorate product characteristics while simultaneously increasing the consumption of cement, water, and energy. Equipment malfunction increases defects and downtime, which in turn raises reprocessing and waste volumes. Thus, environmental performance often improves together with technological discipline and the stability of product quality.

The third feature is that outcomes emerge over different time horizons. Deviations related to dust or water leakage may become visible within a work shift, energy intensity may be assessed monthly or quarterly, while the effect of modernization may appear over an annual period. The fourth feature is the fragmentation of evidence across different departments: laboratory reports, meter readings, process logs, maintenance records, waste-movement documents, and accounting costs may be stored separately. Linking these data by time, equipment, and product batch is a key condition for identifying environmental cause-and-effect relationships.

Author's concept: the management chain from strategy to results

Based on the analysis, the following author-developed definition is proposed: environmental management is an organizational and economic management system aimed at proactively reducing adverse impacts and continually improving environmental performance by linking an enterprise's environmental aspects, obligations, resource



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consumption, risks, and stakeholder requirements with decisions extending from corporate strategy to the work-shift level.

This definition emphasizes that the object of management is not an individual waste stream, but the system of processes that generates it; that responsibility is distributed not only to the environmental unit but also to management and process owners; and that outcomes encompass resource efficiency and risk reduction in addition to legal compliance. Management information should flow from strategy to operational activities, while information about deviations should move in the opposite direction to support managerial decision-making.

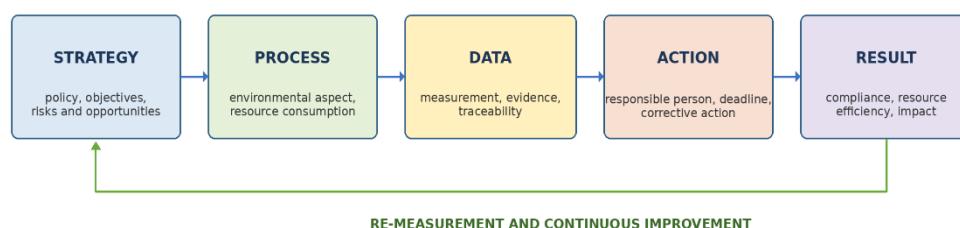


Figure 1. The management chain from strategy to results in environmental management

Source: developed by the author.

If any of the five links in the scheme is broken, system effectiveness declines. If strategy is not translated into processes, environmental objectives remain declarative; if reliable data are not generated by the process, the cause of deviations cannot be identified; if data are not converted into actions with assigned responsibility and deadlines, losses continue; and if results are not re-measured, the effectiveness of the action cannot be demonstrated. Continuous improvement is therefore presented as a feedback loop returning from results to strategy.

According to the author's position, the effectiveness of environmental management is manifested only when three conditions are simultaneously present. The first is organizational maturity: policy, objectives, responsibilities, competence, documentation, and auditing function as an interconnected system. The second is environmental performance: measurable positive changes are observed in resource consumption, emissions, waste, and compliance. The third is management responsiveness: deviations are identified, their causes are analyzed, responsibilities and deadlines are assigned, and the outcomes of corrective actions are re-measured.

If any one of these three conditions is absent, the system cannot be regarded as fully effective. A system with well-developed documentation but unchanged outcomes becomes formalistic. A temporary improvement in results without clearly defined responsibilities and processes is not sustainable. If measurement exists but action is delayed, environmental and

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economic losses continue. This concept serves as a methodological criterion for selecting indicators and calculation methods in subsequent research.

SCIENTIFIC RESULTS. The first scientific result is the systematization of the evolution of environmental management into six stages and its interpretation as an expansion of the object of management along the sequence 'end-of-pipe waste - process - enterprise - life cycle - data and decision chain.' In this progression, decision-making shifts from post-event control toward project-level, shift-level, and operational management, while responsibility expands from the environmental service to management and process owners.

The second result is the development of an author-defined organizational and economic interpretation of environmental management. The definition simultaneously encompasses environmental aspects, resource consumption, compliance obligations, risks, and stakeholder requirements, linking them to decisions from the strategic level to operational processes.

The third result is the proposed concept for evaluating system effectiveness through the unity of organizational maturity, environmental performance, and management responsiveness. Rather than treating certification as the sole criterion, this approach promotes results-oriented management based on evidence, corrective action, and repeated measurement.

The fourth result is the identification of sector-specific features of environmental management in construction-materials enterprises: dispersed impact sources, the interdependence of quality and environmental performance, the formation of results across different time horizons, and the fragmentation of evidence across organizational units. These features substantiate the need to adapt general standard requirements to the level of technological points, work shifts, and product batches.

CONCLUSIONS AND PRACTICAL RECOMMENDATIONS

1. 1. Environmental management is not merely a set of technical treatment measures; it is a corporate management system that integrates strategy, processes, resources, responsibilities, and information.

2. 2. The evolution of environmental management is characterized by a shift from recording consequences to proactively managing sources of impact, and from periodic reporting to rapid, evidence-based decision-making.

3. 3. Implementing ISO 14001 requirements at an enterprise should not be limited to obtaining certification; every environmental objective should be translated into a technological task with an assigned responsible person, deadline, indicator, and supporting evidence.

4. 4. In the construction materials industry, rather than managing environmental and quality indicators separately, dosing, energy, water, equipment condition, and waste flows should be considered within a unified process logic.

5. 5. The effectiveness of an environmental management system should be assessed by jointly considering organizational maturity, measurable environmental



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performance, and management responsiveness. This concept provides the theoretical basis for a subsequent integrated assessment methodology.

6. Practical implementation is recommended to begin with a single workshop or technological line by testing the chain 'environmental aspect - measurement - deviation - responsible person - action - re-measurement,' followed by expansion to the enterprise level.

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