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THE ROLE OF ARTIFICIAL INTELLIGENCE IN ENTERPRISE MANAGEMENT BASED ON QUALITY MANAGEMENT

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Abstract

This article examines the role and practical significance of artificial intelligence technologies in improving quality management systems. In the context of digital transformation, quality management in enterprises extends beyond the inspection of final products and requires the near-real-time analysis of large volumes of process data, the early detection of quality deviations, the prediction of factors that cause defects, and the optimisation of managerial decisions. The study employs systems analysis, comparative analysis, content analysis, a process approach, and conceptual modelling. It proposes a conceptual mechanism for integrating artificial intelligence tools into the Plan–Do–Check–Act (PDCA) cycle of quality management. This mechanism encompasses data collection, intelligent analysis, quality risk prediction, the formulation of an optimal decision alternative, the implementation of corrective measures, and continuous performance monitoring. The findings indicate that artificial intelligence can improve the speed and accuracy of quality control, reduce human error, and strengthen enterprise competitiveness.

Keywords

quality management, artificial intelligence, digital transformation, ISO 9001, ISO/IEC 42001, machine learning, predictive analytics, machine vision, PDCA, quality control, enterprise efficiency.

INTRODUCTION

Intensifying competition in the global economy requires enterprises to ensure consistent product and service quality, respond promptly to changing customer requirements, and continually improve their production and service delivery processes. Although traditional quality management systems rely on standardisation, documentation, auditing, inspection, and corrective measures, the rapid growth in data volumes within the digital economy exceeds the capacity of

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human analysis. Consequently, artificial intelligence (AI) is becoming a new technological component of quality management.

Artificial intelligence refers to a set of algorithms and information systems capable of processing data, identifying patterns, performing classification and prediction, generating recommendations, and automating certain decisions. Technologies such as machine learning, computer vision, natural language processing, anomaly detection, and predictive analytics are particularly relevant to quality management. In addition to detecting defects, these technologies enable the advance assessment of the likelihood that defects will occur.

Integrating AI tools with the core principles of ISO 9001—customer focus, leadership, engagement of people, the process approach, improvement, evidence-based decision-making, and relationship management—enhances the analytical capacity of quality management. In addition, ISO/IEC 42001 establishes a management system approach to the responsible governance of artificial intelligence at the organisational level, risk control, and continual improvement.

The purpose of this study is to substantiate the organisational and economic significance of integrating artificial intelligence technologies into enterprise quality management systems and to develop an AI-enabled quality management mechanism. The research objectives are to classify areas of AI application, identify the mechanisms through which AI affects quality indicators, assess implementation risks and limitations, and propose a conceptual model integrated with the PDCA cycle.

METHODOLOGY

This study adopts a theoretical and conceptual design based on the systematisation of international standards and scholarly approaches to quality management, digital transformation, and artificial intelligence governance. Systems and process approaches provide its methodological foundation. The systems approach enables quality management to be examined as a set of interrelated processes, while the process approach allows the input data, operations, control points, and outputs at each stage to be distinguished.

Comparative analysis is used to compare the characteristics of traditional quality control with those of AI-enabled quality management. Content analysis examines management principles, risk-based thinking, monitoring, and continual improvement in ISO 9001 and ISO/IEC 42001. Conceptual modelling is used to develop a mechanism for incorporating AI tools into the Plan, Do, Check, and Act stages of the PDCA cycle.

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The study proposes evaluating effectiveness using indicators such as quality-related costs, defect rates, rework volumes, customer complaints, process cycle times, prediction accuracy, equipment downtime, and decision-making speed. The effects of AI implementation should therefore be assessed comprehensively in terms of economic, organisational, and customer-oriented outcomes, as well as technical accuracy.

ANALYSIS AND RESULTS

The analysis identifies five principal functions of artificial intelligence in quality management: (1) automated quality control; (2) prediction of quality deviations; (3) optimisation of process parameters; (4) intelligent analysis of customer feedback; and (5) managerial decision support. Each of these functions influences particular stages of quality management.

Table 1. Applications of artificial intelligence technologies in quality management and their expected outcomes

AI application area	Technology used	Quality management function	Expected outcome
Visual quality inspection	Computer vision	Automated defect detection	Faster and more consistent inspection
Predictive quality analysis	Machine learning	Advance assessment of quality deviations	Fewer defective products and less rework
Predictive maintenance	AI analytics	Prediction of equipment failures	Reduced downtime and quality risks
Voice-of-the-customer analysis	NLP	Classification of reviews and complaints	Faster responses to customer requirements
Decision support	AI/DSS	Recommendations on optimal parameters	Faster and better-informed decisions

The first major finding concerns the transition from a reactive to a predictive model of quality control. In traditional quality control, defects are often detected after a product has been manufactured. By contrast, an AI-enabled system can analyse sensor data, equipment parameters, previous defects, and production conditions to identify the likelihood of quality deviations while the process is still underway. This allows an enterprise to take managerial action before a problem arises, rather than only after it has occurred.

The second finding concerns the strengthening of evidence-based decision-making. Quality managers often analyse audit findings, laboratory results, customer complaints, and production indicators separately. AI can integrate these

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data into a unified analytical environment and identify previously unrecognised relationships. For example, identifying a relationship between a raw material batch, equipment temperature, an operator's shift, and a particular defect type can accelerate root cause identification.

The third finding concerns the optimisation of quality costs. In managing the balance between prevention, appraisal, and failure costs, AI-generated predictions help direct resources towards control points associated with the greatest risks. This enables risk-based inspection rather than the inspection of all operations at the same level of intensity.

The fourth finding concerns the development of customer-focused quality management. Natural language processing tools can analyse large volumes of customer reviews, enquiries, and complaints to identify recurring problems, customer sentiment, and emerging requirements. These insights can be incorporated directly into improvements to product or service design.

The study proposes the following sequential mechanism for integrating AI into enterprise quality management: data generation → data quality validation → AI-based analysis and prediction → quality risk assessment → formulation of managerial decision alternatives → human verification → corrective or preventive action → outcome monitoring → model and process improvement. Within this mechanism, AI is regarded as an analytical system that supports timely, evidence-based decisions, rather than as a complete replacement for managers.

The proposed mechanism is linked to the PDCA cycle as follows. At the Plan stage, AI uses historical data to predict quality risks and support the setting of performance targets. At the Do stage, sensors and digital systems collect process data, while algorithms monitor operating parameters. At the Check stage, actual results are automatically compared with plans and standards, and anomalies are detected. At the Act stage, recommendations addressing root causes are generated and improvement measures are implemented.

The findings indicate that artificial intelligence should be regarded not merely as a tool for automating quality management, but as a factor that changes the architecture of management itself. Following AI implementation, the quality department's responsibilities shift from recording defects towards data management, risk prediction, and proactive process optimisation. This requires quality managers to develop competencies in analytical literacy, data handling, and the critical evaluation of algorithmic outputs.

Nevertheless, AI implementation does not automatically guarantee improvements in quality. Algorithmic outputs depend on the completeness and

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reliability of input data. Inaccurate or biased data may produce erroneous predictions. Furthermore, model explainability, information security, personal data protection, employee resistance, and the costs of technological infrastructure represent significant constraints.

A phased approach to AI implementation in enterprises is advisable. Initially, a single process should be selected that has a substantial impact on quality and for which sufficient data are available. The outcomes of the pilot project should be evaluated using key performance indicators (KPIs). At the next stage, the algorithm should be integrated with enterprise information systems, such as enterprise resource planning (ERP), manufacturing execution systems (MES), customer relationship management (CRM), or quality management systems (QMS). A successful solution can subsequently be scaled to other processes.

Human oversight is particularly important. High-risk quality decisions, especially those involving safety, consumer rights, or substantial financial consequences, should not be delegated exclusively to algorithms. The human-in-the-loop principle requires a responsible specialist to review AI-generated recommendations and a human to make the final decision. This approach is consistent with responsible AI governance under ISO/IEC 42001.

This area is particularly relevant to enterprises in Uzbekistan, as the deepening digitalisation of manufacturing and service sectors is creating a new data foundation for quality management. However, AI projects should be preceded by process standardisation, the development of a data architecture, the enhancement of employees' digital competencies, and the identification of indicators for measuring economic benefits.

CONCLUSIONS AND RECOMMENDATIONS

The findings indicate that artificial intelligence substantially enhances the responsiveness, accuracy, and predictive capabilities of quality management. AI-enabled machine vision supports automated defect detection; machine learning enables the prediction of quality deviations; natural language processing (NLP) facilitates the systematic analysis of customer feedback; and predictive analytics enables the advance assessment of technological and managerial risks.

As a theoretical and practical contribution, the study proposes a conceptual mechanism for integrating AI tools into the PDCA cycle of quality management. Its central feature is the transition from a model based on "problem identification and correction" to one based on "problem prediction and prevention".

Three priority conditions for AI implementation in enterprises are identified: first, establishing a high-quality, integrated data foundation; second, linking

technological solutions to business and quality KPIs; and third, maintaining human oversight of algorithmic recommendations. When these conditions are met, AI can help reduce quality costs, increase customer satisfaction, shorten decision-making time, and strengthen an enterprise's long-term competitiveness.

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