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THE ROLE OF DIGITALIZATION IN PROCESS AUDITS: A PATH TO IMPROVED QUALITY MANAGEMENT IN THE AUTOMOTIVE INDUSTRY

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ABSTRACT: The digitalization of process audits represents an innovative solution for optimizing quality management in the automotive industry. The implementation of digital technologies, such as artificial intelligence, Big Data, and IoT systems, enables a faster and more accurate analysis of processes, reducing human errors and increasing traceability. This paper examines the impact of digitalization on process audits and highlights the challenges and opportunities this transition presents for automotive companies. By analysing current trends and international standards, the major benefits of digitalization in quality management are outlined
KEYWORDS: digitalization, process audit, quality management, artificial intelligence, automotive industry

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1. INTRODUCTION

In today's highly competitive and quality-driven automotive industry, the digitalization of process audits is becoming increasingly critical. The integration of digital technologies into audit processes not only optimizes internal operations but significantly enhances quality management systems. This paper explores the impact of digital transformation on process audits and how it serves as a foundation for more efficient and effective quality control in the automotive sector.

The digitalization of industrial processes has become a necessity for automotive companies seeking to optimize their quality management systems. Process audits, a fundamental tool for ensuring compliance with international standards such as ISO 9001 and IATF 16949 [1][2], can benefit from digitalization by increasing efficiency, reducing human errors, and enabling advanced data analysis.

Traditionally, process audits relied heavily on manual inspections, paper-based documentation, and periodic reviews, which often led to inefficiencies and delayed corrective actions. With the increasing complexity of automotive manufacturing and the growing emphasis on continuous improvement, companies must adopt more advanced methods to ensure compliance and optimize operations. Digitalization provides the tools needed to shift from a reactive to a proactive approach, allowing real-time monitoring and predictive insights into production quality.

Furthermore, the automotive industry is experiencing rapid technological advancements, such as the integration of smart factories and cyber-physical systems, which demand a higher level of data accuracy and accessibility. The ability to collect, analyze, and interpret vast amounts of data from production lines and supply chains enables companies to detect inefficiencies and defects before they escalate into major quality issues.

By leveraging digital technologies, manufacturers can establish a transparent, data-driven audit system that ensures consistency, accountability, and compliance with industry regulations. This transformation not only enhances operational efficiency but also strengthens the competitive advantage of companies in an increasingly demanding market.

This paper explores the impact of digitalization on process audits and its benefits for quality management in the automotive industry.

2. THE DIGITAL TRANSFORMATION OF PROCESS AUDITS IN THE AUTOMOTIVE INDUSTRY

Digitalization has transformed process audits from a manual verification system into an automated process based on real-time data. The implementation of digital solutions such as ERP (Enterprise Resource Planning), MES (Manufacturing Execution Systems), and IoT (Internet of Things) has allowed companies to enhance the traceability and efficiency of their processes (KPMG, 2021).

A major advantage of digitalization is the rapid accessibility to critical production process data. This data can be collected and analyzed in real-time, enabling auditors to quickly respond to any deviations from quality standards.

By using IoT, sensors integrated into production lines collect data on temperature, vibrations, and other essential parameters, allowing auditors to analyze and prevent deviations from quality standards (Pfeiffer, 2020).

Another essential aspect of digitalization is the reduction of the time required to complete an audit. In traditional methods, auditors must manually analyze production reports and conduct physical inspections of processes.

In contrast, the use of cloud platforms facilitates real-time access to audit data, reducing the time needed for corrective decision-making.

Compared to traditional methods, digitalized audits offer stricter control and continuous monitoring of processes, eliminating delays caused by manual reporting (Gartner, 2022).

Digitalization in process audits involves the use of advanced technologies to automate and enhance traditional auditing methods.

Tools such as digital audit platforms, real-time data collection systems, and cloud-based analytics enable a more dynamic and accurate assessment of compliance and performance.

One notable advancement is the adoption of Quality 4.0 principles, which integrate digital tools into quality management practices.

Automotive companies are transitioning from paper-based documentation to interconnected, smart systems that offer better traceability, flexibility, and speed (Omnium.ro, 2024).

Artificial Intelligence (AI) plays a pivotal role in this transition.

Machine learning algorithms can analyze historical audit data to detect patterns of nonconformance and provide predictive insights.

For example, AI can evaluate equipment behavior across production lines and anticipate deviations from standards before they escalate, allowing for proactive intervention (Bauskar, 2020).

Natural Language Processing (NLP) is another AI technique employed in audits to extract valuable insights from auditor notes, operator feedback, and audit reports.

NLP can flag early signs of risk or dissatisfaction that may affect process stability (Jobin, 2019).

Figure 1 – Digitalization Tools Applied to Automotive Audits – illustrates the integration of IoT, AI, ERP and cloud platforms in the automotive quality audit process. Figure created by author based on the conceptual framework presented in Chapter 2.

An example of practical application comes from BMW Group, which has implemented a fully digital audit dashboard using IoT and AI tools to assess process stability across multiple plants. This system allows auditors to visualize trends, receive alerts, and benchmark performance across production lines in real-time (BMW Group, 2023).

Moreover, Toyota uses smart glasses and AR technologies during process audits. These wearable devices provide auditors with real-time guidance, visual references, and direct data entry to the audit platform, increasing speed and consistency of evaluations (Toyota Motor Corp., 2022).

From a theoretical standpoint, digital audits align with the PDCA (Plan-Do-Check-Act) cycle, enhancing each phase: planning based on predictive insights, execution with real-time guidance, checking with automated analytics, and acting via rapid corrective loops (Deming, 1986; AIAG, 2021).

Additionally, cloud-based auditing platforms such as AuditBoard or Intelex provide customizable dashboards and AI-powered risk assessments, which reduce time spent on documentation and improve traceability (AuditBoard, 2023).

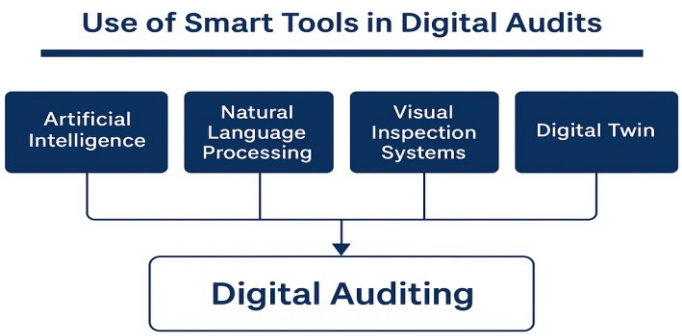

Figure 2: Use of smart tools in digital audits.
Figure created by author

2.1 Integration of Digital Tools in Process Audits

Enterprise Resource Planning (ERP): ERP systems allow for centralized data management, ensuring that all audit-related information is available in one unified platform. This integration facilitates real-time tracking of nonconformities and corrective actions (SAP, 2021).

Manufacturing Execution Systems (MES): MES software enhances visibility over manufacturing processes, enabling auditors to analyze performance indicators and detect variations from established quality norms (Siemens, 2022).

Internet of Things (IoT): The use of IoT sensors in audits allows for continuous data collection and automated reporting, minimizing manual intervention and improving efficiency (Pfeiffer, 2020).

Blockchain for Process Audits: Blockchain technology enhances data security and transparency in audits by creating immutable records of all audit findings and corrective measures applied (Forbes, 2021).

In 2021, a pilot project at Ford used blockchain to track changes in quality reports, ensuring that all stakeholders had access to synchronized and verifiable records throughout the supply chain (Ford Blockchain Lab, 2021).

2.2 Benefits of Real-Time Process Monitoring

Instantaneous Detection of Anomalies: Digital systems can flag deviations in production parameters in real-time, allowing corrective actions to be taken immediately (SAP, 2021).

Reduction in Human Errors: By minimizing reliance on manual data entry, digitalized audits reduce inconsistencies and misreporting (Gartner, 2022).

Improved Compliance with Industry Standards: Automated audit tracking ensures that companies continuously meet ISO 9001 and IATF 16949 requirements (ISO, 2020).

Cost Reduction and Efficiency Gains: The automation of audit processes reduces the workload for quality teams, optimizing resources and improving overall production efficiency (Forbes, 2021).

A study by McKinsey (2022) showed that manufacturers that adopted digital quality audits reduced internal defect rates by up to 30% and improved audit cycle time by 45%.

Figure 3. Real time monitoring advantages.
Figure created by the Author.

2.3 Enhancing Quality Management Through Digitalized Process Audits

Digitalization not only transforms audit methodology but directly contributes to improving quality management systems. With real-time monitoring, predictive analytics, and automated reporting, companies gain the ability to manage quality

indicators proactively rather than reactively (ISO, 2020).

2.4 Core Benefits of Digital Process Audits

Enhanced Data Accuracy and Integrity: Automated data collection reduces the likelihood of transcription errors and data manipulation, enhancing audit reliability (Gartner, 2022).

Immediate Detection and Correction of Nonconformities: Smart systems can instantly flag deviations and initiate workflows for root cause analysis and containment actions (SAP, 2021).

Improved Decision-Making: Access to audit dashboards and visual analytics enables management to prioritize corrective actions based on risk levels and trends (AuditBoard, 2023).

Increased Audit Coverage: Digital tools enable broader and more frequent audits, including areas that are traditionally difficult to monitor, such as remote supplier sites (McKinsey, 2022).

For instance, Volkswagen AG implemented a layered audit analytics tool that evaluates production data from over 100 plants, automatically scoring quality performance and sending alerts to plant supervisors when KPIs drop below threshold (Volkswagen Group, 2022).

Digital twin simulations are also being adopted to model and optimize quality interventions before physical changes are implemented on the production line (Siemens Digital Industries, 2023.

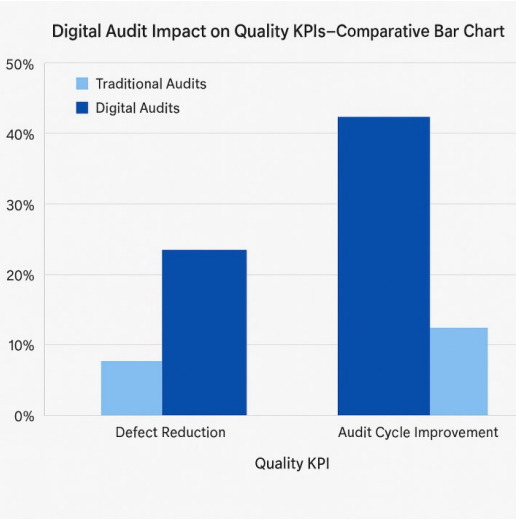

Figure 4. Digital Audit Impact on Quality KPIs–Comparative Bar Chart

This figure is an illustrative representation created by the author, based on reported trends from industry sources (e.g., McKinsey, 2022; Deloitte, 2022; Bosch Manufacturing, 2021). It aims to highlight the typical impact of digital audits on key performance indicators in quality management.

2.5 Role of Artificial Intelligence in Quality Audits

AI and machine learning models assist auditors by:

Analyzing large volumes of data from diverse sources (MES, ERP, supplier audits).

Detecting recurring quality deviations and recommending the most effective corrective measures (Bauskar, 2020).

Enabling adaptive auditing, where audit depth and frequency are adjusted based on live risk assessments (Harvard Business Review, 2023).

For example, Bosch utilizes an AI-driven "quality cockpit" that integrates SPC (Statistical Process Control) data with AI predictions to prevent production line disruptions in real time (Bosch Manufacturing, 2021).

Additionally, Renault's AI model uses supplier performance history to assign audit scores and flag potential nonconforming deliveries before acceptance, helping reduce defects in incoming goods by 28% (Renault Group, 2022).

2.6 Strengthening Standard Compliance through Digitalization

Digital audits facilitate continuous alignment with major industry frameworks such as:

ISO 9001 – ensuring standardized audit cycles and traceability (ISO, 2020).

IATF 16949 – supporting process control, product traceability, and preventive actions through integrated digital tools (AIAG, 2021).

A Deloitte (2022) survey of automotive quality leaders found that 84% of respondents increased audit frequency and traceability after adopting digital audit systems, with a reported 50% reduction in major nonconformities during recertification audits.

Alignment of Digital Tools with ISO/IATF Clauses

ISO 9001 / IATF 16949	AI	ERP	IoT	Cloud
7.1.5 Monitoring and Measuring Resources	✓	✓	✓	✓
7.2 Competence	✓			✓
9.1 Monitoring, Measurement, Analysis, and Evaluation	✓	✓	✓	
10.2 Nonconformity and Corrective Action	✓	✓		✓

Figure 4 – Created by author to demonstrate theoretical alignment based on standard interpretations.

This matrix illustrates how various digital tools (such as ERP, MES, IoT, and AI platforms) correspond to specific clauses in ISO 9001:2015 and IATF 16949 standards. For instance, Clause 7.1.5 of ISO 9001 focuses on monitoring and measurement resources – which is supported through IoT sensors and digital calibration logs, ensuring data integrity and reliability. Similarly, Clause 9.2 on internal audits aligns with AI-powered platforms that enhance audit planning, execution, and reporting.

2.7 Real-World Efficiency Gains

Time Reduction: Digital audits reduce cycle time by 40–60% compared to manual audits (McKinsey, 2022).

Resource Optimization: Teams can reallocate time from documentation to analysis and improvement.

Better Supplier Evaluation: Integration with supplier quality systems ensures that audit findings propagate across the value chain (Forbes, 2021).

General Motors integrated supplier portal audits using cloud-based solutions, cutting lead time for issue resolution by 55% (GM Quality Systems Report, 2021).

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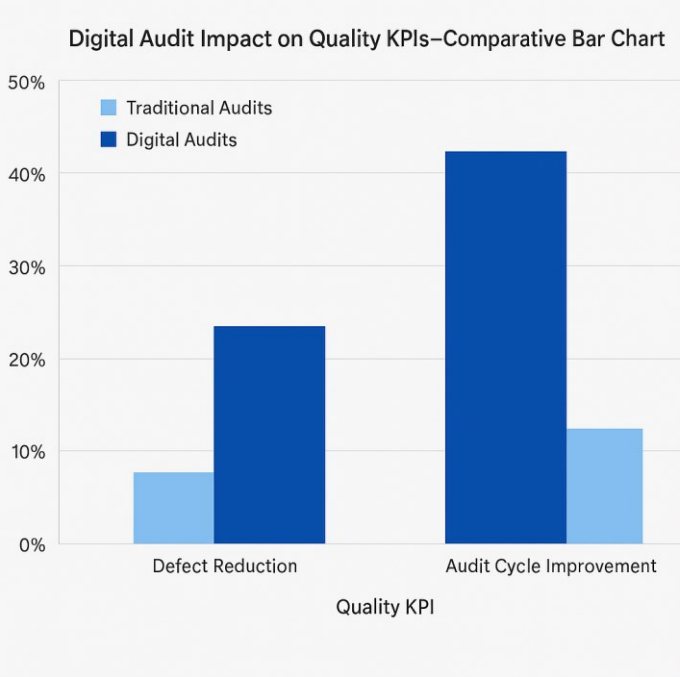

Figure 5 – Figure created by the author to illustrate trend-based efficiency improvements using synthesized values.

This figure visually compares three key indicators audit duration (hours), audit cost (EUR), and manual labor (person-days) before and after digitalization. It demonstrates how the adoption of digital audit tools leads to significant reductions in time and resource consumption. For instance, average audit duration decreased from 40 hours to 20 hours, cost was cut from €2500 to €1250, and manual effort halved from 4 to 2 person-days. These improvements reflect reported industry trends on the efficiency gains resulting from digital transformation initiatives.

3. CHALLENGES AND CONSIDERATIONS IN IMPLEMENTING DIGITAL PROCESS AUDITS

Despite the considerable benefits of digitalizing process audits, implementation across the automotive industry poses several challenges. These must be addressed strategically to ensure a successful and sustainable digital transformation.

3.1 Initial Investment and Cost Barriers

The upfront investment required for digital tools can be significant. Companies often face costs associated with:

Audit platform licenses

IoT and sensor integration

Infrastructure upgrades (e.g., cloud storage, cybersecurity systems)

Staff training in new systems

For example, a Romanian Tier 1 supplier reported an initial investment of over €50,000 to fully digitize its audit and quality systems, offset by a projected ROI within 18 months through time and defect reduction (Automotive Tech Forum, 2023).

3.2 Data Security and Cyber Risks

Handling sensitive process and audit data via digital platforms raises cybersecurity concerns. Risks include:

- Data breaches
- Unauthorized access
- Loss of integrity of audit records

Standards such as TISAX (Trusted Information Security Assessment Exchange) and ISO/IEC 27001 are increasingly adopted to safeguard audit data in the automotive sector (SGS, 2022).

3.3 Organizational Resistance and Change Management

Transitioning from traditional to digital audits often encounters cultural resistance:

- Staff may fear replacement by automation.
- Lack of digital literacy can hinder tool adoption.
- Departmental silos may resist system integration.

Bosch addressed resistance by organizing cross-departmental workshops and involving operators early in system configuration, resulting in smoother adoption and improved feedback loops (Bosch Group, 2022).

3.4 Technical Integration Issues

Integrating audit platforms with existing ERP or MES systems can be complex:

- Incompatibilities between legacy and cloud systems
- Data formatting issues
- Delayed synchronization of audit findings

To resolve this, companies use middleware APIs that bridge systems and ensure real-time synchronization of audit data with production and quality dashboards (Siemens Integration Whitepaper, 2021).

3.5 3.5 Ethical Concerns and Transparency in AI Use

Advanced AI tools used in audit prediction and scoring raise ethical questions:

- Black-box algorithms may generate outcomes without clear rationale.
- Decisions based solely on AI recommendations may lack accountability.

Explainable AI (XAI) techniques like SHAP (SHapley Additive exPlanations) and LIME (Local Interpretable Model-Agnostic Explanations) are increasingly used to provide transparency and trust in AI-driven audits (Jobin et al., 2019; Harvard Business Review, 2023).

For instance, a German automotive startup replaced opaque scoring models with SHAP-based ones, increasing auditor trust and internal acceptance of automated nonconformity classifications (Quality AI Labs, 2023).

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