WORLD SCIENCE PUBLISHING
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London International Monthly Conference on Multidisciplinary Research and Innovation

A PDCA-BASED SEVEN-STAGE MECHANISM FOR IMPLEMENTING AN INTEGRATED QUALITY, ENVIRONMENTAL AND OCCUPATIONAL SAFETY MANAGEMENT SYSTEM AT AUTOMOTIVE COMPONENT SUPPLIERS

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DOI:https://doi.org/10.5281/zenodo.24128978

Abstract. Automotive component suppliers in Uzbekistan typically implement ISO 9001, IATF 16949, ISO 14001 and ISO 45001 as separate systems, which leads to duplicated documents, audits and responsibilities. This paper presents a closed-loop seven-stage mechanism for implementing an integrated management system (IMS) in which every stage is supported by a specific tool and produces a defined document. The mechanism is complemented by an integrated internal audit scheme based on a universal auditor team and IAF MD 11:2023. It was implemented at three automotive component manufacturers. The results show a reduction of documentation and audit events, a 20–25% decrease in defective products and a benefit–cost ratio of 3.45.

Keywords: integrated management system, PDCA, IATF 16949, ISO 14001, ISO 45001, implementation mechanism, integrated audit, IAF MD 11.

Introduction

Automotive component suppliers operate under strict requirements from vehicle manufacturers. Besides certification to ISO 9001 and IATF 16949, customers increasingly expect suppliers to manage environmental aspects (ISO 14001) and occupational health and safety (ISO 45001). When these standards are implemented one after another as independent systems, enterprises maintain parallel procedures, separate risk registers and separate audit programmes, while the same production process is inspected several times from different angles.

The literature offers a solid basis for integration. Integrable elements and functions of management systems have been identified [1], guiding principles of IMS have been formulated [2], and comparative studies show that organizations in different countries follow a common pattern when integrating multiple management systems [3]. Practical recommendations for adapting IMS to the ISO High-Level Structure have been proposed [4], and case studies confirm that implementation should start with gap analysis and process mapping [5]. For the automotive sector, a model for integrating quality management requirements has been developed [6], and empirical research shows that IATF 16949 adds value to ISO 9001 through stricter process control [7].

However, the existing approaches describe implementation stages in general terms. They do not take into account automotive-specific requirements (IATF 16949, customer-specific requirements, AIAG core tools) or the quantitative assessment of quality, environmental and safety risks, and the resource savings from integration are rarely measured on enterprise data. The aim of this study is to develop a mechanism for implementing an IMS at automotive component suppliers in which every stage is supported by a concrete tool, and to evaluate its effect at operating enterprises.

Materials and methods

In this study, a mechanism is understood as a system of sequential stages, each with its own tool and output, aimed at achieving a specific objective. The proposed mechanism consists of seven stages grouped

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according to the PDCA cycle (Table 1). It builds on the functional MMT-PDCA model, in which 22 common clauses of the four standards are combined into unified management processes and the result of risk assessment is transferred to the Check (audit priority) and Act (corrective action) phases.

Table 1. Stages of the IMS implementation mechanism

Stage	PDCA	Main tool	Output
1. Gap analysis	P	Clause-by-clause comparison with ISO 9001, IATF 16949, ISO 14001, ISO 45001	List of nonconformities
2. Risk identification	P	Three-stage risk model, FMEA, Complex Risk Index	Integrated risk register
3. Policy and objectives	P	Integrated policy, unified KPIs	Objectives programme
4. Root cause analysis	P	Problem Solving Report, 4M, 5Why	Corrective action plan
5. Organizational standards	D	Standards architecture, compliance matrix	22–25 organizational standards
6. Pilot implementation	D	Training of personnel and universal auditors	Trained auditor team
7. Monitoring and standardization	C/A	Integrated internal audit, KRI-based audit plan	Updated standards, new risks → stage 2

At stage 2, quality, environmental and OH&S risks are entered in a single register and prioritized by the Complex Risk Index according to the AIAG & VDA FMEA methodology [8]. At stage 4, each nonconformity is analysed in a Problem Solving Report using 4M factors and a 5Why chain, as required by clause 10.2.3 of IATF 16949; the result is linked back to the risk register by re-evaluating the occurrence and detection scores of the corresponding risk. At stage 5, the requirements of clauses 4–10 of the four standards are grouped into common, partly common and specific clauses, and a single “document owner” is assigned to each clause. The resulting organizational standards are arranged in five functional blocks: system base, operations, automotive core tools (SPC, MSA, FMEA, APQP, PPAP), management, and environment and OH&S.

At stage 7, a universal auditor team was formed from quality specialists, technologists, shop managers and environmental and safety engineers, who completed a 48-hour course on ISO 14001, ISO 45001 and ISO 19011. A single audit questionnaire was built on a 27-row compliance matrix, so that each audit finding is traced to a specific organizational standard and standard clause, as required by IAF MD 11:2023 [9]. The level of audit integration was assessed against the seven criteria of IAF MD 11. Economic efficiency was evaluated by cost–benefit analysis on the enterprises' official reporting data.

Results

The mechanism was implemented at three automotive component manufacturers (Enterprises A, B and C). In total, 71 organizational standards were developed and put into practice (Table 2). Content analysis at Enterprise A showed that 86 of the 103 standard clauses covered (83%) are addressed in exactly one document, and 25 organizational standards replaced at least 32 documents previously kept in separate systems.

Table 2. Results of IMS implementation at three enterprises

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Indicator	Enterprise A	Enterprise B	Enterprise C
Integrated standards	ISO 9001, IATF 16949, ISO 14001, ISO 45001	ISO 9001, IATF 16949, ISO 45001, ISO 50001	ISO 9001, IATF 16949, ISO 14001
Organizational standards implemented	25	22	24
Monthly defective products, units	800 → 600 (−25%)	750 → 600 (−20%)	–
Annual audit events (standards covered)	3 → 2 (2 → 4)	–	–
Net annual economic effect, mln UZS; B/C	154.5–164.5; 3.45	–	–

Note: "–" means that comparable data were not obtained at the enterprise.

At Enterprise A, the four standards became covered by one integrated external audit and one annual integrated internal audit: the number of standards covered doubled while annual audit events decreased from three to two, and the processes with the highest KRI were included in quarterly layered audits. Five of the seven IAF MD 11 integration criteria were rated "high" and two "medium". The estimated saving on external audit costs compared with separate certification of four standards was 7.5 million UZS per year.

Monthly defective products at Enterprise A decreased from 800 to 600 units (from 2000 to 1500 PPM), and the reduction was statistically significant ($p < 0.001$). Return on sales increased from 4.2% to 4.7%, which corresponds to an 11.9% increase in profit per unit of sales. The net annual economic effect amounted to 154.5 million UZS in the first year and 164.5 million UZS in subsequent years (B/C = 3.45, ROI = 245%), with a payback period of about 3.5 months.

Discussion

The obtained results are consistent with industry benchmarks. The 25% reduction in defects is close to the improvements in quality costs reported for automotive suppliers, and the increase in return on sales brought the enterprise close to the global average margin of automotive suppliers (4.7% in 2024) [10]. Long-term studies have also shown that ISO 9000 certification leads to statistically significant improvement in financial performance [11]. The main difference of the proposed mechanism from general integration guidelines [2, 4] is that each stage has a concrete tool and output, and new risks and nonconformities are fed back from stage 7 to stage 2, which forms a closed PDCA loop.

The study has limitations. Full calculations of audit events and economic effect were performed at Enterprise A, where all the necessary official documents (hazard matrix, environmental aspects register, audit reports) were available. Applying the full set of indicators at the other enterprises is a task for further research. When the mechanism is transferred to other industries, the set of standards and the risk register must be adapted.

Conclusion

The proposed seven-stage mechanism turns IMS implementation into a closed PDCA loop in which each stage has a defined tool and output. Its application at three automotive component suppliers made it possible to implement 71 organizational standards, reduce documentation and audit duplication, lower defect levels by 20–25% and achieve a benefit–cost ratio of 3.45. The mechanism can be used by other IATF 16949-based suppliers that seek to integrate quality, environmental and OH&S management.

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