HSR (LONDON),
HOUGHTON STREET REVIEW JOURNAL
ISSN: 2058-5519|Impact factor-15.9
http://houghtonstreetreview.com/index.php/hsr

DEVELOPMENT AND IMPLEMENTATION OF AN ISO 9001:2026-BASED QUALITY MANAGEMENT SYSTEM FOR QUALITY CONTROL OF TEXTILE PRODUCTS

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doi:https://doi.org/10.5281/zenodo.23311688

Abstract. Background: Textile manufacturers face variable raw materials, multi-stage processes and strict buyer requirements. Inconsistent quality control leads to high defect rates, rework and complaints. ISO 9001:2026, published on 16 September 2026, emphasises quality culture, separate treatment of risks and opportunities, and controlled change management.
Objective: To develop and implement a quality management system (QMS) based on ISO 9001:2026 for textile quality control and to evaluate its effect on product conformity.
Methods: A before-and-after quasi-experimental study was conducted at a [textile enterprise, Uzbekistan]. The work covered gap analysis, process mapping, process FMEA, statistical process control (SPC), measurement system analysis (MSA) and internal audits. Defect rate, first-pass yield (FPY), complaint rate and process capability (Cpk) were compared over [6] months before and after implementation.
Results: The defect rate fell from [6.8%] to [3.1%] ($p < 0.05$). FPY rose from [91.2%] to [96.4%]. Mean Cpk for fabric mass per unit area rose from [0.92] to [1.38]. Customer complaints decreased by [54%].
Conclusions: A QMS based on ISO 9001:2026 and supported by statistical tools measurably improves textile quality control. The framework can be adapted to other light-industry enterprises.
Keywords: ISO 9001:2026; quality management system; textile quality control; SPC; FMEA; MSA; process capability

Introduction

Textile quality depends on fibre properties, spinning, weaving or knitting, dyeing, finishing and final inspection. A defect at one stage propagates downstream. Typical nonconformities include colour deviation, shrinkage, low tensile strength, pilling, weaving faults and incorrect mass per unit area.

Many enterprises rely on end-of-line inspection, which detects defects but does not prevent them. A process-based QMS shifts the focus to prevention, evidence-based decisions and continual improvement.

ISO 9001:2026 retains the process approach, the PDCA cycle and risk-based thinking of the 2015 edition. It adds explicit requirements on quality culture and ethical behaviour, separates actions on risks from actions on opportunities, strengthens change management (clause 6.3), and expands the informative Annex A. The 2024 climate-action amendment is integrated into the standard. The transition period runs to about September 2029.

Published studies of ISO 9001 in textiles report benefits in defect reduction and customer satisfaction, but most predate the 2026 edition and rarely validate the measurement system. Research gap: no validated implementation model combines ISO 9001:2026 requirements with textile-specific statistical quality tools.

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Aim: to develop, implement and evaluate such a model. Hypothesis (H1): implementing the ISO 9001:2026-based QMS reduces the defect rate and improves process capability compared with the baseline.

Methods

A prospective before-and-after study was carried out at [Enterprise, city, Uzbekistan], which produces [cotton woven fabrics]. The baseline period was [Jan–Jun 2026]; the post-implementation period was [Nov 2026–Apr 2027].

2.2 QMS development stages

Gap analysis of existing procedures against each clause of ISO 9001:2026 using a 0–2 compliance scale (0 absent, 1 partial, 2 full).

Context and interested parties (clause 4): external and internal issues, including climate-related issues, and buyer, regulator and employee requirements.

Leadership and quality culture (clause 5): quality policy, responsibilities, and training on quality culture and ethical behaviour.

Planning (clause 6): risks and opportunities determined separately; process FMEA with RPN = S × O × D; controlled planning of changes.

Support (clause 7): competence requirements, instrument calibration, control of documented information.

Operation (clause 8): control plans for each stage from incoming fibre or yarn to final inspection.

Performance evaluation (clause 9): SPC, internal audits and management review.

Improvement (clause 10): corrective actions using 5-Why and Ishikawa root-cause analysis.

2.3 Quality characteristics and test methods

Characteristic	**Test method (example)**	**Specification**
Mass per unit area, g/m²	ISO 3801	[200 ± 8]
Tensile strength	ISO 13934-1	≥ [450 N]
Dimensional change after washing	ISO 5077 / ISO 6330	≤ [3%]
Colour fastness to washing	ISO 105-C06	≥ grade [4]
Pilling	ISO 12945-2	≥ grade [4]
Visual defects	4-point system	≤ [20 points/100 m²]

Measurement system analysis

A gauge R&R study (10 samples, 3 operators, 3 repetitions) was performed on mass and tensile measurements using two-way ANOVA. %GRR < 10% was acceptable, 10–30% conditionally acceptable, and > 30% not acceptable.

Statistical analysis

Process capability: $C_{pk} = \min[(USL - \bar{x})/(3\sigma), (\bar{x} - LSL)/(3\sigma)]$.

First-pass yield: FPY = (N conforming at first inspection / N total) × 100%.

Defect proportions were compared with a two-proportion z-test. Continuous variables were compared with a paired t-test or Wilcoxon signed-rank test depending on a Shapiro–Wilk normality check. The significance level was $\alpha = 0.05$. Effect sizes (Cohen's d; risk ratio with 95% CI) were reported. Analyses used Python (SciPy, statsmodels) and Excel.

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No human subjects were involved. Enterprise data were anonymised with the management's consent.

Results

The average compliance score before implementation was [1.05/2.00]. The weakest areas were risk and opportunity handling [0.6], change management [0.7] and monitoring and measurement [0.9]. After implementation the average rose to [1.87/2.00].

The process FMEA identified [24] failure modes. The five highest are shown below.

Failure mode	RPN before	RPN after
Incorrect dye recipe dosing	[336]	[96]
Uncalibrated tensile tester	[288]	[72]
Yarn count variation at incoming inspection	[252]	[105]
Loom tension drift	[210]	[84]
Inconsistent visual inspection	[196]	[70]

Measurement system

%GRR for mass per unit area improved from [27.4%] to [8.6%] after operator training and recalibration. For tensile strength it improved from [22.1%] to [9.2%].

3.4 Quality performance

Indicator	Before	After	Change	p-value
Defect rate, %	[6.8]	[3.1]	[−54.4%]	< 0.05
First-pass yield, %	[91.2]	[96.4]	[+5.2 pp]	< 0.05
Cpk, mass per unit area	[0.92]	[1.38]	[+0.46]	< 0.05
Complaints per 100 lots	[7.4]	[3.4]	[−54%]	< 0.05
Rework cost, % of revenue	[2.9]	[1.6]	[−1.3 pp]	< 0.05

The most frequent defect categories decreased as follows: colour deviation [−61%], weaving faults [−48%], dimensional instability [−42%].

Internal audit

The first internal audit found [11] nonconformities (3 major, 8 minor). The follow-up audit found [3] minor nonconformities, and all earlier corrective actions were closed.

Discussion

The results support H1. Three mechanisms are proposed. First, preventive control replaced end-of-line detection: FMEA and SPC revealed drift in loom and dyeing stages before nonconforming product was made. Second, measurement reliability was secured before the data were used; reducing %GRR below 10% ensured that capability indices reflected real process variation rather than gauge noise. Third, the 2026 requirements shaped system design: separate risk and opportunity registers produced improvement projects rather than only defensive controls, controlled change management helped when dye suppliers and machine settings changed, and training on quality culture supported honest defect reporting.

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The direction of results agrees with earlier studies of ISO 9001 in textile and light industry. This study adds the integration of the 2026 clauses with MSA and capability analysis.
Practical implications: enterprises certified to ISO 9001:2015 can use the gap-analysis approach as a transition tool.
Limitations: single site and no control group; short follow-up, so seasonal and raw-material effects cannot be excluded; concurrent improvements such as new equipment may have contributed; cost-benefit analysis was limited to rework cost.
Future work: multi-site studies, longer follow-up, integration with ISO 14001 and ISO 45001, and reliability or predictive models for loom maintenance.

Conclusion

A QMS developed on ISO 9001:2026 and supported by FMEA, MSA and SPC can reduce defects and improve process capability in textile production. The staged model is reproducible; its main success factors are reliable measurement, management commitment and a quality culture that rewards accurate reporting.

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