

THE IMPACT OF INTEGRATING ERP SYSTEMS AND INTERNATIONAL STANDARDS ON PRODUCT QUALITY AND SAFETY IN LIGHT INDUSTRY ENTERPRISES

Sotvoldiyeva Nasibakhon

Andijan State Technical Institute

PhD student, Department of Metrology and Light Industry

Tel: +998337099923

E-mail: nasibakhon_1992@gmail.com

<https://doi.org/10.5281/zenodo.22025591>

Abstract. This thesis is dedicated to the practical-experimental evaluation of the effectiveness of digitally integrating Enterprise Resource Planning (ERP) systems with international quality and safety standards (ISO 9001, Oeko-Tex Standard 100) in light industry enterprises. The research is based on pilot studies conducted at the production facilities of “Bogishamol TEKS” LLC, “NIL GRANIT” LLC, and “FAZO GROUP” LLC. The study mathematically and statistically proves that the application of the Modified Integrated Management System (MIMS) model and the Hybrid Quality Index (HSI) resulted in a 72.0% decrease in the share of defective products, a 63.0% reduction in raw material waste, an 11.4% increase in resource efficiency, and a decrease in the share of Cost of Quality (COQ) in the overall cost from 9.2% to 4.1%.

Keywords: Light industry, ERP system, ISO 9001, Oeko-Tex Standard 100, MIMS model, Hybrid Quality Index (HSI), QM-EHS API, multi-factor regression, resource efficiency.

Introduction and Research Rationale. Ensuring competitiveness in the global textile market and effectively capitalizing on the opportunities of the European Union's GSP+ preferential trade system requires guaranteeing the ecological and chemical safety of products. However, in most domestic light industry enterprises, resource management (ERP) systems and international standards (ISO, Oeko-Tex) are managed separately. This results in quality control remaining a reactive (final-stage) process, leading to an increase in technological defects and material waste.

Objective of the research: To evaluate the practical and experimental effectiveness of ensuring product quality and safety in real time through the digital integration of the ERP system's operational modules with the requirements of ISO 9001 and Oeko-Tex Standard 100.

Methodology and experimental basis. Experimental studies were conducted from 2024 to 2026 at the production and laboratory facilities of three key textile enterprises:

1. “Bogishamol TEKS” LLC: The integration of ERP-MM (Material Management) and ISO 9001 control points was tested on the cotton fiber primary processing and yarn production lines.

2. “NIL GRANIT” LLC: An automated monitoring system using sensors (for pH, temperature, and concentration) was installed in the dyeing and finishing departments in accordance with Oeko-Tex Standard 100 and ZDHC requirements.

3. “FAZO GROUP” LLC: The impact of the TIBT model on resource efficiency and Cost of Quality (COQ) was assessed.

A Hybrid Quality Index (HSI) was developed to digitize processes and comprehensively evaluate quality indicators:

$$HSI = 0.4 \cdot \left(\frac{1}{m} \sum_{i=1}^m S_{ISO,i} \right) + 0.6 \cdot \left(\frac{1}{k} \sum_{j=1}^k \frac{C_{req,j} - |C_{act,j} - C_{req,j}|}{C_{req,j}} \right)$$

Where:

$S_{ISO,i}$ - the fulfillment level of ISO 9001 control points (0 or 1);

$C_{act,j}$ and $C_{req,j}$ - actual and standard chemical-ecological parameters according to Oeko-Tex Standard 100;

m,k - the number of indicators evaluated according to ISO and Oeko-Tex, respectively.

Practical-experimental results and analysis. The dynamics of technical and economic indicators before and after the implementation of the TIBT model and the QM-EHS API interface are presented in Table 1.

Table 1.

Dynamics of technical and economic indicators at the pilot enterprises

Indicators	Before TIBT implementation	After TIBT implementation	Rate of change
Share of defective products (Y_{Defect})	6.8%±0.4%	1.9%±0.2%	decreased by 72.0%
Raw material and supply waste (Y_{Waste})	8.4%±0.5%	3.1%±0.3%	decreased by 63.0%
Hybrid Quality Index (HSI)	0.62±0.04	0.94±0.02	increased by 51.6%
Share of quality costs in the prime cost (COQ)	9.2%	4.1%	reduced by 55.4%
Resource efficiency level	Baseline level (100%)	+11.4%	11.4% savings

A multi-factor regression equation was formulated in the SPSS software package using the experimental database:

$$\Delta D_{defect} = 8.42 - 0.28X_{ERP} - 0.31X_{ISO} - 0.54(X_{ERP} \times X_{ISO})$$

Here: X_{ERP} - the coverage level of the ERP system modules (0–1); X_{ISO} - the level of digital integration of international standard requirements (0–1).

The results of the regression analysis ($R^2=0.814$, $F=64.25$, $p<0.001$) indicated that the integration product coefficient ($\beta_3 = -0.54$) has a negative sign and is statistically highly significant. This proves that the digital integration of ERP and international standards synergistically reduces defects.

Economic efficiency and practical implementation. Based on the experience of “NIL GRANIT” LLC and “FAZO GROUP” LLC, the economic efficiency of the TIBT system was calculated (on the example of an enterprise with 500 employees):

Initial investment costs (C_{invest}): \$25,000 (API software, IoT sensors, employee training);

Annual economic savings (S_{annual}): \$66,000/year (due to the reduction of waste and defects);

Return on investment (ROI):

$$ROI = \frac{66,000 - 25,000}{25,000} \times 100\% = 164\%$$

Payback period (PP):

$$PP = \frac{25,000}{66,000} \times 12 = 4.5 \text{ oy}$$

Conclusion. Practical-experimental trials conducted at “Bogishamol TEKS” LLC, “NIL GRANIT” LLC, and “FAZO GROUP” LLC confirmed the high efficiency of the digital integration of ERP systems and ISO/Oeko-Tex standards.

The application of the TIBT model made it possible to reduce the proportion of defects to 1.9% and raw material waste to 3.1%.

The proposed HSI index and QM-EHS API interface enable light industry enterprises to manage quality and safety in real time and achieve a return on investment within 4.5 months.

References

1. Urishev, B. A. Factors for Increasing the Efficiency of Textile Industry Enterprises. "Science and Education" Scientific Journal/www.openscience.uz, June 2024, Volume 5, Issue 6.
2. Hojiahmedov, G., Yaxyayeva, I., Umarova, M., & Usmonov, A. (2012). Quality Management. Cholpon Publishing and Printing Creative House.
3. Axmedova, Y.S., & Shaldarbekova, A.B. Increasing Product Competitiveness in Light Industry Enterprises. "Economics and Socium" No. 4 (131) -1, 2025, w.iupr.ru. Available at: <https://cyberleninka.ru/article/n/yengil-sanoat-korxonalarida-mahsulot-raqobatbardoshligini-oshirish/viewer>
4. Khankeldieva, G.Sh., & Shakirova, Yu.S. Organization of Production of Export-Oriented Products in Textile Industry Enterprises. Fergana - AL-FERGANUS - 2021.