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DIGITAL TRANSFORMATION IN TRADITIONAL INDUSTRIES:

ANALYZING MES-BASED STRATEGIES IN UZBEKISTAN'S AUTOMOTIVE MANUFACTURING INDUSTRY

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Abstract

This research studies the role of Manufacturing Execution Systems (MES) in the digital transformation of automotive manufacturing companies in Uzbekistan. Today, traditional factories are changing from manual systems to digital and smart manufacturing systems. MES helps companies control production processes, improve quality, reduce mistakes, and increase efficiency.

The research analyzes MES functions used in an automotive manufacturing plant in Uzbekistan. The study focuses on production planning, BOM management, process monitoring, PLC integration, quality inspection, and real-time production tracking. The research also explains the main challenges of MES implementation, such as high costs, old infrastructure, lack of specialists, and integration problems.

At the same time, MES creates many opportunities for smart factory development, better production control, and faster decision-making. The study gives recommendations for improving digital transformation in Uzbekistan's automotive industry.

Keywords:

Digital Transformation, MES, Smart Factory, Automotive Industry, Industry 4.0, Uzbekistan, Manufacturing Execution System

Introduction

In recent years, digital transformation has become very important for manufacturing industries. Many traditional factories are introducing modern digital technologies to improve production efficiency and competitiveness. Industry 4.0 technologies help companies create smart factories with automation, real-time monitoring, and integrated information systems.

The automotive industry is one of the most important industrial sectors in Uzbekistan. It supports economic growth, creates jobs, and increases localization and export opportunities. However, many production processes still use manual operations and separate information systems. Because of this, production management becomes slower and less efficient.

Manufacturing Execution System (MES) is one of the main technologies used in smart manufacturing. MES connects production planning systems with shop-floor operations. It helps factories monitor production processes in real time, manage production data, improve quality control, and reduce production errors.

This research studies MES-based digital transformation strategies in an automotive manufacturing plant in Uzbekistan. The study explains how MES improves production management and supports smart factory development.

Literature Review

Many researchers have studied digital transformation and MES technologies in manufacturing industries. According to Kletti (2007), MES helps companies improve production efficiency and production control through real-time manufacturing information.

McClellan (1997) explains that MES systems support quality management, production tracking, and process integration in manufacturing plants. MES also improves communication between machines, operators, and management systems.

Industry 4.0 technologies such as IoT, PLC communication, cloud systems, and automation are strongly connected with MES systems. Kagermann et al. (2013) explain that digital manufacturing systems help factories become more flexible, efficient, and intelligent.

Modern MES systems usually include:

- Production planning
- BOM management
- Quality inspection
- Machine monitoring
- Label tracking
- User management
- Real-time reporting

However, developing countries still face many problems during digital transformation. These problems include limited infrastructure, high implementation costs, and shortage of digital specialists. Uzbekistan's manufacturing industry also experiences similar challenges.

Methodology

This research uses qualitative analysis and system analysis methods. The study analyzes MES implementation processes in a large automotive manufacturing plant in Uzbekistan. Internal MES documentation and workflow structures are used in the analysis.

The research focuses on:

- MES architecture
- Production planning systems
- BOM management
- PLC communication
- User management

- Production monitoring
- Inspection systems
- Manufacturing process integration

The study also evaluates the challenges and opportunities of MES implementation in automotive manufacturing.

Results and Discussion

1. Role of MES in Manufacturing

MES is an important system in modern manufacturing industries. It connects enterprise management systems with production processes on the factory floor. MES helps companies collect and manage production information in real time.

The analyzed MES platform includes:

- Program Management
- System Management
- BOM Management
- Production Planning
- Work Process Registration
- Inspection Management
- ANDON Monitoring Systems

These systems help factories improve coordination between departments and production lines.

2. Production Planning and BOM Management

MES supports production planning and BOM management in automotive manufacturing. The system manages:

- production sequencing
- work orders
- model information
- option management

- inspection item registration

This helps reduce production delays and improves material tracking during assembly processes.

3. PLC Integration and Real-Time Monitoring

MES systems communicate directly with PLC systems in production equipment.

PLC integration allows:

- machine communication
- production status monitoring
- automatic process control
- real-time data collection

Real-time monitoring improves production transparency and helps operators quickly identify production problems.

4. User and Permission Management

MES systems also manage users and permissions. Different departments and workers receive different access rights based on their responsibilities.

This improves:

- production security
- process control
- system management
- operational discipline

5. Challenges of MES Implementation

Although MES systems provide many advantages, companies still face several implementation challenges.

Main challenges:

- High implementation costs
- Old manufacturing infrastructure
- Lack of MES specialists

- Integration difficulties
- Resistance to organizational changes
- Limited digital skills

Some production operations still depend on manual processes, which reduces the full effectiveness of MES systems.

6. Opportunities for Smart Factory Development

MES implementation creates many opportunities for automotive manufacturing companies.

Main opportunities:

- Smart factory development
- Better production efficiency
- Real-time production control
- Faster decision-making
- Improved quality management
- Reduced operational errors
- Better production traceability

MES systems also support future integration with:

- AI technologies
- IoT devices
- cloud systems
- predictive maintenance technologies

Table 1. MES Digital Transformation Analysis

Challenges	Opportunities
Old manufacturing systems	Smart factory modernization
High implementation costs	Long-term efficiency improvement
Lack of digital specialists	Development of digital workforce
Manual production operations	Automated production control

Challenges	Opportunities
Limited real-time visibility	Real-time monitoring systems
Integration complexity	Better production coordination
Organizational resistance	Flexible manufacturing systems

Recommendations

To improve MES-based digital transformation in Uzbekistan's automotive industry, the following recommendations are proposed:

1. Develop a long-term digital transformation strategy
2. Improve MES integration across all production shops
3. Modernize production infrastructure
4. Train MES engineers and digital specialists
5. Improve PLC and network systems
6. Standardize manufacturing data
7. Increase investment in Industry 4.0 technologies
8. Strengthen cooperation between IT and production departments

Conclusion

Digital transformation is becoming very important for traditional manufacturing industries. MES systems help automotive companies improve production management, quality control, and operational efficiency.

Although there are still several challenges in Uzbekistan's automotive industry, MES technologies create strong opportunities for smart factory development and industrial modernization.

MES implementation can help automotive factories improve competitiveness, reduce production problems, and support future digital manufacturing strategies. Therefore, MES systems should become one of the main priorities for industrial development in Uzbekistan.

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