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THE STATE OF INNOVATIVE ACTIVITIES AND EFFICIENCY OF "AVTOOYNA" LLC WITHIN THE FRAMEWORK OF GREEN ECONOMIC MEASURES

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Abstract - *In recent years, a new development model combining sustainable economic growth and environmental safety has been taking shape in the country's industrial sectors. This process is consistent with the strategic directions of the transition to a green economy, efficient use of resources and reduction of industrial emissions set out in the Development Strategy "Uzbekistan-2030". Political and institutional reforms require industrial enterprises not only to invest in high technologies, but also to form a production culture that meets environmental standards. In this context, the innovative activities of "Avtooyna" LLC are of particular scientific and practical importance, since the enterprise is adapting to the new environmental paradigm of the industry through digitalization of production processes, technological modernization, waste reduction and the introduction of energy-saving systems. This process is not a simple modernization - it is an expression of the enterprise's management philosophy, environmental responsibility and strategic vision aimed at actively contributing to the processes of national transformation.*

Keywords: *Production processes, scientific and practical importance, national transformation.*

INTRODUCTION

In recent years, Uzbekistan has entered an active phase of industrial transformation aimed at achieving sustainable economic growth, technological modernization, and environmental balance. Within this trajectory, manufacturing enterprises are increasingly required to integrate ecological principles and innovation-driven solutions into their development strategies. This shift is обусловлен not only by internal economic priorities, but also by global industrial trends, rising environmental standards, and the need to enhance national competitiveness in international markets. In this context, the adoption of innovative and environmentally oriented approaches is becoming a decisive factor for ensuring the long-term stability and efficiency of industrial enterprises.

The automotive components industry occupies a special place in this transformation process, as it is simultaneously capital-intensive, technologically complex, and environmentally sensitive. Auto glass production, in particular, is characterized by high energy consumption, strict requirements for optical quality and

safety, intensive use of natural resources, and increasing regulatory pressure related to environmental protection. As global automotive manufacturers move toward smart, energy-efficient, and environmentally responsible vehicles, suppliers of automotive components are compelled to adapt their production systems, product portfolios, and management models accordingly. Failure to do so leads to loss of market positions, technological lag, and declining economic performance.

Against this backdrop, the experience of Avtooyna LLC is of particular analytical interest. The enterprise demonstrates how a systematic focus on innovation, digitalization, quality management, and green technologies can serve as a foundation for sustainable industrial development. By integrating modern production technologies, digital quality control systems, automation, and environmentally friendly solutions, the company not only improves its operational efficiency but also strengthens technological safety, reduces environmental risks, and enhances product competitiveness. This approach fully corresponds to the strategic priorities outlined in the “Uzbekistan-2030” framework, which emphasizes energy efficiency, reduction of carbon footprint, development of high value-added industries, and the transition toward a green economy.

The strategic orientation of Avtooyna LLC toward innovative production models and the formation of a strong quality culture reflects broader global trends in the automotive industry. Today, value creation increasingly depends not on production scale alone, but on technological sophistication, digital integration, sustainability, and compliance with international standards. Innovative auto glass products with enhanced strength, optical properties, energy-saving characteristics, and environmental safety become key elements of competitive advantage. At the same time, the growing role of digital technologies and environmental responsibility transforms innovation from a purely technical function into a comprehensive managerial and economic category.

Under these conditions, the assessment of the effectiveness of innovative and ecological initiatives acquires particular importance. Such assessment makes it possible to identify not only direct economic effects, such as cost reduction or productivity growth, but also broader technological, environmental, and social outcomes that determine the long-term development trajectory of enterprises. A comprehensive understanding of these effects is essential for substantiating managerial decisions, optimizing investment priorities, and aligning enterprise-level strategies with national development goals. Therefore, analyzing innovation-driven and environmentally sustainable development practices in the automotive components industry represents an important scientific and practical task, contributing to the formation of resilient, competitive, and future-oriented industrial models in Uzbekistan.

LITERATURE REVIEW

Contemporary theoretical and empirical research on industrial development consistently emphasizes that sustainable competitiveness of manufacturing enterprises is achieved through the coordinated and systemic interaction of technological

innovation, human capital development, and environmental responsibility. Within the framework of innovation economics, scholars argue that technological modernization alone is insufficient to ensure long-term growth unless it is supported by organizational transformation, workforce competence, and an institutional environment that encourages continuous improvement. This perspective is particularly relevant for industrial sectors characterized by high capital intensity and strict quality requirements, such as automotive component manufacturing.

A significant body of literature devoted to the green economy demonstrates that ecological investments should be interpreted not merely as compliance costs, but as strategic drivers of economic efficiency. Studies show that the introduction of energy-saving technologies, resource-efficient production processes, and waste recycling systems contributes to reducing operating costs, improving material efficiency, and stabilizing production outcomes. In energy-intensive industries, environmental innovations often generate a multiplicative effect, simultaneously lowering resource consumption, enhancing product quality, and strengthening corporate reputation. As a result, environmental responsibility increasingly becomes a factor of market differentiation and access to both domestic and international markets.

Research on digital transformation in industrial production highlights the decisive role of digital quality management, automation, and robotization in improving operational performance. Empirical studies confirm that the transition from analog monitoring to digital control systems, including sensor-based inspection and real-time process monitoring, leads to a substantial reduction in production variability and defect rates. By minimizing human error and ensuring stable process parameters, digital quality management enhances reliability and predictability in manufacturing systems. Automation and robotization further reinforce these effects by increasing precision, repeatability, and production speed, while simultaneously reducing occupational risks and production downtime.

Lean management theories occupy a central place in the literature on operational excellence. Among lean tools, the 5S system is widely recognized as a foundational mechanism for organizing the workplace, standardizing processes, and improving labor productivity. Empirical evidence suggests that effective implementation of 5S not only reduces time losses and unnecessary movements, but also fosters a culture of discipline, responsibility, and continuous improvement. In this sense, lean practices act as a bridge between technological innovation and human behavior, ensuring that modern production technologies are used to their full potential.

In recent years, academic research has increasingly focused on artificial intelligence and predictive analytics as key elements of next-generation industrial systems. The concept of the “smart factory” is based on the integration of AI-driven monitoring, data analytics, and adaptive control mechanisms that allow production systems to respond dynamically to changing conditions. Studies demonstrate that AI enables early detection of equipment failures, optimization of energy consumption, and continuous learning of production processes, thereby enhancing both economic efficiency and sustainability. These technologies are particularly valuable in complex

manufacturing environments where micro-level deviations can lead to significant quality or cost losses.

Human capital theory constitutes another important pillar of the literature relevant to this study. Numerous empirical works confirm that investments in employee training, professional development, and retention have a direct and positive impact on labor productivity, innovation capacity, and organizational resilience. Highly skilled and motivated employees are better able to adapt to technological change, operate advanced equipment, and participate in continuous improvement initiatives. Moreover, stable employment relationships reduce knowledge loss and support the accumulation of firm-specific competencies, which are critical for sustaining innovation-driven growth.

Taken together, these theoretical and empirical approaches provide a comprehensive conceptual foundation for analyzing integrated models of innovative development in industrial enterprises. The interaction of technological modernization, digitalization, lean management, environmental sustainability, and human capital development forms a holistic framework that explains how enterprises can achieve long-term economic efficiency and competitiveness. This integrated perspective is particularly relevant for examining the innovative development model implemented at Avtooyna LLC, where innovation is embedded not only in technology, but also in management practices, corporate culture, and environmental strategy.

METHODOLOGY

The methodological approach of this study is based on a comprehensive analysis of innovative, technological, human resource, and environmental indicators reflecting the economic efficiency of Avtooyna LLC’s development strategy. The assessment relies on comparative and dynamic analysis, examining changes in key indicators over time and identifying causal relationships between innovation implementation and performance outcomes.

The methodology includes the evaluation of production modernization indicators such as automation, robotization, digital quality control, and AI-based monitoring, alongside organizational factors including the 5S system and workforce stability. Environmental efficiency is assessed through water recycling rates, waste recycling, energy consumption, renewable energy usage, and the profitability of green investments. Human capital efficiency is analyzed using training investments, competency development, wage dynamics, and staff turnover indicators. This integrated framework allows for a holistic assessment of economic efficiency driven by innovation.

ANALYSIS AND RESULTS

The results of the analysis demonstrate that the dynamics of innovative development at Avtooyna LLC are characterized by a stable and systematic transition toward the production of high value-added automotive glass. The consistent increase in the share of innovative auto glass products indicates that the enterprise has moved

beyond incremental modernization and adopted a strategic orientation toward technologically advanced, energy-efficient, and safety-oriented components. This trend is largely driven by changing market demand, where automotive manufacturers and consumers increasingly prioritize smart functionalities, improved optical characteristics, enhanced strength, noise insulation, and UV protection. As a result, innovation has become a key mechanism for aligning production output with global automotive industry standards and strengthening the enterprise’s competitive position.

A critical factor underlying these results is the expansion of digital quality control systems. The shift from traditional, largely analog inspection methods to sensor-based, automated, and real-time digital monitoring has significantly stabilized production processes. By reducing the role of subjective human judgment and integrating laser inspection, automated defect detection, and continuous data analysis, the enterprise has achieved a notable decline in defect rates, rework volumes, and warranty returns. This confirms that digital quality management not only improves immediate production outcomes but also supports the implementation of the “Zero Defect Philosophy,” where deviations are detected and corrected at the earliest possible stage, preventing the accumulation of systemic quality problems.

The analysis further shows that increasing levels of automation and robotization have had a direct and positive impact on labor productivity and operational efficiency. The introduction of automated cutting lines, intelligent thermal processing systems, conveyor solutions, and robotic handling has shortened production cycles while ensuring process stability. Robotized operations have delivered high precision, consistent speed, and repeatability, particularly in technologically sensitive and high-risk stages such as optical inspection, surface preparation, cutting, and gluing. As a result, workplace safety has improved, accident rates and unplanned stoppages have declined, and overall process reliability has increased. These outcomes confirm that robotization not only enhances economic efficiency but also contributes to social and occupational sustainability.

The effective implementation of the 5S system has complemented technological modernization by improving organizational efficiency at the workplace level. The analysis indicates that higher levels of 5S maturity are associated with reduced time losses, lower excess inventory, fewer unnecessary movements, and better utilization of production space. Beyond operational metrics, the 5S system has strengthened corporate discipline, employee responsibility, and a culture of continuous improvement. This demonstrates that lean management practices play a crucial role in ensuring that advanced technologies are supported by appropriate organizational behavior and production culture.

A particularly significant result is associated with the growing integration of artificial intelligence-based monitoring systems. AI technologies have enabled the enterprise to move from reactive quality control toward predictive and preventive management. Through the analysis of large volumes of production data, AI systems identify micro-deviations, predict equipment failures, optimize energy consumption, and maintain optimal operating conditions. The proportional growth of AI coverage

alongside improvements in quality stability, customer satisfaction, and defect reduction confirms the effectiveness of this approach. Collectively, these developments indicate a gradual transition toward a smart factory model, where production systems are adaptive, data-driven, and self-optimizing.

The steady increase in the innovation system index provides further evidence that innovation at Avtooyna LLC is not fragmented but integrated. Product innovation, process modernization, digital control, automation, robotization, organizational practices, and AI monitoring function as interconnected elements of a single system. This systemic interaction has resulted in proportional improvements in product quality, resource efficiency, labor productivity, and financial performance, highlighting the cumulative effect of coordinated innovation.

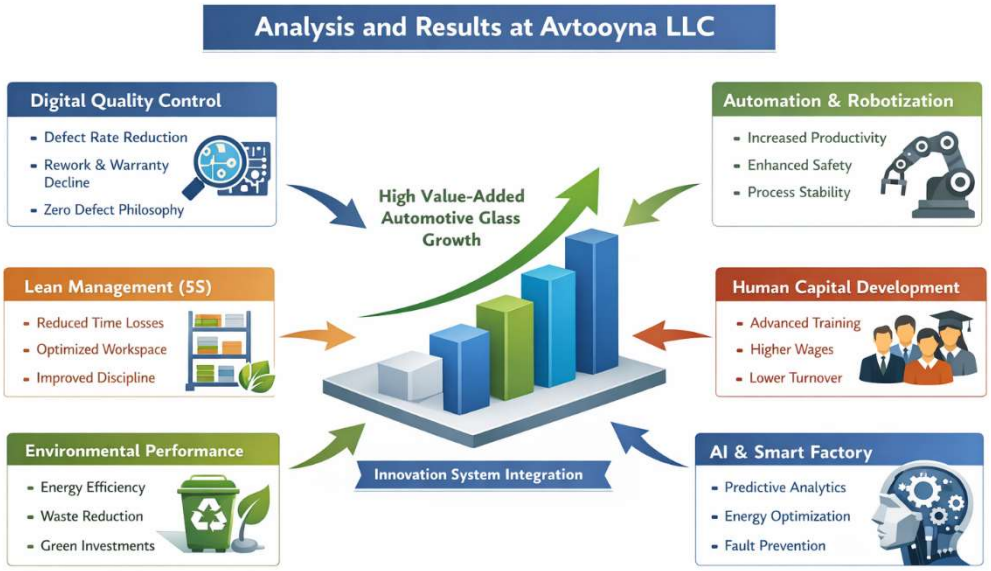

Fig 1. Analysis and results at Avtooyna LLC

From a human capital perspective, the analysis reveals a strong link between investments in training, wage growth, and workforce stability. Increased spending on professional development and advanced training has raised employee competency levels and improved adaptability to new technologies. At the same time, rising wages and improved working conditions have reduced staff turnover and strengthened employee loyalty. This closed innovation cycle—training, competence development, stability, and productivity—has enhanced the enterprise’s capacity to absorb technological change and sustain innovation-driven growth over time.

Environmental performance indicators further reinforce the integrated nature of the enterprise’s development model. Consistent improvements in water recycling, waste utilization, energy efficiency, and renewable energy use indicate the formation of a mature environmental management system. Importantly, the increasing profitability of green investments demonstrates that ecological initiatives are not merely compliance measures but sources of tangible economic returns. By reducing

resource consumption, lowering operating costs, and strengthening its ecological brand, the enterprise has aligned environmental sustainability with financial performance.

Overall, the analysis confirms that Avtooyna LLC has achieved measurable economic, technological, environmental, and social results through the systemic integration of innovation. The observed outcomes illustrate how coordinated investments in technology, human capital, organizational practices, and green solutions can generate a reinforcing spiral of efficiency, competitiveness, and sustainability in modern industrial enterprises.

CONCLUSION

The results of the study demonstrate that Avtooyna LLC has successfully formed an integrated model of innovative and environmentally sustainable development that combines economic efficiency, technological modernization, and human capital advancement. Innovation at the enterprise is not treated as a fragmented technical process but as a comprehensive management philosophy that underpins long-term competitiveness.

The synergy between automation, robotization, digital control, AI-based monitoring, lean management practices, and human resource development has resulted in stable productivity growth, improved quality, reduced risks, and enhanced environmental performance. Green economy principles have become a direct driver of economic efficiency, proving that ecological responsibility and financial performance are mutually reinforcing.

Overall, the experience of Avtooyna LLC confirms that the strategic integration of innovation, human capital, and environmental sustainability creates a resilient industrial model aligned with international standards and national development priorities. This approach not only strengthens the enterprise’s position in domestic and global markets but also contributes to the broader implementation of sustainable industrial transformation objectives set out in the “Uzbekistan-2030” strategy.

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