

RISKS AFFECTING PRODUCT QUALITY AND SAFETY INDICATORS IN THE PRODUCTION OF AUTOMOBILE BODY PARTS AND THEIR ANALYSIS**Khamdamov Baxrom Raimdjonovich**

Andijan State Technical Institute,

Associate Professor,

PhD in Technical Sciences

ORCID: 0000-0001-9621-4086

Ibrohimov Saidmuxtorkhon Ulugbek ugli

Andijan State Technical Institute,

2nd-year Master's Student

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Abstract. This article analyzes the main technological factors affecting product quality and safety in the production of automobile body parts. The study examines the risks arising during the stamping, welding, painting, and final assembly stages of automobile body manufacturing, as well as their impact on product quality. Factors influencing body quality were systematized using the Ishikawa diagram. The results of the research are of scientific and practical significance for quality management, optimization of technological processes, and reduction of defects in automobile manufacturing enterprises.

Keywords: automobile body, body quality, quality indicators, welding, stamping, paint coating, automotive industry, standardization, significance coefficient, ONIX automobile.

In the automotive industry, comprehensive and quantitative assessment of quality indicators is essential to ensure stable product quality and timely identification of inconsistencies in production processes. Since the automobile body is a complex multi-parameter object, evaluating its quality only through separate indicators is insufficient. Studies devoted to automobile manufacturing quality assurance demonstrate that numerous international researchers have investigated factors influencing body quality and safety in production systems [1]–[5].

In particular, Li Zhuoshuai and co-authors investigated corrosion-related problems in automobile bodies and monitored stamping, welding, and painting processes to improve overall vehicle durability [1]. Similarly, Zhou Wei and colleagues applied an improved genetic algorithm to optimize body panel thickness and developed an acoustic-rigid coupling model for body-in-white structures. Their research included free modal analysis and the creation of noise transfer functions aimed at optimizing panel thickness and reducing vibration and noise effects [2].

Chinese researchers Ying Xiang, Long Guo, Shaoqian Ji, Shengchao Zhu, Jimin Guo, and Xu Qiao studied methods for analyzing the importance of factors affecting quality and safety in automobile body manufacturing. Their work proposed effective approaches for identifying the primary factors influencing production quality and ensuring compliance of manufacturing processes with safety requirements [3]. Tang Qingming and co-authors applied the least squares method to create an intelligent analytical model for stamping processes. Using data mining technologies, they identified relationships between manufacturing processes and product quality and determined nine key factors influencing quality prediction [4].

Furthermore, Abdul Karim and colleagues analyzed quality problems in automobile body welding processes. Based on parameters such as welding gun joints, production cost, and process time, they recommended the application of minimal heat input and appropriate filler metal alloy elements to improve welding quality and reduce production defects [5].



Despite the large number of studies conducted worldwide, most investigations focus on individual stages of automobile manufacturing rather than providing a comprehensive assessment of the entire body production sequence. Existing literature mainly evaluates separate components and technological operations, while integrated approaches covering the full manufacturing chain remain insufficient. Consequently, important factors affecting quality and safety throughout the production process cannot always be identified comprehensively [3], [4].

The shape and structural characteristics of an automobile depend on its design, the materials used, and the body manufacturing technology. Technological innovations and modern design solutions require the continuous search for advanced materials with improved mechanical and corrosion-resistant properties. In addition, socio-economic factors significantly influence the development of automobile exterior design and manufacturing technologies [6]. The durability of the automobile body is largely determined by the effectiveness of corrosion protection systems [1].

The automobile body manufacturing process consists of four major stages: stamping, welding, painting, and final assembly. Together, these stages determine the structural integrity, durability, and surface quality of the vehicle, directly affecting safety, reliability, and operational performance [7].

Automobile body stamping is the process of plastically deforming steel sheets into parts with specified shapes and dimensions using specialized equipment and dies. Since stamping represents the first stage of body manufacturing, die precision directly influences the quality characteristics of the final product. Within the 4M1E framework, the stamping process includes human factors (employee skills and training), machine factors (equipment stability and die precision), material factors (steel thickness and cleanliness), method factors (stamping techniques and operational procedures), and environmental factors (workplace conditions and vibration absorption) [4], [8].

The welding stage involves assembling stamped components into the vehicle body structure. Analysis of welding processes within the 4M1E framework identifies several risk factors, including welders' qualifications, welding torch positioning accuracy, material compatibility, welding methods, inspection procedures, and workshop environmental conditions such as humidity and temperature [5], [9].

During the painting process, protective coatings are applied to prevent corrosion and wear while improving the external appearance of the vehicle. The quality of painting depends on workers' skills, the stability of painting equipment, paint properties, adherence to technological procedures, and environmental conditions such as temperature, humidity, and dust-free surroundings [1], [10].

The final assembly stage integrates all components into the completed automobile body. Analysis based on the 4M1E approach demonstrates that assembly quality is influenced by workers' technical skills, reliability of assembly tools, dimensional accuracy of incoming components, adherence to standardized procedures, and cleanliness and ergonomics of assembly areas [7].

To synthesize the identified factors, a fishbone (Ishikawa) diagram was developed to systematically illustrate the relationship between the five major factors—human, machine, material, method, and environment—and the four principal stages of automobile body production: stamping, welding, painting, and final assembly [11].

As a result of the analysis, 36 factors affecting quality and safety in automobile body manufacturing were identified according to the 4M1E framework. The findings indicate that die precision during stamping, welding techniques during welding, coating and electrophoretic solution properties during painting, and component quality during final assembly exert the greatest influence on production quality. In particular, the quality of assembly components



significantly affects the final assembly stage, whereas employee qualification in the painting stage demonstrates relatively lower significance compared to other indicators [3]–[5].

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