TOTAL QUALITY MANAGEMENT IN THE KNOWLEDGE-BASED ORGANIZATION: MANAGERIAL STRATEGIES ORIENTED TOWARDS EXCELLENCE

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ABSTRACT: This article examines the changing dynamics of quality management in the automotive sector, highlighting the use of sophisticated approaches and technology to attain operational excellence. It analyses the implementation of standards such as IATF 16949:2016, the function of tools like FMEA and QRQC, and the influence of agile and data-driven methodologies on quality assurance. The research underscores the importance of Zero-Defect, Manufacturing and continuous improvement methodologies, such as DMAIC and Kaizen, in cultivating a culture of excellence. It examines the application of artificial intelligence and digital technologies in defect identification and predictive maintenance. The study emphasises the significance of supplier collaboration, lean production processes, and staff involvement in maintaining high-quality results in automotive manufacturing through an extensive review of literature and case studies.
KEYWORDS: automotive, quality management, kaizen, zero defects, kanban

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1. INTRODUCTION

The analysis of quality management in the automobile industry is crucial due to the rising complexity and competitiveness in this sector. A review of recent literature identifies various creative strategies and procedures that enhance quality management standards and practices.

The automotive industry comprises intricate procedures and systems essential for maintaining product quality. In this context, integrated quality management systems are crucial for the communication processes that facilitate these operations. The IATF 16949:2016 standard establishes norms for automotive quality management systems and serves as a cornerstone in this domain. These standard underscores the importance of sophisticated product quality planning and risk management techniques, such as FMEA, in proactively resolving quality issues within the product development life cycle, thus enhancing overall production quality [1][2].

Paulíková's depiction of quality management systems underscore the necessity for dynamic representations of standards such as IATF 16949, which incorporates ISO 9001. Conventional static forms may obstruct efficient execution because of their intricacy. Utilising advanced visualisation tools, like TouchGraph Navigator, helps improve comprehension and compliance with these standards, hence supporting more seamless transitions in quality management procedures [3].

The effective handling of complaints is essential for enhancing the quality of automotive components, as outlined by Teplická et al. Their research highlights the significance of Customer Relationship handling systems within the automotive manufacturing sector, namely how proficient complaints handling can result in improvements in inputs and processes. Manufacturers can systematically resolve quality concerns and enhance overall production quality by utilising approaches such as QRQC (Quick Response Quality Control), FMEA, and Pareto analysis [4].

This corresponds effectively with the practices emphasised by Škůrková et al., which illustrate the efficacy of integrating Pareto analysis with the 8D technique to address nonconformities in industrial systems. Their research demonstrates enhancements obtained by a systematic methodology for addressing issues in quality management systems [5].

Chávez et al. provide the Agile Viable Model (AVM) to improve quality management in automotive companies. This approach prioritises adaptability and operational efficiency, enabling organisations to swiftly respond to environmental and market changes. The adoption of agile approaches can considerably enhance decision-making processes for quality management [6]. Mcknight et al. demonstrate

the essential function of data-driven solutions in sustainable quality enhancement, especially in automotive packaging systems. Challenges like manufacturing inefficiencies and inadequate circumstances for returnable packing can be alleviated by greater communication and transparency between automotive plants and suppliers, resulting in enhanced quality [7].

Patidar asserts the need of emphasising supply chain dynamics in maintaining quality within the automobile sector. The intricacy of automotive supply chains, along with international competition and regulatory mandates, highlights the necessity for thorough quality standards encompassing both manufacturers and suppliers [8]. Adopting the supply chain operations benchmark model to assess supply chain performance can yield insights into workflow efficiency and identify opportunities for quality enhancement [9]. The utilisation of artificial intelligence in quality defect control is gaining significance, as elucidated by Matamoros et al. Their comprehensive evaluation emphasises several AI approaches, such as deep learning and neural networks, essential for automating defect identification and predictive maintenance in the automotive industry. The incorporation of AI tools markedly improves the quality management framework by augmenting precision and efficiency in rectifying quality problems [10]. Digital technologies enhance communication as well as monitoring and feedback systems that identify irregularities in real time, facilitating timely interventions in the production process [11][12].

The automotive industry is overseen by prominent automobile manufacturers, like Volkswagen, Ford, General Motors, Tesla, BYD, among others. The life cycle, depicted in Figure 1, of the product created and manufactured by MPA, adheres to distinct phases:

- Offer;
- Contract analysis;
- Product development;
- Prototype validation of product design;
- Industrialisation;
- Validation of product and process;
- Optimisation of production;
- Recycling.

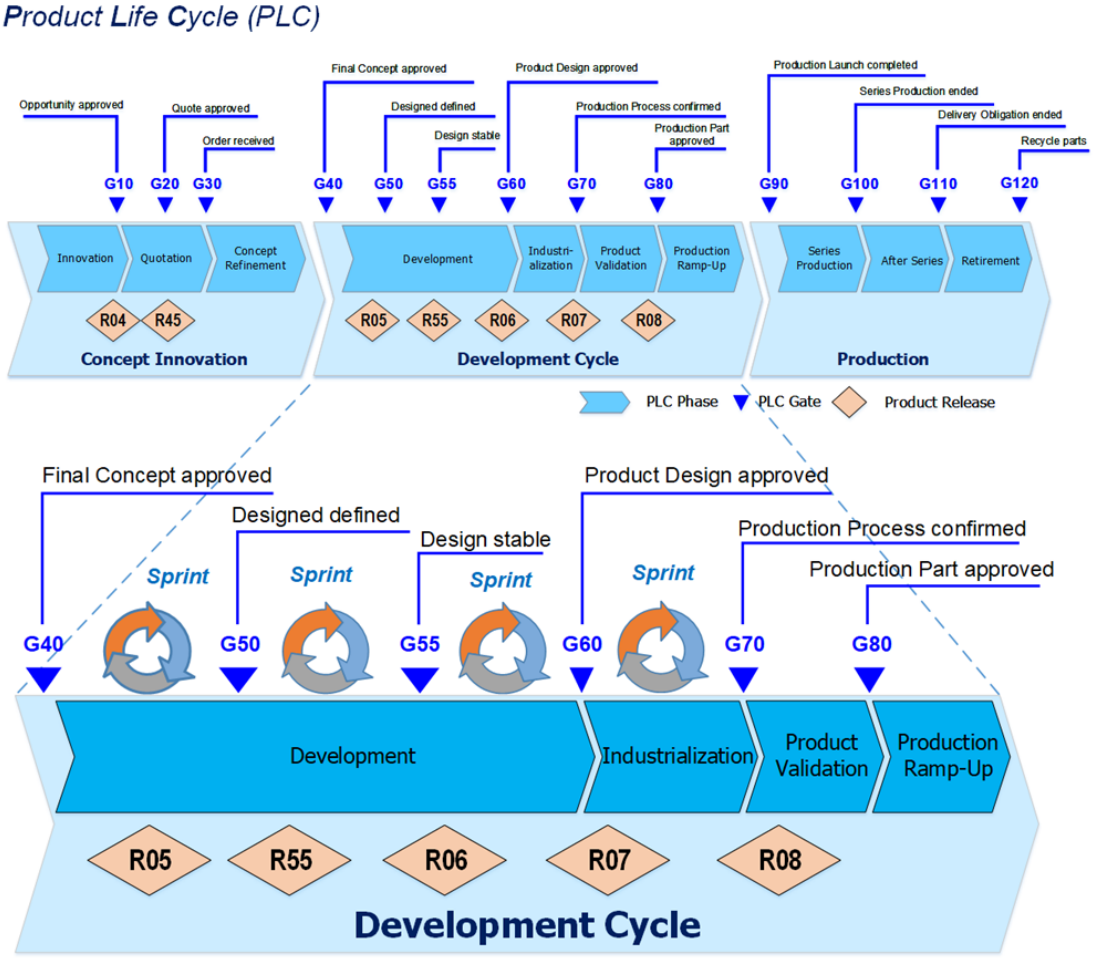

Figure 1. Product Life Cycle (PLC) (readjustment of [13])

On average, it takes three years to plan a new vehicle, or one to one and a half years for a facelift, and production and design centres for cars are located all over the globe. All of the vehicle's parts are painstakingly planned in these projects with an eye towards their shape, functionality, technical traits, and interconnections. The specification is a must-have document that includes all the pertinent information and details needed to guarantee quality and compliance, including technical drawings, rules, and testing. Automobile companies frequently work with specialised suppliers during the design process, taking advantage of their technical knowledge. Involvement of these development vendors in the vehicle design guarantees the best possible component integration. The selection of suppliers for series production is a crucial intermediary step before the components are assembled in the production facilities by vehicle manufacturers. Suppliers are selected according to stringent standards, which encompass, but are not limited to, quality, economic capability, and experience.

Automotive manufacturers place a high value on supplier control and monitoring. Due of the high component count, supplier quality engineers are assigned the task of ensuring that suppliers adhere to the phases. They check that vendors have the right tools, enough space, and the capacity to make high-quality components, as well as that they provide compatible prototypes. To ensure that suppliers can consistently deliver high-quality products, quality engineers conduct pre-production audits. Efficient logistics underpin the production process, reducing stockpiles through "just in time" delivery from a vast network of suppliers. Suppliers are categorised as Tier 1 if they distribute directly to production units, Tier 2 if they supply parts to those units, etc. Suppliers need to prove their quality and capacity to supply in order to move up the ladder [14].

"Product Quality Assurance File" or "Production Part Approval Process" is a crucial document for quality assurance during development and series manufacturing; it documents all quality criteria and phases. Zero defects and continual development are the guiding principles of these tools, which are essential in the automotive sector.

2. ZERO DEFECTS, CONTINUOUS IMPROVEMENT

Important paradigms in manufacturing and organisational quality management, Zero Defects and Continuous Improvement seek to achieve excellence in processes and services while reducing product defects. These ideas have come together in several ways that promote systemic improvements in various manufacturing environments.

In order to improve quality and save waste, Zero Defect Manufacturing strives for a manufacturing process that is free of defects. Several studies have pointed out the growing tendency of using technology, particularly within the framework of Industry 4.0, to aid in the detection and prediction of manufacturing faults. As an example, Grobler-Dębska et al. stress the significance of employing formal programming and utilising technology to enhance process efficiency and product quality, with the goal of attaining outputs free of defects [15].

Figure 2 presents the reasons why Zero Defect Manufacturing should be considered by organisations.

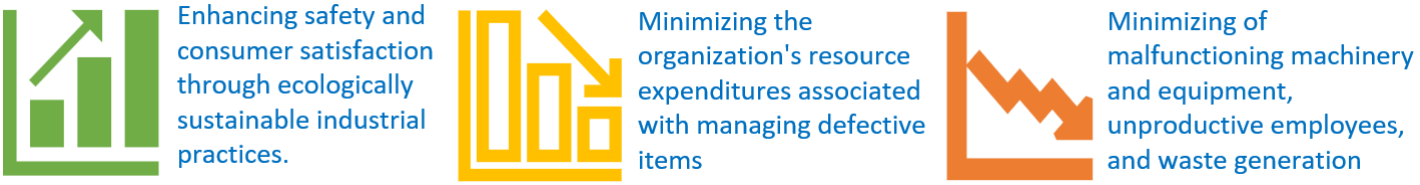

Figure 2. Organizations' motivation for adopting the Zero Defect concept

In order to achieve a Zero Defect mindset, continuous improvement is essential. Innovation and adaptability in operational processes are fostered by ongoing, incremental modifications to procedures. Customer satisfaction rises and rework falls as a consequence of a Zero Defect framework's adaptability to different manufacturing contexts, according to Yadav et al [16].

Organizational methods like DMAIC (Define, Measure, Analyze, Improve, Control) for finding problems and fixing them are common in methodologies for reaching zero faults. Using the DMAIC framework, businesses can lay a thorough groundwork for quality and track their progress in real time. In addition to Poka-Yoke and other preventive measures, qualitative tools like Ishikawa and Pareto diagrams can be useful in identifying the sources of faults [17].

If a organization wants to be efficient and produce high-quality work, it must adhere to the principle of

Zero Defects and implement continuous improvement programs. By fostering a culture of both gradual and radical transformation and utilizing structured methodologies like DMAIC, organizations can effectively work towards defect elimination and operational excellence.

3. THE KAIZEN CONCEPT

Organisational efficiency, quality, and employee satisfaction are greatly enhanced by the tenets of kaizen, which literally translate to "continuous improvement". This idea has deep roots in Japanese management philosophy. With the aim of fostering a culture where all employees proactively seek out and resolve process inefficiencies, it prioritises little changes over large-scale revolutions. Kaizen principles have proven their versatility and broad applicability by their systematic usage in several areas, including as healthcare, manufacturing, and services.

The attributes of Kaizen are as follows:

- disregard all current production organisation concepts;
- completely disregard the present circumstances;
- envision the functionality of the new methodology;
- the pursuit of perfection is unnecessary; a partial enhancement of merely 40-50% of the current situation is acceptable;
- substantial expenditures are not required;
- challenges encountered provide an opportunity to leverage managerial knowledge and skills;
- collective ideas from multiple individuals are superior to those of a single person.

Kaizen management relies on several methodologies and procedures [18]:

- Deming Cycle (PDCA): Plan, Do, Check, Act;
- SDCA: Standardise, Do, Check, Act cycle;
- A recommendation system wherein each employee offers comments for ongoing enhancement to management;
- Just-in-Time (JIT) methodology;
- 5S methodology.

The five fundamental principles of Kaizen management are:

- Upon encountering a problem, proceed to GEMBA (the actual location where each employee operates and value is generated);
- Inspect GEMBUTSU (defective or non-functional equipment);
- Implement immediate corrective actions on-site;
- Identify the root cause through the 5 WHY analysis;
- Standardise processes to avert future occurrences.

The five phases for effective maintenance, known as 5S, are:

- SEIRI – Sorting – distinguishing between essential and non-essential items in GEMBA and eliminating the non-essential ones;
- SEITON – Organising – arranging all items in accordance with SEIRI;
- SEISO – Cleaning and identifying anomalies – workspaces or equipment will be cleaned;
- SEIKETSU – Standardisation – perpetuating the notion of cleanliness for each individual alongside the ongoing application of the three 3S principles mentioned above;
- SHITSUKE – Disciplining – attaining self-discipline and the habituation of each employee engaged in 5S initiatives through standardised practices;

The fundamental idea of Kaizen is its collaborative nature, promoting involvement from all organisational tiers. Dardery et al. assert that effective Kaizen practices rely on a culture of continuous improvement, wherein employees at all levels are encouraged to suggest improvements [19].

Integrating Kaizen into organisational frameworks typically necessitates significant managerial backing and a favourable environment. Ramírez et al. underscore the necessity of supportive management policies that institutionalise continuous improvement activities, vital for sustaining a Kaizen culture [20]. Establishing lines of communication across departments is critical for encouraging collaboration, evaluating improvement suggestions correctly, and putting them into action. Additionally, as pointed out by Mazzocato et al., cross-functional teams that enhance communication between operational and management staff are crucial to the effectiveness of Kaizen operations in healthcare [21].

In addition to enhancing processes, kaizen has far-reaching effects on the happiness and productivity of employees. By showing how a Kaizen culture may improve operational efficiency and staff well-being through goal alignment, Shojaei and Shojaeiáva prove that it is worth implementing [22]. According

to studies conducted by Gasper and Mwenda, the Kaizen mentality has the potential to boost employee satisfaction and productivity indicators by increasing production. The Plan-Do-Check-Act (PDCA) cycle is one such organised process that is often used to drive the implementation of the Kaizen technique. This cycle allows for the systematic examination and refinement of practices [23].

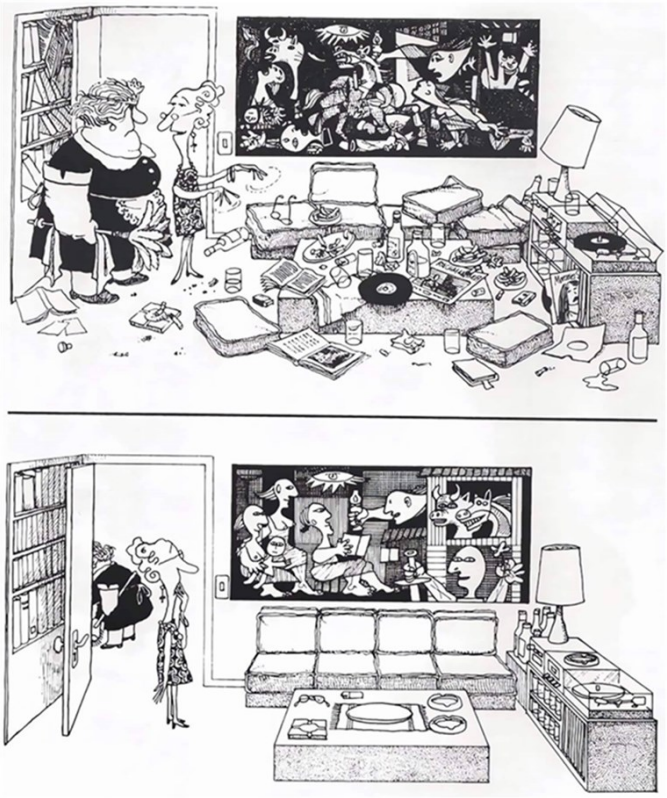

Figure 3. Before and after the implementation of 3S: SEIRI, SEITON, and SEISO (Quino's representation of Picasso's Guernica)

Two states of the identical space exhibit a startling dissimilarity, as shown in Figure 3. It is possible to see the visual disorder in the image above as evidence of the failure to apply the 5S principles, specifically Seiri (Sorting) and Seiton (Putting in Order). Using Seiso (Cleanliness) and cultivating a culture of Seiketsu (Standardisation) and Shitsuke (Support), the remarkable transformation in the scenario below shows how 5S can make an atmosphere that is both efficient and pleasurable.

Kaizen and Kanban are essential methodologies in continuous improvement and lean production, particularly within the automobile sector. This integration of methodologies is rigorously assessed through the modelling of manufacturing processes aimed at maximising efficiency and minimising waste. In “Contributions to the modelling of manufacturing processes for the implementation of the kanban methodology in the automotive industry” [24] the authors underscore the significance of applying Kanban principles to electronic control units (ECUs) within the automotive sector. The authors employ an analytical method to comprehend the production flow, including examining the initial processing durations at various stations. Figure 4 presents the concluding phase in the equilibrium of processing durations inside the production flow for the implementation of the Kanban method.

A more efficient flow of materials and reduced lead times are outcomes of this critical analysis's contribution to "balancing the production line," an essential step in implementing Kanban systems.

"Modeling of the automatic testing process of electronic control units in the automotive industry" their follow-up research [25], elaborates on this idea by detailing a parallel testing algorithm that aims to decrease processing time during the EOL testing phase.

This method safeguards the quality of functional tests, crucial for preserving the integrity of automobile components, while simultaneously increasing the efficiency of testing procedures.

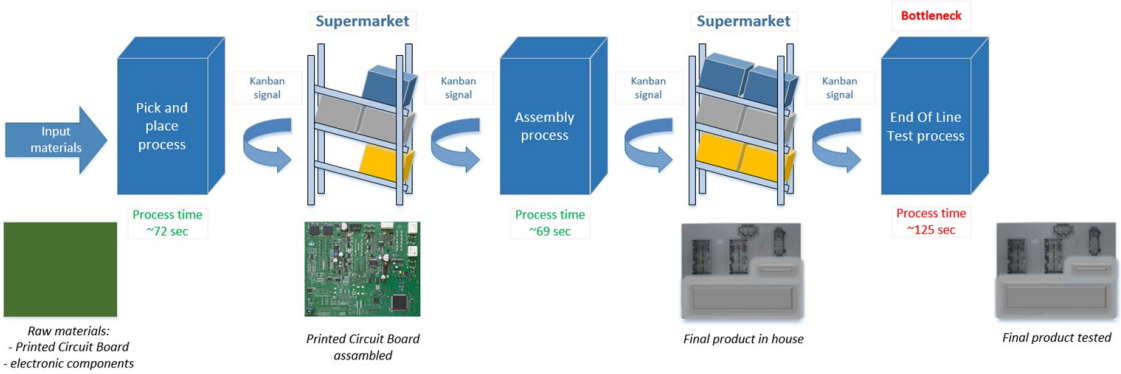

Figure 4. Optimising processing time frames within the production workflow [24]

An integral aspect of kaizen, this optimization seeks to enhance the production flow continuously without sacrificing quality.

Many different types of businesses rely on the kaizen philosophy to propel them towards constant development. Its all-encompassing strategy for performance improvement is visible in its focus on participatory management, rigorous procedures, and the alignment of employee well-being with organizational objectives. Not only do operational capabilities increase when organizations implement kaizen principles, but employee satisfaction and creativity are boosted as well.

4. CONCLUSION

The automotive industry's quest for superior quality management has transformed into a complex initiative, incorporating sophisticated processes, digital technology, and collaborative frameworks. This study emphasizes the essential function of standards like IATF 16949:2016, in conjunction with technologies such as FMEA, QRQC, and Pareto analysis, in the development of effective quality assurance systems. The integration of agile methodologies, data-centric approaches, and artificial intelligence has significantly improved the industry's ability to identify, anticipate, and rectify faults effectively.

The principles of manufacturing and continuous improvement, especially through DMAIC and Kaizen, have become essential components in cultivating a culture of operational excellence. These methods enhance production efficiency while improving employee engagement and satisfaction, fostering sustained organizational growth.

The integration of lean approaches like Kanban and the focus on supplier engagement highlight the significance of systemic thinking in achieving quality goals. As the sector encounters increasing complexity and worldwide competitiveness, the implementation of comprehensive quality management strategies will be crucial for upholding high standards and fostering innovation.

5. REFERENCES

1. Komatina, N., Tadić, D., Aleksić, A., & Banduka, N. The integrated PFMEA approach with interval type-2 fuzzy sets and FBWM: A case study in the automotive industry. *Proceedings of the Institution of Mechanical Engineers, Part D: Journal of Automobile Engineering*, 236 (6), 1201–1212. https://doi.org/10.1177/09544070211034799, (2021)
2. Chiliban, B., Chiliban, M., & Inţă, M. Advanced Product Quality Planning Reference Model in Automotive Industry. *Applied Mechanics and Materials*, 371, 802–806. https://doi.org/10.4028/www.scientific.net/amm.371.802, (2013)
3. Paulíková, A. Visualization concept of automotive quality management system standard. *Standards*, 2(2), 226-245. https://doi.org/10.3390/standards2020017, (2022)
4. Teplická, K., Khouri, S., Mudarri, T., & Freňáková, M. Improving the quality of automotive components through the effective management of complaints in industry 4.0. *Applied Sciences*, 13(14), 8402. https://doi.org/10.3390/app13148402, (2023)
5. Škůrková, K., Fidlerová, H., Niciejewska, M., & Idzikowski, A. Quality improvement of the forging process using pareto analysis and 8d methodology in automotive manufacturing: a case study. *Standards*, 3(1), 84-94. https://doi.org/10.3390/standards3010008. (2023)
6. Chávez, B., Nava, J., Escobar, J., & Matamoros, O. Viable and agile model for improving the quality area in an automotive company in mexico. *Systems*, 13(5), 343. https://doi.org/10.3390/systems13050343, (2025)
7. McKnight, T., Ward, T., & Jenab, K. Data-driven quality improvement for sustainability in automotive packaging. *Applied Sciences*, 14(13), 5723. https://doi.org/10.3390/app14135723, (2024)
8. Patidar, S. Supply Chain Challenges for Indian Automotive Industries. *International Journal for Research in Applied Science and Engineering Technology*, 6(6), 1735–1737. https://doi.org/10.22214/ijraset.2018.6255, (2018)
9. Lemghari, R., Okar, C., & Sarsri, D. Supply Chain Performance Measurement: A Case Study about Applicability of SCOR®Model in Automotive Industry Firm. *MATEC Web of Conferences*, 200, 00016. https://doi.org/10.1051/matecconf/201820000016, (2018)
10. Matamoros, O., Nava, J., Escobar, J., & Chávez, B. Artificial intelligence for quality defects in the automotive industry: a systemic review. *Sensors*, 25(5), 1288. https://doi.org/10.3390/s25051288, (2025)

11. Mazur, M. (2019). *Quality Assurance Processes in Series Production of Car Elements*. Quality Production Improvement - QPI, 1(1), 610–617. https://doi.org/10.2478/cqpi-2019-0082.
12. Karabegović, I., Karabegović, E., Mahmić, M., & Husak, E. (2021). *THE APPLICATION OF INDUSTRY 4.0 IN PRODUCTION PROCESSES OF THE AUTOMOTIVE INDUSTRY*. Mobility and Vehicle Mechanics, 47(2), 35–44. https://doi.org/10.24874/mvm.2021.47.02.03.
13. Bogorin-Predescu, A., Țîțu, S., & Țîțu, A. M. (2023). *Product Life Cycle in Automotive Industry*. In Lecture Notes in Networks and Systems (pp. 411–417). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-31066-9_45.
14. Titu, A. M., Covaci, C.-A., & Bogorin-Predescu, A. (2025). *The Evolution of Product Quality in the Automotive Sector: The Interdependence Between Raw Material Quality, Finished Products, and Supplier Performance*. In Lecture Notes in Networks and Systems (pp. 27–38). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-95194-7_3.
15. Grobler-Dębska, K., Kucharska, E., & Baranowski, J. (2021). *Formal Scheduling Method for Zero-Defect Manufacturing*. Springer Science and Business Media LLC. https://doi.org/10.21203/rs.3.rs-315238/v1.
16. Yadav, N., Kaliyan, M., Saikouk, T., Goswami, S., & Görçün, Ö. F. (2022). *Framework for zero-defect manufacturing in Indian industries – Voice of the customer*. Benchmarking: An International Journal, 30(7), 2303–2329. https://doi.org/10.1108/bij-01-2022-0001.
17. Setiawan, I., & Setiawan, S. (2020). *Defect reduction of roof panel part in the export delivery process using the DMAIC method: a case study*. Jurnal Sistem Dan Manajemen Industri, 4(2), 108–116. https://doi.org/10.30656/jsmi.v4i2.2775.
18. Imai, M. (2012). *Gemba Kaizen: A commonsense approach to a continuous improvement strategy* (2nd ed.). McGraw-Hill. ISBN 978-0-07-179035-2.
19. El Dardery, O. I. S., Gomaa, I., Rayan, A. R. M., Frendy, Khayat, G. E., & Sabry, S. H. Using Fuzzy TOPSIS and Balanced Scorecard for Kaizen Evaluation. *Business Systems Research Journal*, 14(1), 112–130. https://doi.org/10.2478/bsrj-2023-0006, (2023)
20. Alvarado-Ramírez, K. M., Pumisacho-Álvaro, V. H., Miguel-Davila, J. Á., & Suárez Barraza, M. F. Kaizen, a continuous improvement practice in organizations. *The TQM Journal*, 30(4), 255–268. https://doi.org/10.1108/tqm-07-2017-0085, (2018)
21. Mazzocato, P., Stenfors-Hayes, T., von Thiele Schwarz, U., Hasson, H., & Nyström, M. E. Kaizen practice in healthcare: a qualitative analysis of hospital employees' suggestions for improvement. *BMJ Open*, 6(7), e012256. https://doi.org/10.1136/bmjopen-2016-012256, (2016)
22. Shojaei, M., & Shojaeiává, P. Kaizen and employee performance: A path analysis. *Journal of Administrative and Business Studies*, 8(2). https://doi.org/10.20474/jabs-8.2.4, (2022)
23. Gasper, L., & Beny Mwenda. Quantitative analysis of Kaizen philosophy on productivity improvement. *International Journal of Research in Business and Social Science* (2147- 4478), 12(3), 557–562. https://doi.org/10.20525/ijrbs.v12i3.2455, (2023)
24. Țîțu A. M., Bogorin-Predescu A., Contributions to the modeling of manufacturing processes for the implementation of the kanban methodology in the automotive industry, *International Journal of Mechatronics and Applied Mechanics*, IJOMAM Review, eISSN: 2559-6497, Vol. 12, Pag. 94-98, https://doi.org/10.17683/ijomam/issue13.16, (2022)
25. Bogorin-Predescu A., Țîțu A. M, Niță N. M., Domnariu V. L., Modeling of the automatic testing process of electronic control units in the automotive industry, *International Journal of Mechatronics and Applied Mechanics*, IJOMAM, eISSN: 2559-6497, Vol. 12, Pag. 145-155, https://doi.org/10.17683/ijomam/issue12.22, (2022)