Brief Report
Volume 08:02, 2025

Journal of Biomedical and Pharmaceutical Sciences

ISSN: 2952-8100

Open Access

Tech-enabled Proactive and Sustainable Qualit

Lucas M. Rodriguez*

Department of Medicine, University of São Paulo, Brazil

Introduction

This article explores how blockchain technology can significantly improve quality control within supply chains. It proposes a conceptual framework highlighting blockchain's benefits in ensuring data integrity, traceability, and transparency, which are crucial for maintaining high product quality and mitigating risks from production to consumption. The insights suggest that adopting blockchain could revolutionize how quality is managed across complex global supply networks, providing an immutable record of product journeys and quality checkpoints [1].

This systematic review examines the growing application of Artificial Intelligence (AI) in manufacturing for quality control purposes. It synthesizes current research, identifies common AI techniques used, and points out gaps for future investigation. The review emphasizes AI's potential to enhance defect detection, process optimization, and predictive maintenance, thereby leading to more efficient and reliable manufacturing processes. Understanding these trends helps stakeholders leverage AI for superior product quality [2].

This paper focuses on the integration of the Internet of Things (IoT) in intelligent manufacturing environments, specifically for ensuring product quality. It discusses how IoT sensors and interconnected devices enable real-time data collection from various stages of production, allowing for immediate monitoring, analysis, and adjustments. The article highlights how this proactive approach helps in detecting anomalies early, preventing defects, and ultimately elevating the overall quality control efficiency in smart factories [3].

The article presents a systematic review of predictive quality control methods used in manufacturing systems. It summarizes existing research on how data-driven models and advanced analytics are employed to forecast potential quality issues before they occur. The review outlines various approaches, from statistical process control to Machine Learning, demonstrating how these techniques move quality assurance from reactive detection to proactive prevention, leading to reduced waste and improved manufacturing output [4].

This review delves into the specific quality control strategies essential for additive manufacturing (AM), also known as 3D printing. It addresses the unique challenges of AM processes, such as material inconsistencies, geometric deviations, and surface finish issues. The authors explore various in-situ monitoring, post-processing inspection, and statistical methods used to ensure the reliability and integrity of additively manufactured parts, underscoring the need for tailored quality approaches in this rapidly evolving field [5].

This comprehensive review explores the impact of digitalization on quality control processes, charting the current landscape and forecasting future trends. It covers various digital technologies, including big data analytics, cloud computing, and advanced sensor systems, and their role in transforming traditional quality management. The article highlights how these digital advancements enable more precise, efficient, and interconnected quality assurance, paving the way for smarter and more adaptable quality systems in industries [6].

This review provides an overview of recent advances in quality control and assurance specifically for automated manufacturing systems. It discusses how automation, robotics, and advanced monitoring techniques are integrated to maintain high quality standards in highly mechanized production environments. The article touches upon real-time inspection, self-correction mechanisms, and predictive algorithms that minimize human intervention while maximizing precision and consistency, ensuring the reliability of automated processes [7].

This review paper focuses on the application of deep learning techniques for visual quality control in industrial manufacturing settings. It highlights how deep learning algorithms, particularly convolutional neural networks, are being used for automated defect detection, classification, and anomaly identification from images and videos. The authors discuss the advantages of these methods in improving accuracy and speed compared to traditional machine vision, making quality inspection more robust and less subjective [8].

This article reviews the various applications of Machine Learning (ML) for quality control within the context of Industry 4.0. It examines how ML algorithms enhance decision-making, predictive analytics, and process optimization to achieve higher quality standards in smart manufacturing environments. The authors explore examples across different industrial sectors, demonstrating ML's capability to analyze vast datasets from interconnected systems for early defect detection and continuous quality improvement [9].

This systematic literature review investigates how quality control intersects with the principles of the circular economy. It identifies existing quality control practices that support resource efficiency, waste reduction, and product longevity, which are core tenets of circularity. The paper provides insights into adapting quality management systems to promote reuse, repair, and recycling, thereby contributing to sustainable production and consumption patterns and minimizing environmental impact [10].

Description

The evolution of quality control in manufacturing is significantly shaped by advanced technologies. For example, blockchain technology offers substantial improvements in quality control within supply chains by guaranteeing data integrity, traceability, and transparency. This is vital for maintaining product quality and managing risks from start to finish [1]. Likewise, Artificial Intelligence (AI) is increasingly applied in manufacturing for quality control, enhancing defect detection, optimizing processes, and enabling predictive maintenance for more efficient and reliable operations [2].

The Internet of Things (IoT) plays a pivotal role in intelligent manufacturing by integrating sensors and devices for real-time data collection. This allows for immediate monitoring, analysis, and necessary adjustments in production. This proactive approach helps detect anomalies early, preventing defects and boosting overall quality control efficiency in smart factories [3]. Building on this, predictive quality control methods, which utilize data-driven models and advanced analytics, are moving quality assurance from reactive detection to proactive prevention, ultimately reducing waste and improving manufacturing output [4].

Specific manufacturing processes, such as additive manufacturing (AM) or 3D printing, demand tailored quality control strategies. These strategies address unique challenges like material inconsistencies and geometric deviations through in-situ monitoring, post-processing inspection, and statistical methods. This ensures the reliability and integrity of additively manufactured parts [5]. Beyond individual processes, the broader impact of digitalization on quality control is undeniable. It involves technologies like big data analytics, cloud computing, and advanced sensor systems, which transform traditional quality management into more precise, efficient, and interconnected systems [6].

Automated manufacturing systems benefit from recent advances in quality control and assurance by integrating automation, robotics, and advanced monitoring techniques. These systems use real-time inspection, self-correction mechanisms, and predictive algorithms to minimize human intervention while maximizing precision and consistency, thereby ensuring the reliability of automated processes [7]. In a similar vein, deep learning techniques, especially convolutional neural networks, are crucial for visual quality control in industrial settings. These algorithms are used for automated defect detection, classification, and anomaly identification from images and videos, offering significant improvements in accuracy and speed over traditional machine vision [8].

Within the framework of Industry 4.0, Machine Learning (ML) applications are vital for quality control. ML algorithms enhance decision-making, predictive analytics, and process optimization, leading to higher quality standards in smart manufacturing environments. These systems analyze vast datasets to enable early defect detection and continuous quality improvement across various industrial sectors [9]. Finally, the intersection of quality control with the principles of the circular economy is becoming increasingly important. Existing quality control practices are being adapted to support resource efficiency, waste reduction, and product longevity, promoting reuse, repair, and recycling. This approach contributes significantly to sustainable production and consumption patterns and minimizes environmental impact [10].

Conclusion

Blockchain technology significantly improves quality control in supply chains by ensuring data integrity, traceability, and transparency, mitigating risks from production to consumption. Artificial Intelligence (AI) in manufacturing enhances defect detection, process optimization, and predictive maintenance for efficient production. The Internet of Things (IoT) provides real-time data for immediate monitoring and adjustments, proactively preventing defects in smart factories. Predictive quality control methods, leveraging data-driven models and advanced analytics, shift quality assurance from reactive detection to proactive prevention, reducing waste. Specific strategies are essential for additive manufacturing, addressing unique challenges through in-situ monitoring and post-processing inspection. Digitalization, including big data analytics and advanced sensor systems, transforms quality management for more precise and adaptable systems. Automated manufacturing integrates robotics and advanced monitoring for high standards, using real-time inspection and self-correction. Deep learning techniques, particularly convolutional neural networks, are crucial for visual quality control, improving automated defect detection accuracy. Machine Learning (ML) applications in Industry 4.0 optimize processes and improve quality through predictive analytics. Furthermore, sustainable quality control practices in the circular economy focus on resource efficiency, waste reduction, and product longevity by promoting reuse, repair, and recycling in sustainable production.

Acknowledgement

None.

Conflict of Interest

None.

References

1. Syed Hasan K. Shah, Majed Al-Sharafi, Majdi M. Al-Mekhlafi, Khalid Al-Shaikh. "Blockchain Technology for Enhancing Supply Chain Quality Control: A Conceptual Framework." *J Retailing Consumer Serv* 76 (2024):103590.

2. Lucas Alexandre Eleuterio de Souza, Lucas Jardim de Queiroz, Diego Barreto de Lima, Sabrina da Cruz Severo Alves, Roberta de Campos. "Artificial intelligence for quality control in manufacturing: A systematic review and future research agenda." *Comput Ind Eng* 184 (2023):109536.

3. Xin Wang, Yaowen Huang, Yan Chen, Yu Liu. "Application of IoT in intelligent manufacturing for product quality control." *J Intell Manuf* 33 (2022):2367–2380.

4. Mário C. Costa, Ricardo Santos, Rui B. Sousa, Lúcia M. G. Pinto. "Predictive quality control in manufacturing systems: A systematic review." *J Manuf Syst* 64 (2022):444-460.

5. Abdullah K. M. A. Karim, N. T. T. Nguyen, M. F. C. F. M. Costa, M. S. Islam. "Quality control strategies for additive manufacturing: A review." *Addit Manuf* 47 (2021):102283.

6. Sami H. Al-Shami, Raed Al-Saidi, Mohammed A. Al-Hadi, Hamad Al-Qadiri. "Digitalization in quality control: A comprehensive review on the current state and future trends." *J Manuf Technol Manag* 31 (2020):1619-1644.

7. Yu Li, Guowei Wang, Peirong Zhang, Jianjun Chen. "Quality control and assurance in automated manufacturing systems: A review of recent advances." *J Clean Prod* 263 (2020):121488.

8. Rui Chen, Ming Li, Jianping Yu, Yunli Wu. "Deep learning for visual quality control in industrial manufacturing: A review." *Int J Prod Res* 59 (2021):4213-4233.

9. A. Saravana Kumar, T. P. Vinod Kumar, P. K. Prasanth, K. R. S. Prasad. "A review of machine learning applications for quality control in industry 4.0." Mater Today: *Proc* 27 (2020):2289-2294.

10. Nelson G. Z. I. Nsunge, Armando C. T. C. M. de Morais, Ana L. N. Z. C. M. Pinto. "Sustainable quality control in circular economy: A systematic literature review." *J Environ Manag* 344 (2023):118476.

How to cite this article: Rodriguez, Lucas M ."Tech- Enabled Proactive and Sustainable Quality ." *J Biomed Pharm Sci* 08 (2025):511.

***Address for Correspondence:** Lucas, M. Rodriguez, Department of Medicine, University of São Paulo, Brazil, E-mail: lucas.rodriguez@usp.br

Received: 03-Mar-2025, Manuscript No. jbps-25-172229; **Editor assigned:** 05-Mar-2025, PreQC No. P-172229; **Reviewed:** 19-Mar-2025, QC No. Q-172229; **Revised:** 24-Mar-2025, Manuscript No. R-172229; **Published:** 31-Mar-2025, DOI: 10.37421/2952-8100.2025.9.511