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Production Management Strategy in Reducing Product Defect Level: Systematic Review

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ABSTRACT
This systematic review synthesizes research on production management strategies for reducing product defect rates to address fragmented understanding of the effectiveness of various approaches and implementation challenges in the manufacturing industry. The review aims to evaluate the effectiveness of various production management strategies in reducing defect rates, compare methodological approaches used, identify key tools and techniques that improve product quality, and analyze barriers and enablers in implementing quality improvement programs. A systematic analysis of seven empirical and conceptual studies published between 2020 and 2025 was conducted, emphasizing the global manufacturing sector with mixed methodologies including case studies, surveys, and quantitative analysis using DMAIC, Statistical Process Control, and integrated approaches. The findings reveal that the integration of Lean Six Sigma approaches consistently produces significant defect rate reductions, with Industry 4.0 technologies such as AI, IoT, and machine learning reinforcing the effectiveness of traditional Statistical Process Control methods. However, heterogeneity of industrial contexts and limitations of longitudinal research constrain the generalization of results, while organizational factors such as management commitment and employee training significantly moderate implementation success.

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INTRODUCTION

Research on production management strategies for reducing product defect rates has emerged as a critical area of inquiry due to its significant impact on operational efficiency, customer satisfaction, and company profitability. The evolution of this field traces back to the development of Statistical Process Control (SPC) in the 1920s to the emergence of the Zero Defect Manufacturing (ZDM) concept and its integration with Industry 4.0 technologies in the last decade (Psarommatis et al., 2024). Modern manufacturing industries face increasing pressure to produce high-quality products with minimal defect rates, given that the cost of poor quality can reach 20% of total sales in companies with less mature quality systems (Quality Management, 2025).

The paradigm shift from reactive quality control to proactive quality assurance has driven the adoption of various methodologies such as Total Quality Management (TQM), Lean Manufacturing, Six Sigma, and their integration into Lean Six Sigma (Kareska, 2023; Luthra et al., 2023). Effective implementation of these strategies has been shown to reduce process variability by up to 70% and dramatically lower defect rates (Quality Management, 2025). Advances in digital technologies such as artificial intelligence, machine learning, and the Internet of Things (IoT) have opened up new opportunities in predictive quality management and real-time defect detection, with the potential to reduce error rates by up to 90% (StartUs Insights, 2025).

Despite growing interest, the specific issue of how various production management strategies can be optimally integrated to reduce product defect rates still requires further exploration. Existing studies often focus on the implementation of a single methodology or specific industry context without fully explaining the integration mechanisms and contextual factors influencing implementation success. Furthermore, there is debate regarding the relative effectiveness of traditional approaches such as SPC and modern AI-based approaches in the context of Industry 4.0 (Psarommatis et al., 2024). The consequences of this knowledge gap include suboptimal investment in quality improvement programs and missed opportunities to achieve operational excellence through zero-defect manufacturing.

The conceptual framework underlying this review defines production management strategy as a systematic approach that integrates tools, techniques, and methodologies to identify, prevent, and eliminate defects in manufacturing processes. Defect reduction encompasses preventive (preventing defects from occurring), detective (detecting defects early), and corrective (fixing the root causes of defects) efforts implemented in an integrated manner within a company's quality management system. The framework states that the effectiveness of a defect reduction strategy depends on the interaction between technical (tools and technology), organizational (structure and systems), and human (competence and culture) aspects, supported by the theory of Continuous Improvement and Quality Management Systems.

The purpose of this systematic review is to empirically analyze and synthesize current research on production management strategies for reducing product defect rates in the global manufacturing sector.

This study aims to fill the identified gap by providing a comprehensive understanding of the effectiveness of various approaches, best practices in implementation, and critical factors influencing the success of defect reduction programs, thereby offering actionable insights for academics and industry practitioners.

This review employs a methodology that combines qualitative and quantitative studies from diverse industry contexts, applying a structured analytical framework to evaluate the effectiveness of various strategies and identify key factors for successful implementation. The findings are organized thematically to describe the methodology, tools and techniques, implementation results, and managerial implications, guiding future research and practice in quality management and production excellence.

Theoretical Foundation/Literature Review

Production Management

Production management is a series of activities related to planning, organizing, directing, and controlling the production process to produce goods or services effectively and efficiently (Heizer et al., 2020). According to Stevenson and Chuong (2021), production management is a management function responsible for planning, coordinating, and controlling the resources needed to produce a company's products and services.

The scope of production management includes five main aspects, namely: (1) production planning which includes determining the type, quantity, and time of production; (2) production control to ensure the process runs according to plan; (3) quality control to ensure products meet established standards; (4) maintenance to ensure the smooth operation of machines and equipment; and (5) inventory management to optimize the availability of raw materials and finished products (Krajewski et al., 2022).

The production management function in the context of reducing product defects is crucial because it involves integrated process design, capacity planning, and quality management (Jacobs & Chase, 2020). Modern production management emphasizes a systematic approach to identifying and eliminating sources of variability that cause product defects through the application of methodologies such as Statistical Process Control (SPC), Total Quality Management (TQM), and Lean Six Sigma (Reid & Sanders, 2020).

Recent developments in production management include the integration of Industry 4.0 technologies, which enable real-time monitoring, predictive maintenance, and automated quality control, thereby enhancing companies' ability to proactively prevent and reduce product defect rates (Xu et al., 2021). The implementation of smart manufacturing systems enables companies to achieve zero-defect production through continuous monitoring and adaptive control mechanisms (Wang et al., 2023).

Quality Control

According to Montgomery (2009), quality control is a technical and managerial activity. The stages of quality control are as follows: product quality characteristics are measured, compared with established specifications or requirements, and appropriate corrective action is taken if there is a difference between actual performance and established standards. Quality control can be defined as an effort to maintain the quality of the resulting product so that it complies with the specifications set by the company (Assauri, 2008). Thus, it can be concluded that quality control is an activity that aims to maintain and improve the quality of products or services. This maintenance or improvement of quality is carried out so that it can meet the desired or expected specifications.

The purpose of quality control is to investigate suspected causes or process shifts so that investigations into the process and corrective actions can be taken before the production results are not in accordance with each unit. And reducing product variability is the main goal of quality control (Montgomery, 1990). There are five goals of quality control proposed by Yamit (2000): suppressing or reducing the volume of errors and repairs, maintaining or improving quality, reducing complaints or consumer rejections, enabling output explanations and improving or maintaining company image. These five goals are very helpful for companies to produce quality products and can meet consumer desires.

Product Defects

Based on the opinion of Karim, Asma, and Talaat (2011:154) in the Oxford Dictionary (1992) which termed defective products as defective, which can be interpreted as imperfect or incomplete products. Meanwhile, according to Hansen and Mowen (2009:271) stated that what is meant by a defective product is a product that does not comply with its specifications. From the above definition, it can be explained that all companies have in principle established standard product specifications for sale. If the product does not comply with the established specifications, the company classifies it as a reject or defective product.

Meanwhile, according to Bastian and Nurlela (2010:13), a defective product is a product produced in the production process, where the product produced does not comply with the established quality standards, but economically the product can be repaired by spending certain costs, in this case it is necessary to pay attention to the costs incurred to repair it being lower than the selling value after the product is repaired.

Product Quality Control Costs

Cost of quality (COQ) is the total cost a company incurs to ensure products meet established quality standards, as well as the costs arising from failure to meet those standards (Campanella, 2020). According to Feigenbaum's further developed classification, quality costs can be categorized into four main groups: prevention costs, appraisal costs, internal failure costs, and external failure costs (Kumar & Sharma, 2021).

Prevention costs include all costs incurred to prevent defects from occurring, such as quality planning, process development, employee training, and preventive maintenance. Appraisal costs include the costs of inspections, testing, and quality audits conducted to ensure products meet specifications before they reach consumers (Gitlow et al., 2022). Investments in prevention and appraisal costs have been shown to significantly reduce failure costs in the long run (Ahuja & Khamba, 2020).

Internal failure costs are the costs incurred when a defective product is detected before it is shipped to the customer, including rework, scrap, and production downtime. Meanwhile, external failure costs include warranty costs, customer complaint handling, product recalls, and loss of reputation that occurs after the defective product reaches the consumer (Montgomery, 2020). Research shows that external failure costs can be 10–20 times the cost of internal failure, emphasizing the importance of early product defect detection (Dale et al., 2023).

Optimizing quality costs can be achieved through an optimal balance between prevention-appraisal costs and failure costs, where appropriate investment in preventive activities can minimize total quality costs (Magar & Shinde, 2022). Recent studies show that implementing an effective quality management system can reduce total quality costs from 20-30% to 10-15% of sales through a dramatic reduction in failure costs (Psomas & Antony, 2021).

Previous Research Results

Safitri, Vira (2023), Reducing Defects in Bakpia Cake Product Quality Using the Seven Tools Method at Harapan Jaya Bekasi MSMEs, Problem: Throughout August 2021 – January 2021, Harapan Jaya Bekasi MSMEs experienced production defects of 2.21% exceeding the tolerance limit of 1%, Solution: Reduce the production defects that occur to return to the production defect tolerance limit of 1% using the Seven Tools method, Analysis method: Seven Tools, Research Results: Improvement efforts to reduce production defects that occur are by making improvements to human factors, machines, and methods so that the percentage of defective products is within the defect tolerance limit.

Pratama, NA (2023), Quality Control Analysis with Seven Tools and Kaizen Methods in an Effort to Reduce Product Defect Levels, Problem: Production defects such as burnt bread, unrisen bread, and large bread pores reduce product quality, Solution: Conducting an analysis of the occurrence of production defects in Roti Bakar Azhari MSMEs using the Seven Tools & Kaizen method, Analysis Method: Seven Tools and Kaizen, Research Results: The type of burnt bread defect has a defect percentage of 22.19%, the unrisen bread defect has a defect percentage of 57.3%, and the large bread pore defect has a defect percentage of 20.51%. The solution provided is in the form of creating SOPs and changing the layout of the workplace.

Nugroho, A., & Wijaya, T. (2022), "Implementation of Lean Six Sigma to Reduce Defect Rate in the Textile Industry", Problem: PT Textile Indonesia experienced a product defect rate of 8.5% which caused significant financial losses and decreased customer satisfaction.

Solution: Implementing the Lean Six Sigma methodology with the DMAIC (Define, Measure, Analyze, Improve, Control) approach to identify and eliminate the main causes of production defects. Analysis Method: Lean Six Sigma with the DMAIC framework, Value Stream Mapping (VSM), and Statistical Process Control (SPC). Research Results: The implementation of Lean Six Sigma successfully reduced the defect rate from 8.5% to 2.3% in a 6-month period, resulting in quality cost savings of IDR 450 million per year. The analysis identified that 60% of defects were caused by process variability in the weaving machine, 25% from the quality of raw materials, and 15% from human error. Improvements are made through process standardization, planned preventive maintenance, and increasing operator competency through structured training programs.

Pratiwi, S., Rahman, F., & Kusuma, H. (2024), "Implementation of Statistical Process Control and Total Quality Management in Reducing the Defect Rate of Electronic Products", Problem: CV Elektronika Jaya faces a high product defect rate of 6.8%, with the dominant defect types being soldering defects (45%), component misalignment (30%), and cosmetic defects (25%). Solution: Integrating the Statistical Process Control (SPC) method for real-time monitoring with the Total Quality Management (TQM) philosophy to build a quality culture throughout the organization. Analysis Method: Statistical Process Control (X-bar and R-chart), Process Capability Analysis (Cp and Cpk), Failure Mode and Effect Analysis (FMEA), and TQM implementation framework. Research Results: After 8 months of implementation, the defect rate decreased to 1.9%, with the process capability index (Cpk) increasing from 0.85 to 1.45. The implementation of SPC allows for early detection of out-of-control conditions, while TQM creates ownership of quality at all levels of the organization. Research also found that top management commitment and employee involvement were key success factors, with employee engagement scores increasing from 65% to 88%.

METHODOLOGY

This research is a literature study, analyzing the role of Production Management Strategy in Reducing Product Defect Levels based on the literature based on the Effectiveness of Lean Six Sigma, Process Control in Monitoring and Prevention, Total Quality Management, Implementation of Defect Reduction Strategy.

RESEARCH RESULT

The Effectiveness of Lean Six Sigma in Reducing Product Defects

A systematic literature review shows that the Lean Six Sigma (LSS) approach is the most effective and consistent strategy for reducing product defect rates across various manufacturing industry contexts. The integration of Lean principles, which focus on waste elimination, with the Six Sigma methodology, which emphasizes reducing process variability, creates a powerful synergy for continuous improvement.

Studies show that companies adopting LSS achieve a mean defect rate of 3.18% with an average production throughput of 134.08 units per hour, a significant improvement compared to baseline operations (Science Direct, 2025).

Implementing LSS using the DMAIC (Define, Measure, Analyze, Improve, Control) framework has been proven to drastically reduce rejection rates in a relatively short time. In a case study of the automotive filters industry, the application of VSM and DMAIC successfully reduced the rejection rate from 12% to 4%, with the delivery cycle reduced from 12 days to 11 days (Emerald, 2023). Similar success was also recorded in the axle manufacturing industry, where the rejection rate dropped from 9.19% with financial savings reaching Rs. 7,33,000 per month through the elimination of non-value-added activities and systematic process improvements (Materials Science and Engineering, 2021).

Furthermore, recent research reveals that integrating LSS with Industry 4.0 technologies produces superior results compared to traditional LSS implementations. A framework that combines LSS principles with computer vision and automated monitoring achieved a 75% reduction in crack defects and a 67% reduction in porosity defects, supporting the achievement of zero-defect manufacturing (International Journal of Production Research, 2025). These findings confirm that LSS is not merely a stand-alone methodology, but a platform whose effectiveness can be enhanced through digitalization and automation.

The Role of Statistical Process Control in Monitoring and Prevention

Statistical Process Control (SPC) has emerged as a crucial foundation in product defect reduction strategies through preventive and detective approaches. SPC enables companies to distinguish between common cause variation (inherent in the process) and special cause variation (indicating problems requiring corrective action), thus facilitating more accurate and timely decision-making (6Sigma.us, 2025). Research shows that companies that effectively implement SPC can reduce process variability by up to 70%, which directly impacts product quality improvement and production costs (Savvycom, 2025).

The evolution of SPC towards SPC 4.0 marks a significant transformation in quality management in the Industry 4.0 era. The integration of real-time sensor analytics, machine learning, and advanced statistical methods within the SPC 4.0 framework enables more accurate predictive and preventive defect detection. The implementation of an integrated system that combines Hotelling's T^2 control charts with ML classifiers (Gradient Boosting and CNN) resulted in substantial improvements in defect prediction accuracy and response time (Efficiens Journal, 2025).

The synergy between SPC and Fault Detection (FD) systems yields significant additional benefits in semiconductor manufacturing and the high-precision industries. Integrated SPC-FD systems minimize defects, optimize processes, and reduce downtime simultaneously, generating substantial cost savings through a centralized data repository and real-time correlation analysis between equipment performance and product quality metrics (Applied SmartFactory Solutions, 2024).

Furthermore, AI-enabled SPC applications can achieve up to a 90% reduction in error rates through automated pattern recognition, predictive maintenance, and adaptive control limits (IJSRM, 2025).

Total Quality Management as a Cultural Foundation

Total Quality Management (TQM) serves as a philosophy and culture that underpins the successful implementation of product defect reduction strategies. TQM emphasizes an organization-wide commitment to quality improvement, where every individual within the organization is responsible for quality, not just the quality control department (Kareska, 2023). Research shows that 89% of organizations practicing TQM experience increased customer satisfaction within the first two years of implementation (ASQ Global Quality Report, 2024).

TQM principles such as customer focus, continuous improvement, employee empowerment, and process-oriented thinking create a strong foundation for implementing sustainable quality improvement initiatives. TQM in production organizations focuses on process optimization, defect prevention, and a customer-centric approach, which collectively result in reduced waste, improved product quality, and increased customer satisfaction (SSRN, 2023). Successful TQM implementation requires cultural transformation and strong leadership commitment, with leadership commitment emerging as a significant moderator, averaging 3.47 on a 5-point scale (ScienceDirect, 2025).

The integration of TQM with modern approaches such as Quality 4.0 brings a new dimension to quality management, where traditional quality principles are combined with digital technologies, IoT, AI, and connectivity. Quality 4.0 enables real-time quality monitoring, predictive analytics, and automated decision-making, which strengthens the effectiveness of TQM in achieving zero-defect goals and world-class customer satisfaction (Journal of Applied Research in Technology & Engineering, 2025). However, effective TQM implementation requires structured training programs, with an average of 26.3 hours of structured training required to ensure adequate workforce development (ScienceDirect, 2025).

Barriers and Enablers in Implementing Defect Reduction Strategy

Literature analysis identifies several critical barriers that often hinder the successful implementation of defect reduction strategies. High initial costs and technology infrastructure requirements emerge as the most significant barriers, where investment in advanced quality systems, training, and process redesign can be prohibitive, especially for small-to-medium enterprises (International Journal of Production Research, 2025). Lack of skilled workforce and competency gaps are also major challenges, given that implementing methodologies such as Six Sigma or SPC requires statistical knowledge and analytical capabilities that may not be available in the existing workforce.

Resistance to change is a human factor consistently identified as a major obstacle in quality improvement initiatives. Organizational inertia, fear of job displacement, and comfort with the status quo can hinder the adoption of new processes and technologies (European Journal of Business and Management Research, 2025).

Furthermore, data quality issues, inadequate management support, and a lack of clear strategic alignment between quality initiatives and business objectives can lead to suboptimal results or even program failure.

On the other hand, several critical enablers have been identified that facilitate successful implementation. Management commitment and leadership engagement emerged as the highest-ranking enablers, while visible leadership support, resource allocation, and strategic prioritization of quality improvement form the foundation for sustainable success. Employee engagement and empowerment are also crucial, with organizations that involve frontline workers in problem-solving efforts able to reduce lead times by up to 50% (Quality Control Best Practices, 2025).

Strategic agility, trust-building among stakeholders, and policy support also play a crucial role in enabling a successful quality transformation. Technology infrastructure readiness, an organizational learning culture, and effective change management strategies facilitate a smooth transition and sustainable improvement. Integrating quality initiatives with a broader business strategy, combined with robust training programs and continuous feedback mechanisms, creates a conducive environment for long-term quality excellence (Efficiens Journal, 2025).

CONCLUSION AND SUGGESTIONS

The results of a systematic literature review indicate that an effective production management strategy for reducing product defect rates requires a holistic approach that integrates methodological, technological, organizational, and human aspects. Lean Six Sigma emerged as the most robust and versatile methodology, consistently producing significant defect rate reductions across various manufacturing contexts, with effectiveness further enhanced through integration with Industry 4.0 technologies.

Statistical Process Control, both in its traditional form and the evolved SPC 4.0, plays a critical role as a monitoring and prevention mechanism that enables real-time process control and predictive defect detection. The integration of SPC with AI and machine learning technologies results in a quantum leap in defect detection accuracy, with potential error rate reductions reaching 90%. Total Quality Management provides an essential cultural foundation and philosophical framework for sustainable quality improvement, emphasizing organization-wide commitment and a customer-centric mindset.

The successful implementation of a defect reduction strategy is heavily influenced by organizational factors, particularly management commitment, employee engagement, and the adequacy of training programs. Technology infrastructure, strategic agility, and effective change management also play crucial roles in moderating implementation success. Major barriers such as high initial costs, resistance to change, and skills gaps can be minimized through a phased implementation approach, comprehensive training programs, and strong leadership support.

This research identifies a gap in longitudinal studies examining the long-term sustainability of defect reduction programs and their comparative effectiveness across different industrial contexts. Future research should focus on developing integrated frameworks tailored to specific industry characteristics, exploring synergies between traditional quality methodologies and emerging technologies such as AI, IoT, and digital twins, and investigating human and organizational factors that facilitate or hinder quality transformation.

REFERENCES

Anwar, C., Andika, F., & Rosdiana, E. (2021). The Relationship between Knowledge, Attitude and Role of Health Workers with Breast Care for Pregnant Women in the Third Trimester in the Work Area of Lamteuba Health Center, Seulimum District, Aceh Besar Besar District. In Journal of Healthcare Technology and Medicine (Vol. 7, Issue 1).

Ahuja, I. P. S., & Khamba, J. S. (2020). An evaluation of cost of quality practices in manufacturing organizations. International Journal of Quality & Reliability Management, 37(6/7), 1010-1030.

ASQ. (2024). Global Quality Report 2024. American Society for Quality.

Campanella, J. (2020). Principles of quality costs: Principles, implementation, and use (4th ed.). ASQ Quality Press.

Dale, B. G., van der Wiele, T., & van Iwaarden, J. (2023). Managing quality (7th ed.). Wiley-Blackwell.

Efficiens Journal. (2025). Integrating SPC 4.0 and Machine Learning for Predictive Quality Management in Smart Manufacturing. Efficiens: Journal of Management Science and Operations, 1(1), 49-58.

Gitlow, H. S., Levine, D. M., & Popovich, E. A. (2022). Design for Six Sigma for green manufacturing (2nd ed.). Pearson Education.

Heizer, J., Render, B., & Munson, C. (2020). Operations management: Sustainability and supply chain management (13th ed.). Pearson.

International Journal of Production Research. (2025). A framework for integrating Lean Six Sigma and Industry4.0 for sustainable manufacturing. International Journal of Production Research. https://doi.org/10.1080/00207543.2025.2571202

Jacobs, F. R., & Chase, R. B. (2020). Operations and supply chain management (16th ed.). McGraw-Hill Education.

Journal of Applied Research in Technology & Engineering. (2025). TQM Implementation for enhancement of product and service quality: A review on developments and latest trends. Journal of Applied Research in Technology & Engineering, 6(1), 63-72.

Kareska, K. (2023). Total Quality Management in Production and Service Organizations. SSRN Working Paper. https://doi.org/10.2139/ssrn.4591999

Krajewski, L. J., Malhotra, M. K., & Ritzman, L. P. (2022). Operations management: Processes and supply chains (13th ed.). Pearson.

Kumar, S., & Sharma, R. K. (2021). Cost of quality: A review of methodology and empirical research. International Journal of Quality & Reliability Management, 38(1), 227-251.

Luthra, S., Garg, D., Agarwal, A., & Mangla, S. K. (2023). Total Quality Management (TQM): Principles, Methods, and Applications. CRC Press, Taylor & Francis Group.

Magar, V. M., & Shinde, V. B. (2022). Cost of quality analysis: Driving force for quality improvement. International Journal of Quality Research, 16(1), 135-150.

Montgomery, D. C. (2020). Introduction to statistical quality control (8th ed.). John Wiley & Sons.

Nugroho, A., & Wijaya, T. (2022). Implementasi Lean Six Sigma untuk mengurangi defect rate pada industri tekstil. Jurnal Teknik Industri, 24(2), 156-168. https://doi.org/10.9744/jti.24.2.156-168

Parashare, G. R. (2025). AI-Enabled Statistical Process Control for Semiconductor Manufacturing Quality Improvement. International Journal of Scientific Research and Management (IJSRM), 13(06), 2279-00. https://doi.org/10.18535/ijsrm/v13i06.ec07

Pratiwi, S., Rahman, F., & Kusuma, H. (2024). Penerapan Statistical Process Control dan Total Quality Management dalam menurunkan tingkat kecacatan produk elektronik. Jurnal Manajemen dan Teknik Industri, 6(1), 45-58. https://doi.org/10.21776/jmti.2024.006.01.05

Psarommatis, F., et al. (2024). Zero defect manufacturing in 2024: A holistic literature review for bridging the gaps and forward outlook. International Journal of Production Research. https://doi.org/10.1080/00207543.2024.2388217

Psomas, E., & Antony, J. (2021). Total quality management elements and results in higher education institutions: A systematic review. Quality Assurance in Education, 29(2/3), 206-223.

Quality Management Trends. (2025). Quality Management Trends and Predictions for 2025. Retrieved from https://www.qualityze.com/blogs/quality-management-trends-2024

Reid, R. D., & Sanders, N. R. (2020). Operations management: An integrated approach (7th ed.). John Wiley & Sons.

Savvycom Software. (2025). Statistical Process Control in Manufacturing: Maximizing Quality and Efficiency in the Digital Age.

Stevenson, W. J., & Chuong, S. C. (2021). Operations management (14th ed.). McGraw-Hill Education.

Wang, J., Ma, Y., Zhang, L., Gao, R. X., & Wu, D. (2023). Deep learning for smart manufacturing: Methods and applications. Journal of Manufacturing Systems, 48, 144-156.

Xu, L. D., Xu, E. L., & Li, L. (2021). Industry 4.0: State of the art and future trends. International Journal of Production Research, 56(8), 2941-2962.