Defect Reduction in The Manufacturing Industry: Systematic Literature Review

Mukti Ali Sadikin
Department of Industrial Engineering, Universitas Trisakti, Jakarta, Indonesia

Email: mukti.quality@gmail.com

*Corresponding author

ABSTRACT

Defect reduction is an important aspect of quality improvement in the manufacturing industry, as it directly impacts product quality, customer satisfaction, and operational efficiency. This paper presents a systematic literature review on defect reduction in the manufacturing industry. The study systematically reviewed articles published in the period 2012-2022 in the Google Scholar, ScienceDirect, Emerald, and Springer Link databases. The review aims to provide a synthesis of research studies, methodologies, and best practices employed to minimize defects and enhance overall product quality. This review identifies key themes, challenges, and future directions in defect reduction by analyzing the existing literature, offering valuable insights for researchers and practitioners.

DOI: https://doi.org/10.24002/ijieem.v5i2.7495

Keywords: Defect reduction, manufacturing industry, systematic literature review, quality improvement

Research Type: Review Paper

Article History: Received Juni 20, 2023; Revised December 17, 2023; Accepted December 21, 2023

How to cite: Sadikin, M.A. (2023). Defect reduction in the manufacturing industry: Systematic literature review. *International Journal of Industrial Engineering and Engineering Management, 5*(2), 73-83.

1. INTRODUCTION

Quality improvement is essential to meet customer needs, increase customer satisfaction, and achieve business success. Defect reduction is an important aspect of quality improvement because it directly affects product and service quality, costs, and customer satisfaction. Product defects in manufacturing are a serious problem faced by every manufacturer. Even afterwards proper care in design, material selection, and product manufacturing, there are broken parts (Sreedharan et al., 2018).

Several quality improvement methods have been developed to reduce defects, such as Six Sigma, Lean Six Sigma, Total Quality Management (TQM), and the PDCA cycle. This method aims to identify the causes of defects, reduce variability, and improve process performance.

This systematic literature review (SLR) aims to provide a synthesis of research studies, methodologies, and best practices employed to minimize defects and enhance overall product quality. By analyzing the existing literature, this review identifies key themes, challenges, and future directions in defect reduction, offering valuable insights for researchers and practitioners in the field. The SLR also aims to provide insights for practitioners and researchers to increase the effectiveness of defect reduction methods.

The initial approach to this research was to answer the following questions:

RQ1. What are the key methodologies and techniques utilized in defect reduction studies within the manufacturing industry?

RQ2. What are the best practices and lessons learned from successful defect reduction case studies in the manufacturing industry?

RQ3. How does defect reduction impact product quality, customer satisfaction, and overall business performance in the manufacturing industry?

RQ4. What are the current research gaps and areas for future exploration in defect reduction within the manufacturing industry?

RQ5. What are the emerging trends?
The purpose of these questions was to guide the search even if it was expected that existing literature might not be sufficiently developed to translate each question directly into a finding.

Defect reduction refers to the process of identifying, analyzing, and minimizing or eliminating defects in a product, process, or system. Defects are typically defined as deviations or flaws that cause the product or system to perform below its intended or expected level of quality. These defects can arise due to various factors such as design flaws, manufacturing errors, software bugs, or inadequate processes.

Defect reduction involves implementing systematic approaches to identify and address defects throughout the lifecycle of a product or system. This includes activities such as defect detection, root cause analysis, corrective and preventive actions, and continuous improvement efforts. The primary objective of defect reduction is to enhance the overall quality and reliability of the product or system, leading to increased customer satisfaction, reduced costs, and improved efficiency.

Organizations often employ various methodologies and tools to achieve defect reduction, such as statistical process control, Six Sigma, lean manufacturing, failure mode and effects analysis (FMEA), and quality management systems. By focusing on defect reduction, organizations can strive for continuous improvement and minimize the occurrence of defects, thereby improving their competitiveness in the market.

Defect reduction is an important aspect of quality improvement that helps organizations minimize errors, waste, and rework, resulting in significant cost savings and increased customer satisfaction. Defect reduction can be achieved through a variety of techniques, including statistical process control, root cause analysis, and process improvement methodologies. This paper will explore various approaches used by previous researchers in reducing defects including various tools and techniques available to reduce defects in the manufacturing industry.

Rejected products have a significant impact on the manufacturing industry, both financially and operationally. Here are some of the main impacts that can occur:

Additional costs: Rejecting products results in additional costs for the manufacturing industry. Defects and quality problems can cause significant costs for manufacturers and increase external failure costs (Faciane, 2018). These costs include wasted raw materials, time and labor used to manufacture substandard products, and costs to repair or replace rejected products. The higher the reject rate, the greater the costs incurred.

Decreased productivity: Reject products disrupt production flow and reduce efficiency and productivity. When products have to be rejected and reprocessed, production times become longer, causing a reduction in overall productivity. In addition, reject-related issues can cause production disruptions that affect delivery schedules and product availability.

Decreased reputation and customer trust: Rejected products can damage a company's reputation and reduce customer trust. Products that do not meet quality standards can result in customer disappointment and can affect the company's brand image. Conversely, a reputation for producing high-quality components can increase brand value, attract new customers, and foster long-term business relationships (Juran, 1993). Customers may lose faith in the company and tend to look for alternatives to competitors that offer better quality.

Market loss and business opportunities: Rejected products can cause market losses for the company. If products do not meet customer expectations or do not meet market requirements, the company can lose market share or potential business opportunities. Dissatisfied or disappointed customers may switch to competitors offering better products.

Low quality and reclamation: Repeated rejects can indicate an underlying problem, such as a production process failure, poor raw material quality, or problems in the quality control system. This can lead to a company's reputation as a low-quality producer and hinder long-term growth.

Therefore, the manufacturing industry must proactively reduce the rate of rejected products through the implementation of good quality management practices, strict production controls, employee training, and root cause analysis to improve production processes. By reducing rejected products, the manufacturing industry can increase operational efficiency, improve reputation, and increase customer satisfaction, which in turn will provide long-term benefits for the company.

Defect reduction is a critical aspect of the Body of Knowledge (BOK) in the field of Industrial and Systems Engineering (IISE). There are fourteen (14) knowledge areas in the Industrial and Systems Engineering Body of Knowledge (IISEBoK) (Institute of Industrial and System Engineers, 2021). The IISE BoK is a comprehensive repository of knowledge and best practices in IISE, and it is used by practitioners and educators around the world. The IISE BoK includes a knowledge area on Quality and Reliability Engineering, which covers the principles and techniques for improving the quality and reliability of products and services. Defect reduction is a key focus of this knowledge area. Some of the specific topics covered in the IISE BoK related to defect reduction include Statistical process control (SPC), Design for manufacturability (DFM), Six Sigma, Failure mode and effects analysis (FMEA), and Root cause analysis (RCA).

2. REVIEW METHODOLOGY

The systematic literature review methodology follows the guidelines proposed by (Kitchenham and Charters, 2007) and the Preferred Reporting Item Guidelines for Systematic Reviews and Meta-Analysis (PRISMA) (Moher et al., 2009). The systematic literature review process is carried out in three main stages: review planning, review implementation, and review reporting (Kitchenham and Charters, 2007; Brereton et al., 2007).

Planning:

1) Formulate research problems and research objectives.
2) Develop research protocols: research protocols include research scope, strategy, criteria, quality assessment, and data extraction.

3) Set relevance criteria: the research criteria help ensure that we only include papers that are most relevant to the research question and exclude papers that are not related.

Implementation:

1) Literature Search: Online literature search from leading academic journals.
2) Screening for inclusion.
3) Quality assessment of relevant studies: Each article must be assessed for quality, depending on the methodology used.
4) Data extraction: extract the relevant data from each study included in the review.
5) Analyzing and synthesizing data: using appropriate techniques, such as quantitative or qualitative analysis, or both to combine the facts gathered.

Reporting:

1) Reporting of findings: reporting a detailed systematic review of the literature as well as the results of the review.
2) Dissemination: publishing systematic reviews in academic journals to contribute knowledge in the field (Figure 1).

A search was conducted on the Google Scholar, ScienceDirect, Emerald, and Springer Link databases, using the keywords “Defect reduction”.

We use the keywords “defect reduction and minimize defect” to search for articles related to the reduction of defective products, using the keyword "defect reduction". Searchers use keyword defect reduction to get 217 potential studies.

2.1. Inclusion criteria (IC)

1) Research Objective: defect reduction techniques, totabols, strategies, or methodologies.
2) Publication Type: Peer-reviewed journal articles.
3) Time Period: 2012-2022.
4) language: Only in English.
5) Research Design: Only empirical studies (case studies).
6) Section reduction includes defect prevention, defect detection, defect prediction, and defect management.
7) Relevance to Domain: Manufacturing and Automotive industry.

2.2. Exclusion criteria (EC)

1) Studies that are not peer-reviewed.
2) studies that are not directly related to defect reduction.
3) articles that did not meet the inclusion criteria, duplicate articles, and articles that were not related to the research question.
4) We do not include articles related to the service industry, material science, Medicine and Dentistry, and Nursing and Health Profevaluate.
5) Experimental study material in material science.

Literature search and evaluation for inclusion according to the PRISMA method is presented in Figure 2. Clustering analysis will be performed using the VOS viewer software.

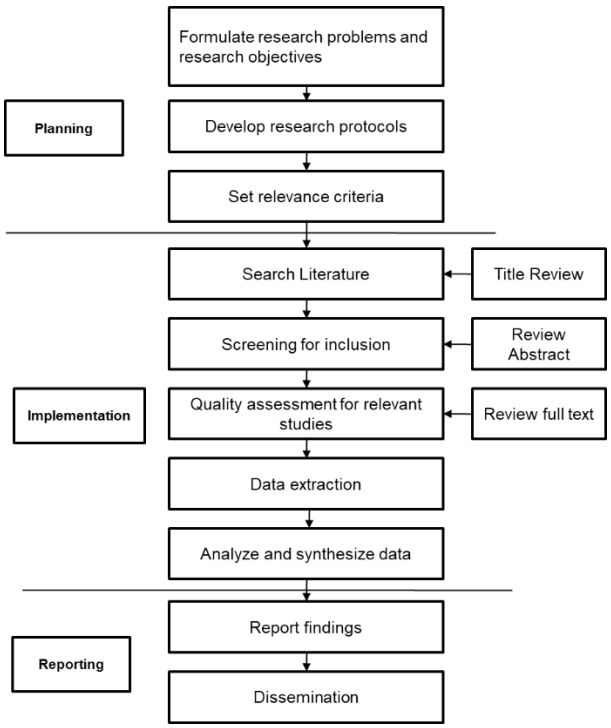

Figure 1. Flow chart

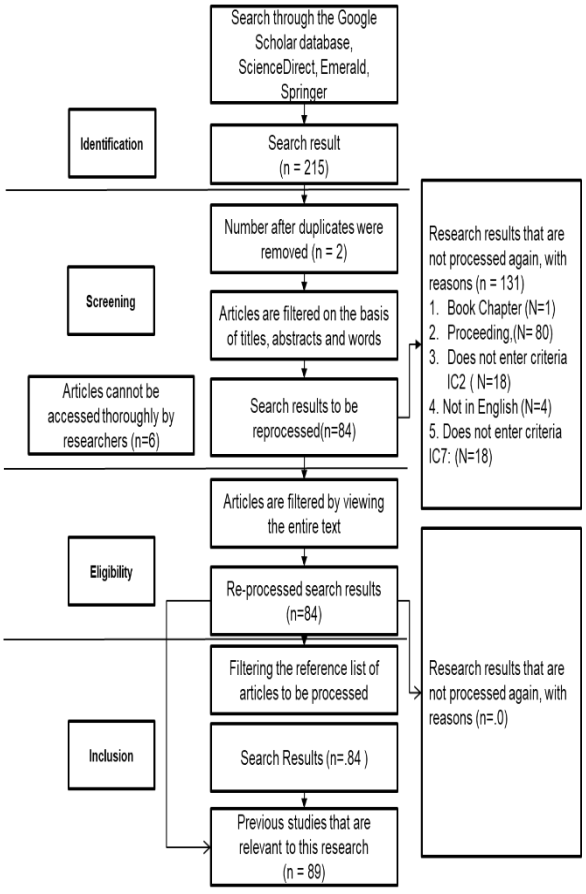

Figure 2. Literature search and evaluation for inclusion

Table 1. Existing literature review of defect reduction in the manufacturing and automotive industry

No.	Authors	Methodology	Country	Industry
1.	Singhtaun & Prasartthong (2012)	Design of Experiment	Thailand	Electrodeposition painting manufacturing industry
2.	Suman et al. (2012)	TQM	India	Fastener manufacturing
3.	Pongtrairat & Senjuntichai (2013)	DMAIC	Thailand	Hardisk drive Manufacturing
4.	Sawatsuphaphon & Chutima (2020)	DMAIC	Thailand	Integrated circuits
5.	Gosavi & Inamdar (2014)	Root Cause Analysis	India	Fabrication
6.	Jirasukprasert et al. (2014)	Six Sigma & DMAIC	UK	Rubber gloves manufacturing
7.	Joshi (2014)	Pareto Analysis and Cause and Effect Diagram	India	Metal casting industry
8.	Chen & Brahma (2014)	Six Sigma & DMAIC	USA	Metal casting industry
9.	Sanny & Amalia (2015)	QC 7 Tools	Indonesia	Food industry
10.	Giannetti et al. (2015)	Six Sigma, TQM, 7 Epsilon	UK	Foundries industry
11.	Kannan et al. (2015)	Design of Experiment	India	Ring blank casting industry
12.	Coupek et al. (2017)	Cloud-based architecture of control systems	German	Electric motor in the automotive industry
13.	Abebe et al. (2017)	Reliability-based robust optimization	South Korea	Metal forming industry
14.	Senjuntichai et al. (2018)	Six Sigma	Thailand	Ready rice product
15.	Sreedharan et al. (2018)	TQM and LSS	India	Electrical part industry
16.	Hasan et al. (2018)	TQM	India	Cracker manufacturing industry
17.	Memon et al. (2019)	QC 7 Tools	Pakistan	Automobile industry
18.	Chartmongkoljaroen et al. (2019)	DMAIC	Thailand	Jewelry industry
19.	Raman & Basavaraj (2019)	Six Sigma	India	Capacitor industry
20.	Supapan & Chutima (2019)	DMAIC, Six Sigma, FMEA, DOE	Thailand	Injection Molding industry
21.	Simegnaw & Mebrate (2020)	TQM	Ethiopia	Cotton spinning industry
22.	Vanany et al. (2021)	Six Sigma	Indonesia	Food industry
23.	Mancini et al. (2020)	Modeling Plastic Deformation	Italy	Manufacturing of ferritic stainless steels flat bars industry
24.	Sawatsuphaphon & Chutima (2020)	DMAIC	Thailand	Integrated circuit industry
25.	Sirimongkol et al. (2020)	Six Sigma	Thailand	Fired clay floor tiles industry
26.	Imaroh & Mustofa (2022)	SPC	Indonesia	Glass bottle packaging product industry

3. REVIEW RESULTS AND DISCUSSIONS

The 26 journals on defect reduction in the manufacturing and automotive industries were selected for review in Table 1. The selected journals or articles were analyzed from the aspect of the method used by researchers for defect reduction in the manufacturing industry, industry type, distribution of research based on the year of publication, and the country of the authors, then also analyzed by research object the result for following review of selected articles.

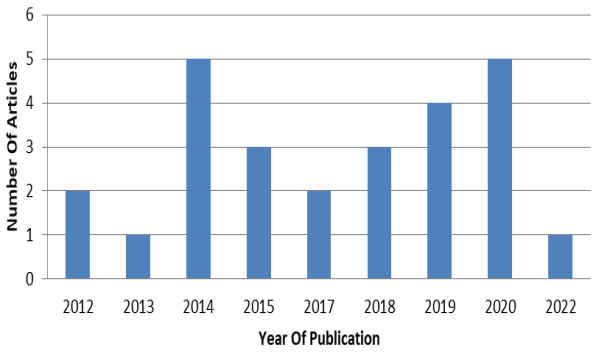

Figure 3. Years of publication

In the period from 2012 to 2014, the research trend for reducing defective products with the type of case study research in the manufacturing industry and the automotive industry increased. Then there was an increase in the trend again in the period 2017 to 2020, with case studies in the manufacturing industry being the highest in 2014 and year 2020.

The list of publishers and the number of publications is shown in Table 2. Trans Tech Publications Ltd. and Emerald Publishing Limited are the two publishers with the highest number of publications with topic defect reduction, namely five and three publications. A list of journals and the number of publications are shown in Table 3.

Table 2. List of publishers and their number of publications

Name of publisher	Number of articles
Trans Tech Publications Ltd.	5
Emerald Publishing Limited	3
Citeseer	1
Growing Science	1
Hindawi Limited	1
IEEE	1
IGI Global	1
IJENS Publishers	1
Kuwait University	1
Maxwell Scientific Publications	1
MDPI	1
Medwell Publishing	1
Praise Worthy Prize	1
Scientific Publishing House DARWIN	1
Research India Publications	1
Springer	1
Taylor & Francis	1
Transstellar Journal Publications and Research Consultancy Private Limited (TJPRC)	1
Wiley-Blackwell	1
World Scientific Publishing Co. Pte Ltd	1
Grand Total	26

Table 3. Journal and number of publications

Name of publisher	Number of articles
Applied Mechanics and Materials	2
Solid State Phenomena	2
Engineering, Technology & Applied Science Research	1
IEEE Transactions on Industry Applications	1
International Business Management	1
International Journal of Engineering Research	1
International Journal of Innovation, Management and Technology	1
International Journal of Knowledge and Systems Science (IJKSS)	1
International Journal of Lean Six Sigma	1
International Journal of Mechanical and Mechatronics Engineering	1
International journal of mechanical and production engineering, ISSN	1
International Review of Mechanical Engineering (IREME)	1
International journal of mechanical engineering and robotic research	1
Journal of Engineering	1
Journal of Enterprise Transformation	1
Journal of Islamic Marketing	1
Journal of Social Science	1
Journal of Supply Chain Management: Research and Practice	1
Management Science Letters	1
Materials Science Forum	1
Metals	1
The International Journal of Advanced Manufacturing Technology	1
TQM Journal	1
World Scientific News	1
Grand Total	26

3.1. Distribution of publication

It analyzes the distribution of publications on Defect Reduction in the manufacturing industry identified in Figure 4. India has registered the most significant number of publications with seven papers. This is followed by Thailand with five papers, Indonesia with three papers, China with four papers, and Indonesia with three papers.

Publications based on the type of manufacturing industry are shown in Figure 5.

Based on the provided data on the industries examined in a case study of reducing defects in the manufacturing industry, here is an analysis:

The food industry is represented by the highest number of case studies. This indicates the significance of defect reduction in food production processes.

The metal casting and metal forming industry also has a significant number of case studies. This suggests that defect reduction is a critical concern in these manufacturing processes.

The integrated circuits industry, which involves the production of electronic components, has been examined in two case studies. This indicates the importance of defect reduction in ensuring the quality and reliability of electronic devices.

The Automobile Industry and the other 15 types of industries, each, have one case study about defect reduction, these industries include the Capacitor Manufacturing Industry, the Cotton Spinning Industry, the Electric motor in the automotive industry, the Electrical Part Industry, the Fabrication Industry, the Fastener Manufacturing Industry, and the Fired Clay Floor Tiles Industry.

This indicates the importance of defect reduction in the production of each industry.

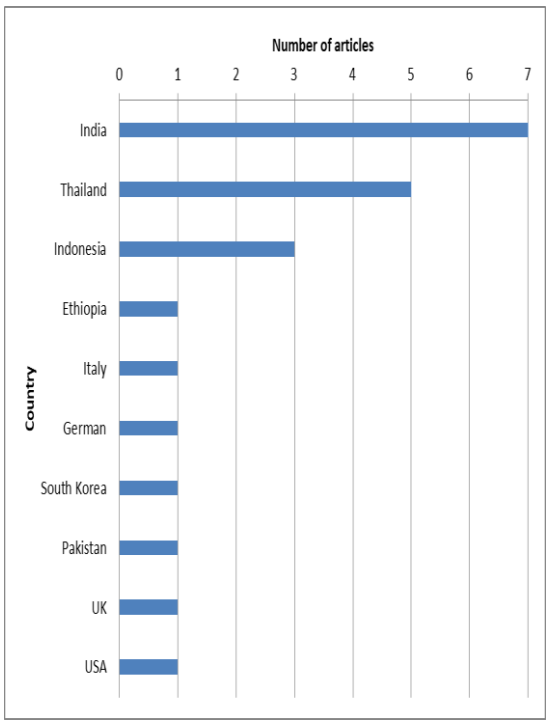

Figure 4. Number of publications by country

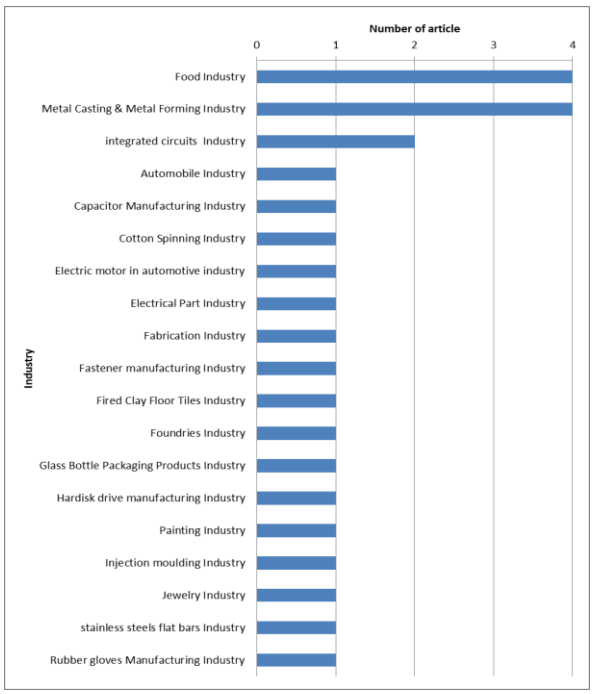

Figure 5. Publications based on the type of manufacturing industry

3.2. Methods used by researchers for defect reduction in the manufacturing industry

Based on the provided data on the methods used by researchers in Figure 6 to reduce defective products in percentage, here is an analysis:

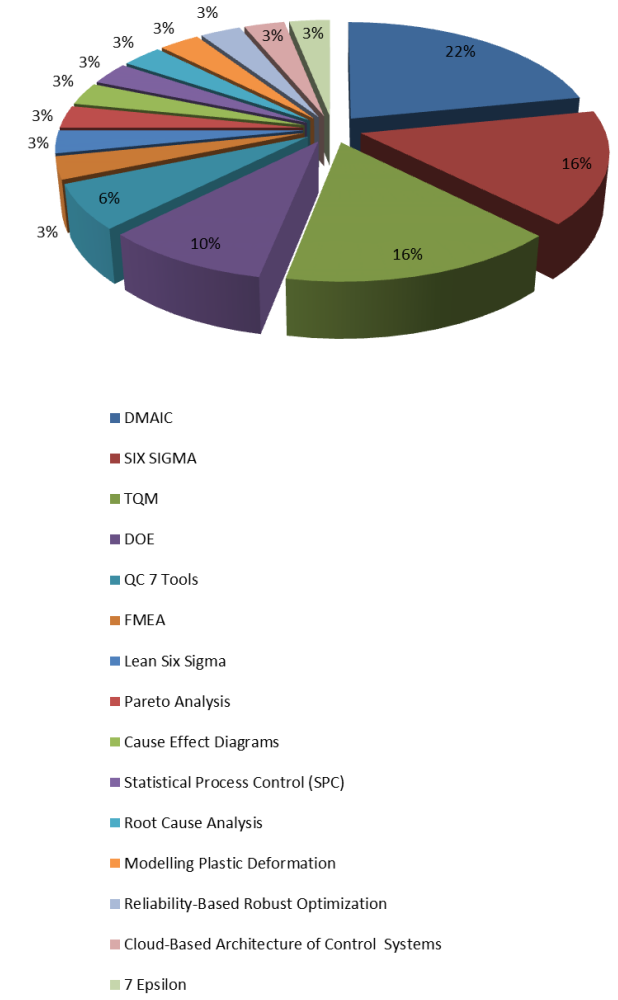

Figure 6. Method used in the study of the reduction of defective products in the manufacturing industry

1) DMAIC: 23%

DMAIC (Define, Measure, Analyze, Improve, Control) is a problem-solving methodology commonly associated with Six Sigma. With the highest percentage, it indicates that DMAIC is widely utilized as an effective method for defect reduction in the manufacturing industry.

Chartmongkoljaroen et al. (2019) conducted a study on the Jewelry Industry in Thailand. The results clearly indicate that the defect rate of resins decreased significantly.

Sawatsuphaphon & Chutima (2020) conducted a study on the Integrated circuits Industry in Thailand. After the improvement, the product (lots) on hold criteria V_limiter (REQA) was reduced from 9.5% to 5.82%. Pongtrairat & Senjuntichai (2013) conducted a study on the hardisk drive manufacturing industry in Thailand. The result after the improvement is the defective rate of the spiral scratch decreased by 48.8% from 6.03% to 3.09%.

2) Six Sigma: 17%

Six Sigma is a data-driven approach aimed at reducing process variation and defects. A significant percentage suggests that Six Sigma is a well-

recognized and commonly employed method for defect reduction.

Senjuntichai et al. (2018) conducted a study on the Ready Rice product (food industry) in Thailand. the result after improvement is the total defective percentage reduced by 56.42% from 5.14% to 2.24%. Sirimongkol et al. (2020) conducted a study on the Fired Clay Floor Tiles Industry in Thailand. The result found that the defect was reduced to 49,151.14 DPPM, which is 67.85% of the defect before the improvement.

3) TQM (Total Quality Management): 17%

TQM is a management philosophy that emphasizes continuous improvement, customer satisfaction, and defect prevention. The equal percentage with Six Sigma indicates that TQM is also widely adopted for defect reduction.

Hasan et al. (2018) conducted a study on the Cracker Manufacturing Industry (Food Industry). The result of the study total defects were reduced average of 23%.

4) DOE (Design of Experiments): 10%

DOE involves systematically planning, executing, and analyzing experiments to optimize process variables and identify significant factors affecting product quality. The moderate percentage suggests that DOE is utilized but to a lesser extent compared to DMAIC, Six Sigma, and TQM.

Kannan et al. (2015) conducted a study on the Ring Blank Casting Industry in India. The results were able to reduce the CM defect from 55000 ppm to 18791 ppm.

Singhtaun and Prasartthong (2012) conducted a study on the Electrodeposition painting manufacturing industry in Thailand. The experimental verification results showed that the number of incomplete coating defects decreased from 4% to 1.02% and operation costs decreased by 10.5%.

5) QC 7 Tools: 7%

QC 7 Tools, also known as the Seven Basic Tools of Quality, are a set of problem-solving techniques. The percentage suggests that these tools, including check sheets, histograms, Pareto charts, and control charts, are utilized to a notable extent for defect reduction.

Memon et al. (2019) conducted a study on the Automobile Industry in Pakistan. It was found from the results that after the successful implementation of the QC tools, the defect level was reduced by 90% (from 132 to 13 defects) at the chassis line. Similarly, the defect level was reduced by 80% (from 157 to 28 defects) at the trim line.

6) FMEA (Failure Mode and Effects Analysis): 3%

FMEA is a proactive risk assessment tool that identifies and prioritizes potential failures and their impact on product quality. The lower percentage indicates that FMEA is employed but not as extensively as DMAIC, Six Sigma, TQM, and DOE.

Supapan and Chutima (2019) conducted a study on the injection molding Industry in Thailand. They combined FMEA, DMAIC, and DOE in their study. The result shows that the defect rate of the in-mold decoration process decreased from 22.3% to 0.7% in July 2018 after improvement.

7) Lean Six Sigma: 3%

Lean Six Sigma combines the principles of Lean manufacturing (waste reduction) and Six Sigma (defect reduction). The percentage suggests that Lean Six Sigma is utilized to a lesser extent compared to DMAIC, Six Sigma, and TQM.

Sreedharan et al. (2018) conducted a study on the Electrical part Industry in India. They combined LSS and TQM in their study. Introducing TQM and LSS to manufacturing can reduce the customer return rate to 1,300 parts per million (PPM) and even to 1,000 PPM in the future.

8) Pareto Analysis: 3%

Pareto Analysis is a technique that prioritizes problems or causes based on their frequency or impact. The percentage suggests that Pareto Analysis is utilized but to a limited extent.

Joshi (2014) conducted a study on the Metal casting Industry in India. They used Pareto Analysis and a Cause-and-effect Diagram in their study. The result suggested some other remedial issues and implemented possible of them reduced total rejection by more than 30%. If the suggested remedy of automation is implemented, it reduces all defects by more than 70%.

9) Cause-Effect Diagrams: 3%

Cause-effect diagrams, also known as Fishbone or Ishikawa diagrams, visually represent the potential causes leading to a specific effect or problem. The percentage indicates that Cause-Effect Diagrams are employed but not as prominently as DMAIC, Six Sigma, TQM, and QC 7 Tools.

10) Statistical Process Control (SPC): 3%

SPC involves monitoring and controlling process variations using statistical techniques, such as control charts. The percentage suggests that SPC is utilized, but its adoption may not be as widespread as DMAIC, Six Sigma, TQM, and QC 7 Tools.

Imaroh and Mustofa (2022) conducted a study on the Glass Bottle Packaging Products Industry in Indonesia. This study shows a fairly good decrease in production based on improvements from the calculation results, namely before repairs from January to March 2021. The total defects were 550,962 pc and, after repairs in January to March 2022, the total defects are 496,260 pieces so a decrease of 10% with a cost of Rp. 711,816,014/year.

11) Root Cause Analysis: 3%

Root Cause Analysis is a systematic approach to identifying the underlying causes of problems or defects. The percentage suggests that Root Cause Analysis is applied but to a limited extent.

Gosavi and Inamdar (2014) conducted a study on the Fabrication industry in India. The results of various aspects of the complaints on grease leaks and opinion tooth failure have been reviewed. Possible causes are analyzed, and potential causes are identified. Corrective and preventive action

plans are suggested.

12) Modeling Plastic Deformation: 3%

Modeling Plastic Deformation involves mathematical and computational modeling techniques to understand and predict material behavior during plastic deformation processes. The percentage indicates that this method is mentioned, but its usage may be relatively less common.

Mancini et al. (2020) conducted a study on the stainless-steel flat bars Industry in Italy. Results have shown that the defect is caused by processing conditions that trigger anomalous heating which, in turn, induces uncontrolled grain growth on the edges. The work-hardened and elongated grains do not recrystallize during hot deformation. Consequently, they tend to squeeze out the surrounding softer and recrystallized matrix towards the edges of the bar where the fractures that characterize the surface defect occur.

13) Reliability-Based Robust Optimization: 3%

Reliability-Based Robust Optimization is an approach that aims to optimize designs by considering both performance and reliability criteria. The percentage suggests that this method is employed but may not be as prevalent as others.

Abebe et al. (2017) conducted a study on the Metal-forming industry in South Korea. This study has established the possibility of a reduction in product defects using RRO for an MDF process. The simulation results show that the shape error of the final product is improved by changing the control process parameter settings. The RRO numerical results show that both the magnitude and sensitivity of the final product defects are reduced with respect to the scatter in the noise parameters.

14) Cloud-Based Architecture of Control Systems: 3%

Cloud-Based Architecture of Control Systems refers to the utilization of cloud computing technology in the design and implementation of control systems. It involves leveraging the capabilities and resources provided by cloud service providers to enhance the functionality, scalability, and accessibility of control systems in various industries.

Coupek et al. (2017) conducted a study on Electric motors in the automotive industry in Germany. The results show how such a cloud-based architecture can increase product quality while decreasing the number of scrap parts in a real industrial scenario, consequently saving valuable resources such as energy and raw materials. Reduction of deviations is crucial for this emerging industrial sector as electric motor production for vehicles is moving towards mass production in the future.

3.2. Cluster analysis using VOS viewer software

The results of cluster analysis using VOS Viewer software. There are 59 items of keywords used by researchers that can be divided into 10 clusters, as shown in Figure 7.

Network visualization is presented in Figure 8. The results of network visualization show that research on defect reduction is most related to Six Sigma, TQM, DMAIC, cause-effect diagram, DMAIC, Pareto chart, and process improvement.

The overlay visualization in Figure 9 results show that defect reduction research related to topics related to defects and costs, the chicken meat industry, plastic deformation, and contactless chip modules, are the most current research topics.

The results of the density visualization of the research in Figure 10 on the decrease in defects are most related to Six Sigma.

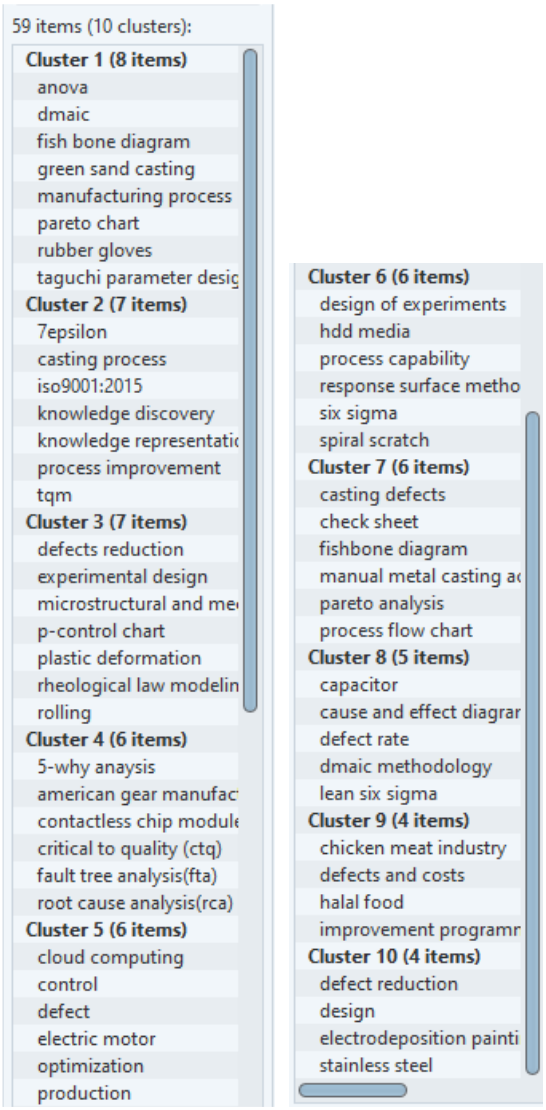

Figure 7. Cluster Analysis

4. CONCLUSION

The systematic literature review on defect reduction in the manufacturing industry provides a comprehensive analysis of existing research and practices in this field. The review highlights various defect reduction techniques, methodologies, and strategies employed by researchers and practitioners to improve product quality and operational efficiency. It presents a synthesis of the current state of knowledge regarding defect reduction in

manufacturing, including the effectiveness of different approaches and their impact on overall performance.

The case study on defect reduction in the manufacturing industry provides valuable insights into the practical implementation of strategies and methods to minimize defects and improve product quality. Through a detailed analysis of a specific manufacturing scenario, the case study highlights the effectiveness of various defect reduction methods and techniques, such as DMAIC, Six Sigma, TQM, Design of experiment, statistical process

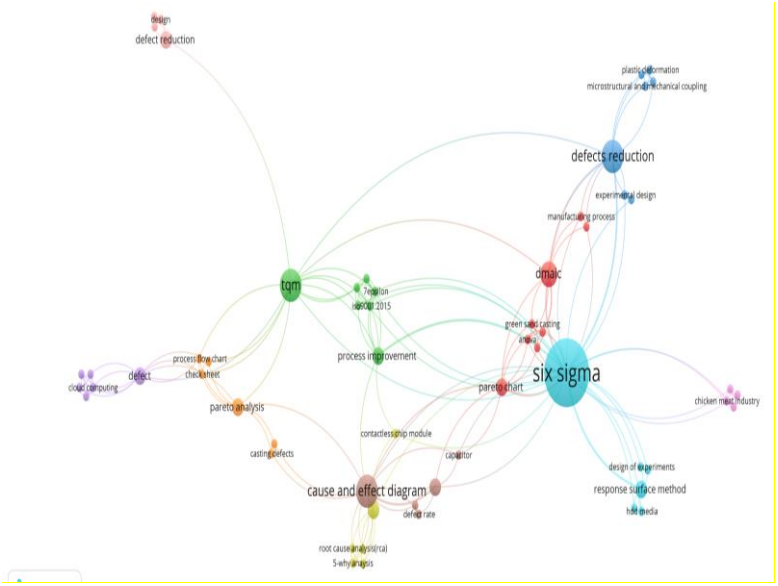

Figure 8. Network visualization

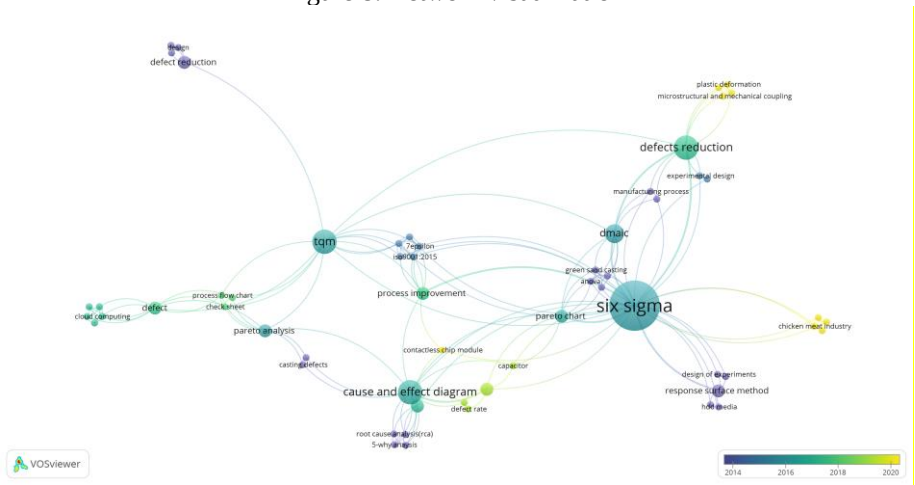

Figure 9. Overlay visualization

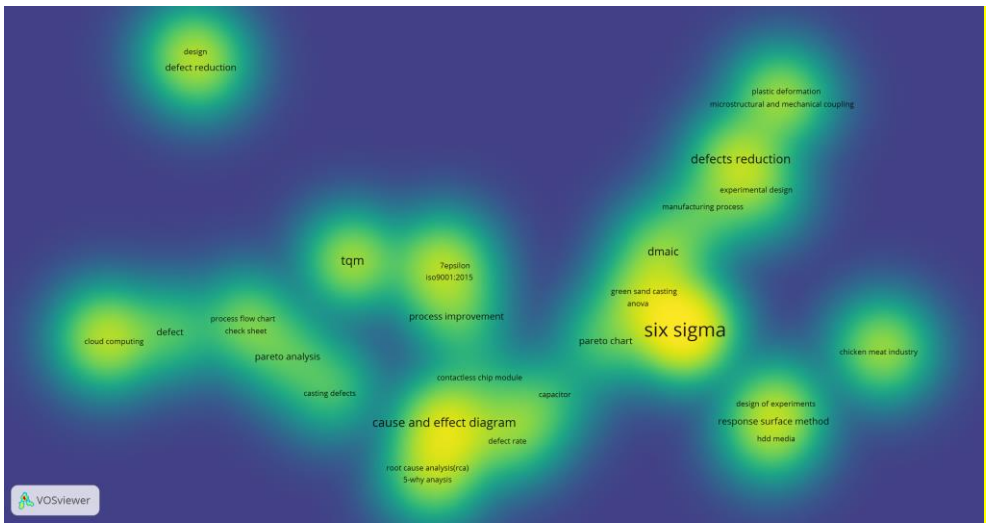

Figure 10. Density visualization

control (SPC), Root Cause Analysis (RCA), FMEA, QC 7 Tools, Lean Six Sigma, and Pareto Analysis.

The findings of the case study demonstrate the importance of adopting a systematic and proactive approach to defect reduction in manufacturing. Implementing appropriate strategies and methodologies can significantly reduce defects, enhance customer satisfaction, and improve overall operational efficiency. The case study showcases the positive impact of defect reduction efforts on product quality, production cycle time, and cost savings.

This paper presents a systematic literature review on defect reduction in the manufacturing industry. The study systematically reviewed articles published in the period 2012-2022 in the Google Scholar, ScienceDirect, Emerald, and Springer Link databases. The review aims to provide a synthesis of research studies, methodologies, and best practices employed to minimize defects and enhance overall product quality. This review identifies key themes, challenges, and future directions in defect reduction by analyzing the existing literature, offering valuable insights for researchers and practitioners.

This paper is novel in that it provides a comprehensive and up-to-date overview of the defect reduction landscape in the manufacturing industry. The review identifies a number of key themes and trends, including:

1) The increasing adoption of data-driven and analytical approaches to defect reduction.
2) The growing focus on defect prevention and root cause analysis.
3) The importance of employee engagement and empowerment in defect reduction initiatives.

The review also identifies a number of challenges that need to be addressed in order to further improve defect reduction performance in the manufacturing industry, including:

1) The need for more robust and integrated defect reduction frameworks.
2) The lack of standardization in defect reduction methodologies and tools.
3) The need for better training and awareness of defect reduction practices.

Overall, this paper provides a valuable resource for researchers and practitioners who are interested in defect reduction in the manufacturing industry. The review offers a comprehensive overview of the current state of the art, identifies key themes and trends, and highlights areas for future research and development.

Additional novelty:

The paper could also include a section on emerging trends in defect reduction, such as the use of artificial intelligence and machine learning.

The paper could also include a case study of a successful defect reduction initiative in the manufacturing industry. This would provide readers with a concrete example of how defect reduction can be implemented in practice.

While the case study offers valuable insights, there are research gaps that future studies can address to further advance the field of defect reduction in the manufacturing industry:

1) Generalizability: The case study examines a specific manufacturing scenario, which may limit its generalizability to other manufacturing contexts or industries. Future research can conduct case studies in diverse manufacturing sectors to validate the effectiveness of defect reduction strategies across different settings.
2) Long-term Impact: The case study focuses primarily on short-term outcomes, such as defect reduction rates and immediate improvements. There is a need for longitudinal case studies that assess the sustained impact of defect reduction initiatives over an extended period, including the long-term effects on product quality, customer satisfaction, and financial performance.
3) Organizational Factors: The case study does not extensively delve into the organizational factors that influence the success of defect reduction efforts, such as organizational culture, leadership support, employee engagement, and change management. Future case studies can explore these organizational aspects, critical and failure factors to gain a deeper understanding of their influence on the implementation and sustainability of defect reduction initiatives.

By addressing these research gaps, future case studies can contribute to a more comprehensive understanding of defect reduction in the manufacturing industry and provide practical guidance for organizations aiming to enhance product quality and operational excellence through effective defect reduction strategies.

REFERENCES

Abebe, M., Park, J. W., & Kang, B. S. (2017). Reliability-based robust process optimization of multi-point dieless forming for product defect reduction. *International Journal of Advanced Manufacturing Technology*, *89*(1–4), 1223–1234.

Brereton, P., Kitchenham, B.A., Budgen, D., Turner, M., & Khalil, M. (2007). Lessons from applying the systematic literature review process within the software engineering domain. *Journal Systems and Software*, *80*(4), 571-583.

Chen, J. C., & Brahma, A. R. B. (2014). Taguchi-based Six Sigma defect reduction of green sand casting process: An industrial case study. *Journal of Enterprise Transformation*, *4*(2), 172–188.

Chartmongkoljaroen, L., Sirianukul, R., Puttibarncharoensri, P., & Marksin, W. (2019). Defect reduction by DMAIC method: A case study of a jewelry manufacturer. *Journal of Supply Chain Management: Research & Practice*, *13*(No. 2), 67–84.

Coupek, D., Lechler, A., & Verl, A. (2017). Cloud-based control strategy: Downstream defect reduction in the production of Electric Motors. *IEEE Transactions on Industry Applications*, *53*(6), 5348–5353.

Faciane, M. (2018). *Reducing the costs of poor quality: A manufacturing case study*. In Walden Dissertations and Doctoral Studies. 5329.

Giannetti, C., Ransing, M. R., Ransing, R. S., Bould, D. C., Gethin, D. T., & Sienz, J. (2015). Organisational

knowledge management for defect reduction and sustainable development in Foundries. *International Journal of Knowledge and Systems Science*, *6*(3), 18–37.

Gosavi, V. V., & Inamdar, K. H. (2014). Defect reduction in fabricated components using root-cause analysis. *International Journal of Engineering Research & Technology (IJERT)*, *3*(3), 2026–2032.

Hasan, Md. Z., Rezwan, A., Islam, Md. R., & Dutta, A. (2018). Defect reduction by total quality management in a crackers manufacturing system. *World Scientific News*, *98*. 150-171.

Imaroh, T. S., & Mustofa, A. (2022). Defect reduction analysis to improve glass bottle packaging products quality using statistical process control (SPC) at PT. Muliaglass Container (MGC). *Journal of Social Science*, *3*(5), 1003–1018.

Institute of Industrial and System Engineers. (2021). *Industrial and systems engineering BoK*. 1. https://www.iise.org/details.aspx?id=43631

Jirasukprasert, P., Arturo Garza-Reyes, J., Kumar, V., & K. Lim, M. (2014). A six sigma and DMAIC application for the reduction of defects in a rubber gloves manufacturing process. *International Journal of Lean Six Sigma*, *5*(1), 2–21.

Joshi, A. (2014). Investigation and analysis of metal casting defects and defect reduction by using quality control tools. *International Journal of Mechanical And Production Engineering*, *2*(2014), 87–92.

Juran, J. M. (1993). Juran's quality handbook. In *Training for Quality* (Fifth Edit, Vol. 1, Issue 2). McGraw-Hill Companies.

Kannan, P., Balasubramanian, K., & Vinayagamoorthy, R. (2015). Defect reduction in ring blank casting through design of experiments. *International Review of Mechanical Engineering*, *9*(6), 536–541.

Kitchenham, B., & Charters, S.M. (2007). Guidelines for performing systematic literature review in software engineering. UK: University of Durham.

Mancini, S., Langellotto, L., Di Nunzio, P. E., Zitelli, C., & Di Schino, A. (2020). Defect reduction and quality optimization by modeling plastic deformation and metallurgical evolution in ferritic stainless steels. *Metals*, *10*(2), 1–18.

Memon, I. A., Jamali, Q. B., Jamali, A. S., Abbasi, M. K., Jamali, N. A., & Jamali, Z. H. (2019). Defect reduction with the use of seven quality control tools for productivity improvement at an Automobile Company. *Engineering, Technology & Applied Science Research*, *9*(2), 4044-4047.

Moher, D., Liberati, A., Tetzlaff, J., & Altman, D.G. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA Statement. *PLoS Medicine*, *6*(7), Article e1000097.

Pongtrairat, A., & Senjuntichai, A. (2013). Spiral defect reduction of hard disk drive media. *Applied Mechanics and Materials*, *421*, 93–98.

Raman, R. S., & Basavaraj, Y. (2019). Defect reduction in a capacitor manufacturing process through six sigma concept: A case study. *Management Science Letters*, *9*(2), 253–260.

Sawatsuphaphon, T., & Chutima, P. (2020). Contactless chip module defect reduction. *Solid State Phenomena*, *305*, 59–64.

Senjuntichai, A., Wonganawat, N., & Thampitakkul, B. (2018). Defect reduction in ready rice packaging by applying six sigma. *International Journal of Innovation, Management, and Technology*, *9* (4), 178-183.

Simegnaw, A., & Mebrate, M.A. (2020). In-depth analysis and defect reduction for Ethiopian cotton spinning industry based on TQM approach. *Journal of Engineering*, *34*, 1-8.

Singhtaun, C., & Prasartthong, N. (2012). The application of an experimental design for the defect reduction of electrodeposition painting on stainless steel washers. *World Academy of Science, Engineering, and Technology*, *6*(10), 349–353.

Sirimongkol, W., Chutima, P., & Nilpairach, S. (2020). Defect reduction in forming process of fired clay floor tiles by six sigma approach. *Solid State Phenomena*, *305*, 147–153.

Sreedharan, V. R., Rajasekar, S., Kannan Santhosh, S., Arunprasad, P., & Trehan, R. (2018). Defect reduction in an electrical parts manufacturer: A case study. *TQM Journal*, *30*(6), 650–678.

Suman, R., Duhan, R.K., & Deshwal, S. (2012). Study of implementation of quality techniques for defect reduction in manufacturing industry. *International Journal of Mechanical Engineering and Robotic Research*, *1*(3), 284-289.

Supapan, J., & Chutima, P. (2019). Defect reduction in the manufacturing process of in-mold decoration of injection molded components. *Materials Science Forum*, *962*, 181–188.

Vanany, I., Hua Tan, K., Siswanto, N., Arvitrida, N. I., & Pahlawan, F. M. (2021). Halal six sigma framework for defects reduction. *Journal of Islamic Marketing*, *12*(4), 776–793.

This page is intentionally left blank