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A Review on Tools and Methods for Analyzing Production Quality Control in the Food and Textile Industries

Ibnu Idqan[1], Firmansyah[2], Eva Imelda[3], Fiky Nugraha[4], Hernadewita[5]

[1,2,3,4,5]Master of Industrial Engineering, Faculty of Engineering, Mercu Buana University

ABSTACT: The methods reviewed in this study include DMAIC (Define–Measure–Analyze–Improve–Control), FMEA (Failure Mode and Effect Analysis), Kaizen, Seven Tools of Quality, SPC (Statistical Process Control), and SQC (Statistical Quality Control). Each method offers different strengths and limitations in improving product quality and process performance. DMAIC and SPC provide a structured, data-driven approach to identifying root causes and implementing systematic remedies. FMEA supports proactive risk analysis by identifying potential failures before they occur. Kaizen emphasizes continuous improvement through employee engagement and incremental change, while Seven Tools of Quality facilitates visual identification of problems and basic quality analysis. Meanwhile, SQC ensures the monitoring and quantitative control of production performance. The study concludes that the food industry benefits the most from DMAIC–SPC–FMEA integration due to its strong emphasis on safety, risk prevention, and process consistency. In contrast, the textile industry achieves better results through the combination of Kaizen–DMAIC–Seven Tools, which focuses on optimizing sustainable processes, reducing waste, and minimizing variability in the production process.

KEYWORD: Quality Control, Food Industry, Textile Industry, DMAIC, FMEA, SPC, SQC, Kaizen, Seven Tools

1. INTRODUCTION

The food and textile industries are two important sectors that help economic growth and meet the needs of the community. The sector relies heavily on a good quality control system to maintain product quality, make processes more efficient, and build consumer trust. Various factors such as the complexity of the supply chain, the variety of raw materials, and the role of humans cause quality control to be the main thing in maintaining the consistency of production results and increasing competitiveness in the international market. If the quality control system does not work properly, there can be an increase in defective products, waste of resources, and large financial losses [54][59].

Figure 1. General Stages of the Quality Control Process

In the food industry, quality assurance is closely related to the aspects of consumer safety and compliance with applicable regulations. Problems such as bacterial contamination, harmful chemicals, or the presence of foreign objects can damage product quality and lead to mass product recalls (food recalls). Therefore, the food industry needs to implement a complete quality control system, from the selection of raw materials to the distribution process, in order to ensure safety and transparency in production [22]. In addition, the increasing public awareness of food safety also encourages companies to combine the principles of desire and social responsibility in their quality management [54].

Meanwhile, the textile industry faces a variety of challenges, where product quality is highly dependent on material properties, process stability, and machine conditions. Problems such as color variations, flaws in the weave, and texture mismatches often arise during the production process. To ensure the final result meets the aesthetic and functional standards desired by the global market, consistent quality control is indispensable [59]. With the increasing demand for environmentally friendly and sustainable products, the textile industry is also required to implement a quality control system that focuses not only on the final product, but also on efficient use of energy, waste management, and traceability of raw materials [39].

Although these two sectors have different characteristics, they both emphasize the importance of quality control systems that are adaptable, consistent, and incorporated with the latest technology. However, comparative studies on quality control in the food and textile sectors are still limited. Therefore, this research aims to deepen understanding of the importance of quality control in both industries, as well as to find the knowledge shortcomings that still exist in the application of mutually supportive and technology-based systems.

This paper aims to identify, review, and systematically analyze various tools and methods used in production quality control in the textile and food industry. Part 2 shows the literature review methodology, explaining how to select the literature. Part 3 analyzes the tools and methods (including strengths and disadvantageses) for identification. Part 4 will discuss proposed tools and methods for the identification and assessment of quality control in the textile and food industry, and will conclude this paper in Part 5.

2. LITERATURE REVIEW METHODOLOGY

This paper will follow the methodology of a Systematic Literature Review (SLR) – which is a standard method for researching a particular subject, consisting of four steps, as shown in Figure 2 below:

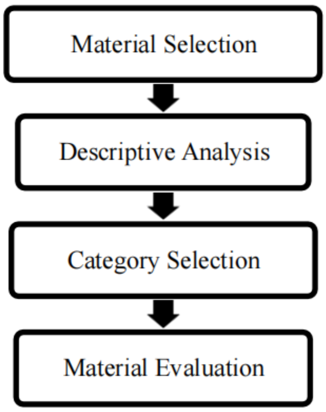

Figure 2. Four steps of Systematic Literature Review

Reference: H. Hernadewita, B. I. Saleh (2020)

Conducting a SLR such as describe here is a non-trivial exercise. It is not reasonable nor even advisable to expect that, whenever a scholarly paper is written, its "theoretical background" section would involve a SLR. While these guidelines can certainly help one to identify the literature, the effort involved to conduct a full SLR would be overkill for the purpose of supporting a scholarly paper with a primary contribution other than presenting the literature [37].

In the first stage of this research, papers were selected from peer-reviewed journals with reliable databases, such as Autex Research Journal, Jurnal Mitra Teknik Industri Info Sains, Factory Jurnal Industri, Manajemen Dan Rekayasa Sistem Industri, Jurnal Industrial Galuh, IJIEM (Indonesian Journal of Industrial Engineering & Management), Atlantis Press International BV, Periodicals of Engineering and Natural Sciences (PEN), Jurnal Inovasi Dan Kreativitas (JIKa), Publikasi Sub-Clumpun Ilmu Keteknik Industri, Jurnal Penelitian Ilmu Ekonomi, IOP Conference Series: Materials Science and Engineering, Jurnal Riset Manajemen Dan Akuntansi, Journal of Food Technology and Halal Science, Gazi Üniversitesi Fen Bilimleri Dergisi Part C: Tasarım ve Teknoloji. With years of publication range from 2013 – 2025.

3. CATEGORY FOR TOOLS AND METHOD SELECTION REVIEW

Journals are selected and categorized based on method, type of research, and industry. Based on the findings from the selected journal, it is a case study. The total number of journals used as a reference for review is thirty journals. Summarizes numbers of tools and methods being used and numbers of industries can be seen in Figure 3 dan 4.

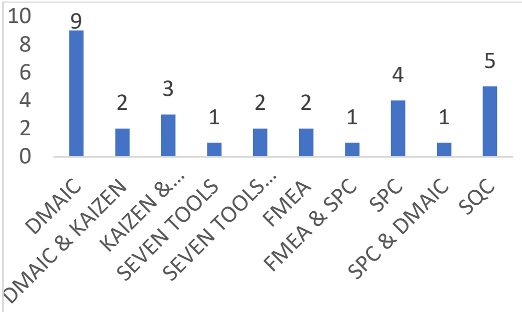

Figure 3. Tools and Methods with total published journal

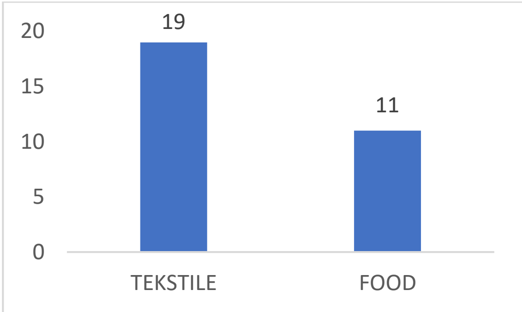

Figure 4. Industries researched with total published journal

Based on Figure 3, it is known that there are six tools and methods used in controlling production quality control, including: Define-Measure-Analyze-Improve-Control (DMAIC), Failure mode and effect analysis (FMEA), KAIZEN, SEVEN TOOLS, Statistical Process Control (SPC) and Statistical Quality Control (SQC). From several reviewed journals, there are journals that use two different tools and methods. Therefore, the review is conducted based on each tool and method used.

3.1. Review of DMAIC for Analyzing Production Quality Control

DMAIC stand for Define-Measure-Analyze-Improve-Control, this method usually adopted in a systematic approach of Six Sigma to reduce non-conforming products to the resting state so that the identified sources of a problem, process performance measures or implementing continual improvement [52][55]. Each step of the DMAIC process is so important; identify the problem & goal, Mearue the process performance, Analize the root cause of the raid defects, formulation of improvement action, maintain the results (DMAIC) [23][5].

Each stage in DMAIC has its own. The Define stage is used to define the main problem and set the goals to be achieved. The Measure stage is carried out to measure process performance and find out the real conditions in the field. Then, the Analysis stage focuses on finding the root cause of product defects. After that, the Improve stage is carried out by applying a design repair solution. Finally, the Control stage ensures that the repair results continue to run properly and do not return to problems [23][5]. The five phases of the DEMAIC methodology (Figure 5).

DMAIC has been widely used in the food industry, positively impacting the reduction of the number of defective products and facilitating the making of the production process more efficient. As a result, through the utilization of DMAIC and the integration of Kaizen, such products as instant noodles and kremes noodles are the leverage of important factors in quality Critical to Quality issues, the decrease in the value of Defect per Million Opportunities, and the regular control of the product quality with the help of control diagrams and standard operating procedures [52][23]. Meanwhile, in the textile and apparel industry, DMAIC is widely used to analyze processes such as dyeing, spinning, or sewing that often cause defects such as broken threads, non-uniform colors, or folded fabrics [46][43][27][51]. At the measurement and analysis stage, companies typically use tools such as Pareto charts and Ishikawa charts (fish bones) to find the root cause of problems. Then, at the repair and control stage, the focus is on operator training, engine standardization, and routine inspections so that repair results are maintained [16][44][2][51].

Figure 5. The five phases of the DMAIC methodology
Reference: https://blog.proactioninternational.com/en/dmaic-process-to-optimize-operations

Overall, DMAIC has many advantages because its approach is data-driven and easy to apply across a variety of industries. In addition, this method also encourages cooperation between departments so that quality improvement can be carried out more effectively [55][43]. However, the implementation of DMAIC still requires careful analysis, accurate data, and full support from management so that the results of the improvement can last a long time [10][2]. Even so, DMAIC remains one of the most reliable methods in quality control, as it is able to help companies improve while maintaining the stability of the production process in various industrial sectors [52][46][27][51].

3.2. Review of FMEA for Analyzing Production Quality Control

Failure mode and effect analysis (FMEA) is used to identify potential failures that can occur in the production process and assess their impact on product quality. The analysis was carried out by assessing the severity, probability of occurrence, and detection ability to determine the priority of improvement based on the combination of the three factors [35][14]. This approach allows companies to assess the process areas that are most vulnerable to defects, thus allowing for the determination of appropriate corrective actions to improve the efficiency and reliability of production systems [3]. By using FMEAs (Figure 6), companies can move from fault detection systems to more proactive and scalable risk prevention systems [21][35].

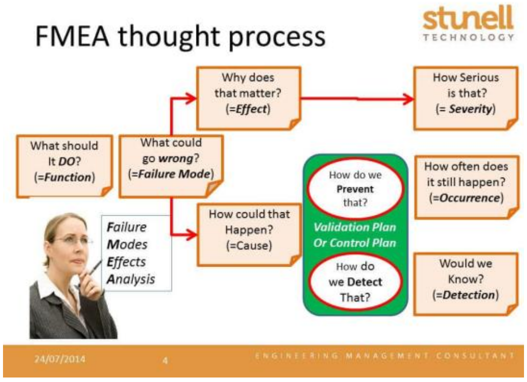

Figure 6. FMEA Process Flow Diagram
Reference: https://www.stunell.com/fmea-training/

$$Risk\ Priority\ Number\ (RPN) = Severity\ (S) \times Occuration\ (O) \times Detection\ (D) \tag{1}$$

In the textile and food industry, FMEA plays a key role in identifying the root cause of defects and prioritizing remedial measures. In the textile industry, this method is used to analyze defects such as fill scratches, warp scratches, and long threads, which are usually caused by operator errors, incorrect machine settings, and non-standard working methods [35][14][3]. The results of the analysis are used to strengthen the machine maintenance system, improve labor competence, and improve operating procedures to reduce product defects. In the food industry, FMEA is used to analyze process risks such as environmental cleanliness, processing temperature, and raw material homogeneity. To improve things, they use strict hygiene practices, keep temperatures under control, and check processes more regularly. This helps ensure the production quality stays high [4][21].

The FMEA method has advantages because it can identify the possibility of failure in a structured manner, prioritize risks based on measurable data, and increase cooperation between departments in improving product quality [35][14][3]. This approach also assists companies in allocating resources efficiently to prevent quality issues before they occur [21][35]. However, FMEA has disadvantages such as subjective-based assessments, reliance on analyst team experience, and difficulties in detecting new types of unprecedented failures [4][21]. However, FMEA remains considered an effective tool in risk-based quality control, due to its ability to combine continuous analysis, prevention, and quality improvement across various industry sectors.

3.3. Review of KAIZEN for Analyzing Production Quality Control

The Kaizen method is used to continuously improve production processes, involving all employees to increase effectiveness, reduce waste, and maintain product quality [52][33]. This method prioritizes small changes made routinely through the implementation of the 5S principles (seiri, seiton, seiso, seiketsu, shitsuke) and assessment of aspects of people, machines, materials, methods, and the work environment [55][57]. Kaizen not only prioritizes the end result, but also the process of continuous improvement so that the production system becomes more organized and well-managed [25].

In its application, Kaizen is successfully used in the textile and food sectors to find the cause of damage and improve process stability. In the textile sector, Kaizen is applied to reduce defects in yarn and improve the way it works by providing training to operators, maintaining machines, and conducting regular inspections on the production line [55][33]. Meanwhile, in the food sector, this method is used to maintain the cleanliness of the work area, organize production flows, and improve work discipline so that products become more consistent and in accordance with quality standards [25][57]. By involving all employees, Kaizen builds a sense of collective responsibility for the quality and efficiency of work [52][57].

The Kaizen method has several advantages, such as ease of implementation, does not require large costs, and is able to create an orderly work environment and focus on continuous improvement [52][55][25]. However, there are also drawbacks to this method, such as taking a long time to see significant results and relying on the commitment of all members in the organization [55][57]. Even so, Kaizen is still considered an important strategy in quality management because it prioritizes error prevention and the active participation of all employees in maintaining product quality.

3.4. Review of SEVEN TOOLS for Analyzing Production Quality Control

The Seven Tools method is a basic set of quality control tools used to detect, analyze, and control variations in the production process. This tool consists of *a check sheet, histogram, pareto chart, cause-and-effect diagram, control chart, scatter diagram,* and *flowchart,* (Figure which function to identify the cause of the defect and determine corrective steps systematically [33][25]. The use of Seven Tools helps companies transform production data into information that can be used to make evidence-based decisions and maintain consistency of product quality [57][17]. In general, this method is the main foundation in the implementation of quality control systems because of its ability to present analysis results that are clear, easy to understand, and directly lead to corrective action [4]][21].

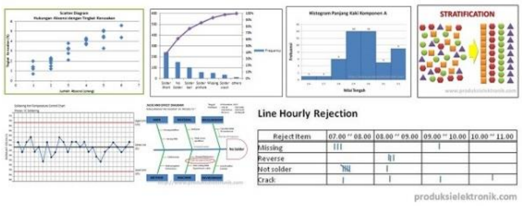

Figure 7. Seven Tools of Quality Control

Reference: https://produksielektronik.com/pengertian-qc-7-tools-tujuh-alat-pengendalian-kualitas/

The application of Seven Tools is widely carried out in the food industry, where this method plays an important role in tracing the causes of product defects and optimizing the production process. In bread processing, *check sheets* are used to collect defect data, *pareto charts* help determine the dominant causes, while *fishbone diagrams* map the cause-and-effect relationship between human, machine, and working methods [25]. In the production of tofu and amplang, *control charts* and *pareto charts* are used to monitor defect tendencies and find the most critical process points for quality degradation [57][17]. In addition, in small industries such as traditional food processing, Seven Tools is used to trace the influence of temperature, hygiene, and uniformity of raw materials on product quality, the results of which are used to improve working procedures and maintenance of production tools [4][21].

The Seven Tools method has the advantage of being easy to implement, able to visualize data clearly, and effective in increasing cross-sectional participation in the quality improvement process [33][25]. This tool helps production teams understand the root cause of the problem in concrete terms and focus corrective efforts on the source of the non-conformity [57][17]. However, this method also has a disadvantage, namely it is descriptive without providing a quantitative measure of risk, and relies heavily on the accuracy of data collection and interpretation by analysts [4][21]. Nevertheless, Seven Tools remains an effective and fundamental approach to quality control because of its ability to transform process observation results into the basis for continuous improvement.

3.5. Review of SPC for Analyzing Production Quality Control

The *Statistical Process Control* (SPC) is one of the tools in the form of a process control method using data and statistical tools to maintain process stability to meet the specifications provided by consumers [3][42]. Statistical

Process Control (SPC) is a statistical technique that is widely used to ensure that processes meet standards [3]. SPC aims to control the quality characteristics of methods, machines, products, and equipment, both for companies and operators with seven outstanding key components [1]. According to Smith (2003) in Dzul Arnendy Muhammad, dkk (2025) SPC consists of a number of production concepts and methods that can be used to improve product efficiency and quality so that the products produced can be competitive. This statistical process control also improves performance and maintains production control over quality [11][53].

In its application, Statistical Process Control (SPC) is carried out through observation during the production process [42]. SPC has the main statistical tools that can be used as a quality control tool such as checksheets, control charts, pareto charts, cause and effect charts, scatter charts, and flow charts [3].

1. Checksheet is a data collection tool that is presented in the form of a table containing data on the amount of production and types of non-conformities and their numbers [3][42].
2. Control Chart is a tool to control processes statistically. Using p charts because the quality control carried out is attributes, (proportion of damage) data in the form of the number of defective products, and data obtained to be used as a sample of irregular observations. The use of p charts because the type of damage can still be reworked (rework) so it must be rejected. The steps to make a p chart are as follows [3][42][58]:

a. Calculating the Percentage of Damage

$$p = \frac{np}{p} \qquad (2)$$

Legend:

np = Number of damaged in subgroup

p = Number checked in subgroup

b. Center Line (CL)

$$CL = \bar{p} = \frac{\sum np}{\sum n} \qquad (3)$$

Legend:

CL = $\bar{p}$ Centr Line

$\sum np$ = Total Amount Damaged

$\sum n$ = Total Amount Checked

c. Upper Control Line (UCL)

$$UCL = \bar{p} + 3\left(\sqrt{\frac{\bar{p}(1-\bar{p}}{n}}\right) \qquad (4)$$

d. Lower Control Line (LCL)

$$LCL = \bar{p} - 3\left(\sqrt{\frac{\bar{p}(1-\bar{p}}{n}}\right) \qquad (5)$$

3. A Pareto chart is a bar chart that shows the classification and value of data, and a line chart represents the total cumulative data [3][42]. This diagram is a tool to identify the problems that have the most impact so that more attention is needed quickly to address them. The data classification is sorted from left to right by highest to lowest ranking. So that it helps to find important problems to be immediately overcome with the highest ranking to problems that do not have to be immediately finished with the lowest ranking [3].
4. The Cause and Effect diagram or commonly called the fishbone diagram is useful to show the causative factors that affect the quality and have an effect on the existing problems [3]. The use of this fishbone diagram can see the causative factors in more detail that have an impact on the main factors [3][42][48].
5. A Scatter Chart is a diagram that shows the correlation between two variables and shows the degree of closeness of the relationship between the two variables. Correlation does not state a cause-and-effect relationship, but can be used to measure the strength and direction of the relationship between the two variables [3].

There is variable X as the causal variable (independent) that is not influenced by other variables, and variable Y as the effect variable (dependent). In addition to looking for correlations between the two variables, scatter diagrams can be used to perform regression calculations to predict the value of the effect variable (dependent) based on the value of the causal variable (independent) [3].

6. A flowchart is defined as a graphical method that depicts the entire existing production process, from beginning to end, using simple symbols, lines, and words that indicate activities and sequences in a production process [3].

The advantage of this SPC method is that it is very simple and good when implemented for the first time. This system has several advantages when applied in industrial sectors, where various quality defects occur. By considering the factory situation and analyzing the advantages and disadvantages of various SPC implementation methods, it was found that the application of the manual SPC method became much more appropriate. This system mostly involves plotting data on a control diagram manually, using pre-prepared graph paper [1]. Thus, the disadvantages of the SPC method is that the Company requires proper training and education for workers which is a factor in the existence of defective products about SPC [3][1]. Then the analysis using the SPC method can narrow down various types of defective products to facilitate continuous repair.

3.6. Review of SQC for Analyzing Production Quality Control

The "*Statistical Quality Control* (SQC) method is a system developed to maintain uniform standards of the quality of production products, at a minimum cost level and is an aid to achieve efficiency" [12][58]. The SCQ (Statistical Quality Control) method, which is carried out in 4 (four) stages, namely, the inspection stage with using a check sheet, calculating with a control map, identifying defects using a Pareto diagram and solving problems with a Cause and Effect diagram analysis [29].

The application of SQC can be directly effective in working in the area where a production process takes place so that product deviations can be prevented as early as possible [40]. By conducting effective direct quality supervision during production process activities [29]. The SQC (Statistical Quality Control) method has 4 stages, namely: stage 1 (one) examination using an examination sheet or (Check Sheet) carried out by a QC (quality control), stage 2 (two), which is calculating with a control map [7], stage 3 (three) which is the identification of defects using a Pareto diagram (Pareto Analysis) or stage 4 (four) which is problem solving with Cause and Effect Diagram analysis [40][29].

The advantage of the SQC method is that it works based on objective data/facts and not based on subjective opinions. SQC has the ability to describe process abnormalities, see patterns of process improvements/decreases, so that corrective actions can be taken and even preventive measures can be taken before the problem actually occurs [40]. Using the StatisticalQuality Control (SQC) method in quality control can minimize product failures [12]. And as for the disadvantages of the SQC method to obtain accurate data during product control, it still uses manual reports [12)][40]. Therefore, in the industry, it is highly recommended to use this method to maintain quality stability in the production process.

4. PROPOSED TOOLS AND METHODS FOR ANALYZING PRODUCTION QUALITY CONTROL IN THE FOOD AND TEXTILE INDUSTRIES

Of the six methods presented, there are advantages and disadvantages, therefore it is necessary to make a comparison of each of these methods.

Table 1. Comparison of the Advantages and Disadvantages of the Six Methods

Method	Advantage	Disadvantages
DMAIC (Define–Measure–Analyze–Improve–Control)	Systematic and data-driven approach. Suitable for various industries (food and textiles). Focus on continuous improvement and cross-departmental collaboration. Deliver measurable results through performance indicators.	Requires full management support. Requires accurate data and in-depth analysis. Implementation is relatively complex and time-consuming.
FMEA (Failure Mode and Effect Analysis)	Able to proactively identify potential failures. Prioritize risks based on severity and likelihood of occurrence. Assist in resource efficiency in preventing product defects.	Assessment is subjective and depends on the experience of the analysis team. Difficult to detect new types of failures. Does not visually demonstrate cause-and-effect relationships.
KAIZEN (Continuous Improvement)	Assessment is subjective and depends on the experience of the analysis team.	The resulting changes tend to be small and take a long time to produce significant results.
	Difficult to detect new types of failures. Does not visually demonstrate cause-and-effect relationships.	Depends on the commitment of all members of the organization.
SEVEN TOOLS of Quality	Simple and easy to understand. Presents data in visual form (Pareto diagram, fishbone diagram, control chart). Suitable for finding root causes and monitoring process stability.	Descriptive in nature, it does not provide a quantitative measure of risk. Accuracy is highly dependent on the data and the analyst's interpretation.
SPC (Statistical Process Control)	Can detect process variations in real time. Helps maintain consistent product quality. Effective in controlling mass production processes.	Requires a sufficient understanding of statistics. Not always able to explain the root causes of variation.
SQC (Statistical Quality Control)	Capable of analyzing large amounts of production data. Provides quantitative measures of process performance. Suitable for long-term evaluation and reporting.	Does not focus on identifying specific causes. Not suitable for processes with unstable or non-routine data.

Based on the advantages and limitations of each method, a combined approach is recommended to produce a comprehensive, sustainable, and data-driven quality control system in both the food and textile industries.

Table 2. Combination of Quality Control Methods and Their Respective Purposes and Benefits

Combination of Methods	Purpose and Benefits
DMAIC + SPC	Combining a systematic improvement approach (DMAIC) with statistical data-driven surveillance (SPC) to achieve continuous improvement. Suitable for repetitive production processes such as food processing and fabric dyeing.
FMEA + FISHBONE	Used for structured root cause and risk prioritization analysis. FMEA determines potential risks, while fishbone visually depicts cause-and-effect relationships.
KAIZEN + DMAIC	Increase employee engagement in the implementation of DMAIC improvement measures. Suitable for building a quality culture in food and textile factories.
SEVEN TOOLS + SPC	Ideal combination for day-to-day operational process control. Seven Tools are used for early identification of problems, and SPC ensures process stability with quantitative data.
FMEA + DMAIC	FMEA is used in the *Analyze* stage to assess the risk of failure, while DMAIC ensures controlled and continuous improvement outcomes. Suitable for risk-based quality management systems (QMS).

5. CONCLUSION

There is no one method that is completely superior; A combination of methods is the best solution to achieve effectiveness and efficiency in controlling production quality. The food industry is better suited to adopt DMAIC + SPC + FMEA, due to its focus on product safety and consistency. The textile industry is more suitable to adopt Kaizen + DMAIC + Seven Tools, as it emphasizes continuous improvement and control of production process variations.

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