JOURNAL OF BAKU ENGINEERING UNIVERSITY- ECONOMICS AND ADMINISTRATION
2026. Volume 10, Number 1 *Pages 151-161*

UDC: 005.6:658.5
DOI: https://doi.org/10.30546/2521-6341.2026.01.6134

THE 8S METHODOLOGY IN QUALITY MANAGEMENT

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ARTICLE INFO

Article history:
Received:2025-06-27
Received in revised form2025-07-13
Accepted:2025-08-15
Available online:2026-06-26

Keywords:
Toyota Production System (TPS), 8S, Kaizen, Just-in-Time (JIT).
JEL classification
L15, M11, L23

ABSTRACT

In modern manufacturing The Quality improvement methods and techniques have been investigated in different fields of manufacturing during the last decades. The Quality in Manufacturing areas are some of the key differentiators between competing entities in the business environment and the marketplace. Therefore, improving quality in production or services standards is the one of the main aim companies. The companies applied the Kaizen system for continues improvement. The KAIZEN process aims at continuous improvement of processes not only in manufacturing sector but all other departments as well. Implementing Kaizen tools is not the responsibility of a single individual but involves every member who is directly associated with the organization. The 8S methodology in quality management focuses on organizing and maintaining a clean and efficient workspace to enhance productivity and efficiency, reduce waste and quality cost. The Application of 8S principles has also positive impact for protection of Environment by reducing waste in production.

1. INTRODUCTION

The purpose of the study – In modern manufacturing, by applying the quality control and improvement techniques such as 8S, enterprises are to achieve maximum efficiency with minimum waste and continuous improvement of the quality of products and services and also without harming the environment, human health and safety. The research aim of the study was to assess the application of 8S tool, to investigate its application in a manufacturing management and to achieve a culture of a clean, safe, productive environment, quality improvement, elimination of wastes, minimizing of total cost, enhancement of equipment production performance, to increase the quality and elimination of cost of quality. 8S will assist the organization to actively detect potential equipment failures before it can occur and assist in the reduction of product defects and improve total quality. Application of new 8S methods in manufacturing are the one part of Total Quality Management.

1.1 Objectives of the study

The two objectives of the research are as follows:

1. To study all steps of 8S and introduce the new 8S technique to identify cost of quality in quality control.

2. To calculate Total Quality Cost, assess poor product quality costs and identify the root causes of costs.

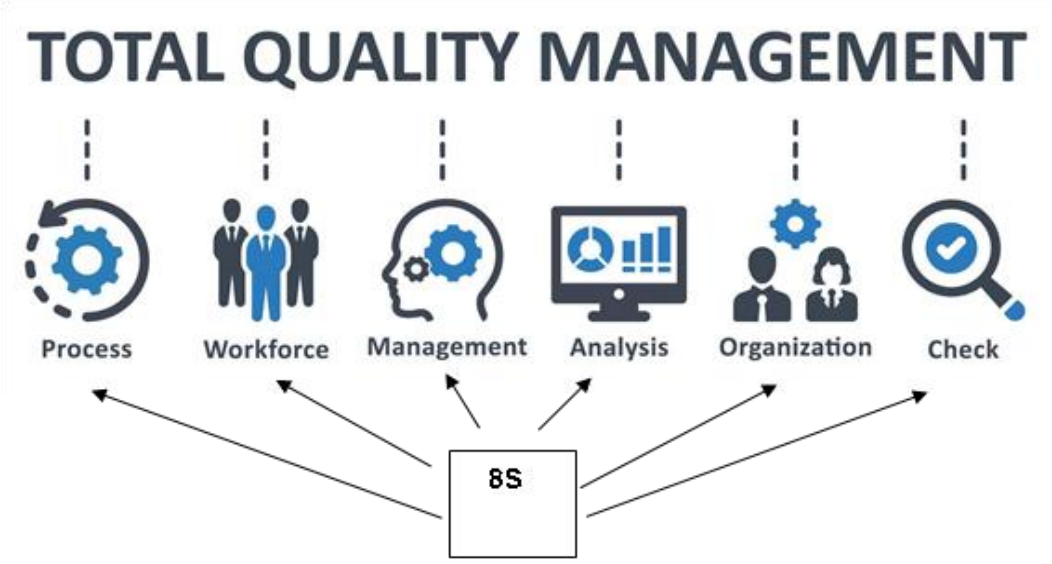
The applied significance of the study – Definition and Reducing of cost of quality, improving quality and enhancement of equipment production performance.

Scientific innovation of the research – The definition and calculation of all quality cost by application of 8S methodologies leading to reducing of production cost and minimizing wastes and enhancement of equipment production performance.

One of the most important aspects in manufacturing is the minimization of defects, elimination of costs, reducing injuries, improving productivity, efficiency and the perseverance of quality in the involved processes and products [11].

The latest 8S indicates the quality assurance which can be defined as part of the quality management focusing more on the proactive activities implemented towards providing confidence that a product or service will fulfil requirements for quality. The first main case for quality control is the consideration of raw materials quality prior entering it to production process. Thus, quality control can be considered as a subset of quality assurance which is also a subset of quality management in general (Figure 1). Finally, quality inspection is part of quality control focusing on the actual inspection techniques which are being carried out either during the processes or most commonly when the product is already finished in order to evaluate its quality.

Figure 1. *Relationships between process, management, workforce, analysis, organization, checking with 8S.*



The 8S - standardization refers to standardize all process in management system including all department activities. Lean manufacturing which one part of quality improvement, originally developed by Toyota to minimize waste and optimize processes, has evolved significantly with technological integration and the demands of contemporary industrial environments. The 8 S is one of the main aspect of Lean manufacturing. The lean principles, indicates such as waste reduction, continuous improvement, and value maximization, followed by a discussion of widely used lean practices like 8S, Kaizen, Just-in-Time (JIT), and Kanban's.

Today, quality control is more than just a checkpoint. It serves as the backbone of operational excellence and is integral to maintaining competitive advantage. The implications of quality control in modern manufacturing include:

Enhanced Product quality: Consistent quality control processes result in products that meet customer expectations, thereby reducing returns and bolstering brand loyalty.

- **Total Cost Reduction:** By catching defects early such like raw materials, auxiliary materials, spare parts, companies can avoid the extensive costs incurred from rework or product recalls.
- **Production Process Optimization:** Continuous monitoring and adjustments lead to refined production processes which boost overall efficiency and productivity.
- **Regulatory Compliance:** Meeting international and local quality standards is essential for both market access and customer trust.

2. THE STEPS OF THE S METHODOLOGY (EIGHT S)

1S (Sort)

It is the first step of the 8S approach, in which the organization needs to retain what is needed and eliminate unwanted materials from the workplace. To remove unused hand tools, raw materials, auxiliary materials mainly expired chemicals materials, spare parts, any damaged and unusable equipment and any other parts.

2S (Set in order)

This second step is to set items in order, to improve the flow of work and easily identify tools and materials. The objective of this step is to arrange the work in an orderly way and to encourage the use of visual aids to reduce the time spent searching for items.

3S (Shine)

Once the unwanted or unused tools, raw materials, spare parts have been removed and the workplace has been set in order, the next step is to tidy and clean up the production, storage and all related places, machine, tools, spare parts. This step includes eliminating all forms of dirt, contamination, and untidiness from the workplace.

4S (Standardize)

1. To obtain, prepare and continuously improve the manual, site operation procedures, testing a commissioning procedures, Maintenance procedures, Health, Safety and Environment Procedures, instructions, strategy, plans, related drawings, strategy for company goals.

2. Standardize the product and service quality parameters and continuously improve it based on people health, safety and protection of environment.

5S (Sustain)

In order for an organization to ensure an effective culture of neat and tidy workplace, it should intermittently monitor performance to identify deviations. This would help to put measures in place that ensure that progress is sustained. customer satisfaction and for all organization activities.

6S (Safety)

1. Personnel safety and 2. Process safety 3. Environmental safety

The safety is a tool for effective safety management, including the prevention of hazards, fatal accidents, injuries, and deaths.

7 (Spirit as the seventh 'S')

The impact of organizational culture and the crucial element of respect for employees, choosing to include 'spirit or morale or rising desire on each employee' as the seventh step of the methodology highlights support for the people factor in the workplace.

8S (Save of Quality Cost 'SQC')

The application of KAIZEN in manufacturing for improvement of product and service quality cause increased cost of quality. So by application of Six Sigma DPO (Defect per opportunity) companies can analyses and decrease the cost of quality. First old data analysis related with poor quality and then analyzing of source of poor quality based on each defect opportunity the cost of quality is going to be decreased.

3. THE COST OF QUALITY.

28 years later in 2022, a Gartner survey revealed that one out of every three companies do not use *any* emerging technologies to manage their cost of quality (First Production Quality Cost Slope). Only 18% were using an QMS, one of the prime enablers of a culture of quality [2]. The cost for first production cost covering first natural quality cost of product.

In modern business the aim is achieving the optimal balance between quality and cost is a major challenge, and this balance is called the quality-cost trade-off problem. So below is given the Slope of First production cost PCS.The PCS has the first quality change on each product. The formula for Production Cost Slope is PCS*ij*:

$$PCS_{ij} = \frac{\Delta CPQ_{ij}}{\Delta PCQ_{ij}} \qquad (1)$$

ΔCPQ_{ij} – Cost of First Production Quality, $\sum (\Delta PCQ_{ij})$– First Production changes of Quality,

The second quality slope indicates the periodical changes on product quality such us adding chemicals, increase of sampling and analyzing, staff trainings, improvement of preventive maintenance, application of modern technologies, improvement of working conditions, delivery of raw materials with high quality and another one. So the second formula indicates changes on quality. The formula for Cost Slope of Improved Quality is IQCS*ij*:

$$IQCS_{ij} = \frac{\Delta CIQ_{ij}}{\Delta QIC_{ij}} \qquad (2)$$

ΔCIQ_{ij} – Cost of Improved Quality, ΔQIC_{ij} – Quality Improvement Changes,

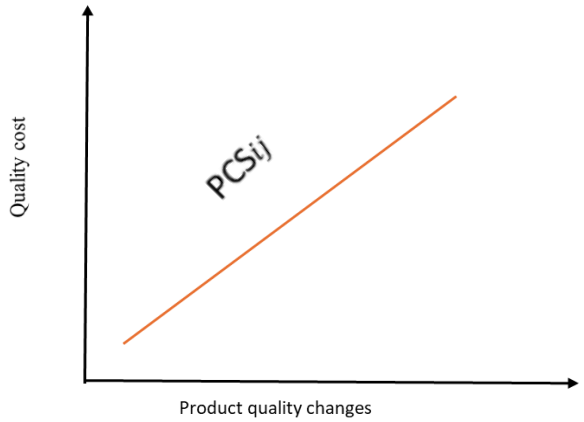


Figure 2. *Slope of quality changes and improvement*

Company produces 500mm diameter, wall thickness 2mm piping with 6-meter length. The one 6 meter piping without painting has the cost 50$. This is the ΔCPQ *ij* – Cost of First Production Quality, ΔPQ *ij* – First Production changes of Quality is 5 (using welding rod, coal, cutting disc, purification, using cooling oil, using knife). But after requirement from customer the quality changes for pipe quality improvement are required and new coal, and new knife were used instead of old ones. So ΔCPQ *ij* increased to 80$ and ΔPQ *ij* increased to 7. This is the practical application.

Six Sigma allows you to figure out the cost of quality by estimating the following [11]:

The cost of production of the wasted original product, the cost of the recall, Scrapping or rework, Additional work done to rectify the original product, the resultant cost of the recall, the cost of manpower working with the product before, during and after the recall, the cost of losing business, Bad publicity, their impact on stock price and The delay in working on another product or another feature for the same product.

Here are some of the main points to remember:

- cost of quality is not the cost of producing a quality product or service, but the cost of not doing so. It includes all the costs associated with preventing, detecting, and correcting defects and errors in the processes and outputs of an organization.

- Cost of quality can be used as a strategic tool to measure, monitor, and improve the quality performance and customer satisfaction of an organization. It can also help identify the root causes of quality problems and prioritize improvement actions. [7]

- Cost of quality (Natural Cost Slope) can be calculated by adding up the four categories of quality costs: prevention costs, appraisal costs, internal failure costs, and external failure costs.

Additionally, the cost of quality can be represented by the sum of two factors: the cost of good quality and the cost of poor quality equates to the cost of quality — as shown in the equation below:

Mathematically:

Cost of Quality (CoQ) = Cost of Good Quality (COGQ) + Cost of Poor Quality (COPQ)

1. **COGQ = Prevention Cost (PC) + Appraisal Cost (AC)**
2. **COPQ = Internal Failures Cost (IFC) + External Failures Cost (EFC)**

The final formula is:

3. COQ = COGQ + COPQ = (PC + AC) + (IFC + EFC)

Understanding and optimizing CoQ can help businesses reduce waste, improve efficiency, and enhance profitability.

The cost of good quality is represented as CoGQ , The cost of poor quality is represented as CoPQ, The prevention cost is represented as a PC, AC represents the appraisal costs, IFC represents the internal failure costs and EFC represents the external failure costs.

4. CLASSIFICATION OF COST OF POOR QUALITY

The cost of poor quality (COPQ) refers to the costs of providing poor quality products or services. The cost of poor quality is divided into three categories:

1. **Appraisal costs** incurred to ascertain the degree of conformance to quality requirements.
2. **Internal failure** costs related to defects found before the customer receives the product or service.
3. **External failure costs** associated with defects found after the customer receives the product or service.

Furthermore, quality-related activities that incur costs may be divided into prevention, appraisal, and internal and external failure costs [11]. According to Gartner [2], an astounding 46% of a company's cost of quality is actually the cost of *poor* quality—the failures spotted onsite (internal failures) and by the customer (external failures).

3. Prevention Cost

PC - Prevention Costs are expenditures made intentionally to keep defects from occurring in the first place, preceding the actual production cycle. There's more to prevention "costs" than many realize. To understand what they are—and what exactly they prevent—we need to turn to quality guru Armand Feigenbaum's idea of the "hidden factory". According to Feigenbaum (who developed the Total Cost of Quality formula that captures the costs of good and bad quality), every factory has an evil parasitic twin. The activities classified under prevention costs share the goal of defect avoidance before a production run begins. The prevention activities are: Quality Training for Employees, Supplier Quality Assurance, Investment in Process Capability, The acquisition of Robust Equipment Design, Preventative Maintenance Programs and Quality Data Analysis and Reporting Systems.

Prevention Costs = (Number of potential problems x Cost to fix each problem) x (Probability of each problem occurring)

4.1. Types of Preventive Costs

As in project management, preventive measures are often taken in order to avoid cost overruns, schedule delays, and other potential problems. Some examples of preventive costs to avoid internal failure costs in project management include: **Hiring a Project Manager**: **Risk Assessment**, **Staff Training**, **Upkeep Costs and** Ongoing **Costs.**

Prevention costs can be difficult to calculate, but they are an important part of any project management budget. By including prevention costs in your budget, you can help ensure your project stays on track and that potential problems are identified early and dealt with before they escalate into costly rework or delays.

4.1.2 Strategy for Reducing of prevention cost

Prevention costs are those that are incurred to keep the project on track and avoid problems. They are often seen as necessary evils, but they don't have to be. By taking a few simple steps, you can reduce the prevention costs in your project and improve your bottom line.

1.Allocate Competent Resources

Allocate competent resources during the project initiation phase. This ensures that you have the right people working on the project from the start and that they are familiar with the project's goals and objectives.

2.Track Spending

Track forecasted vs. actual spending to control project costs. This helps you to identify areas where you are overspending and makes it easier to adjust your budget accordingly.

3.Use Job Strategy

You can boost productivity through a job rotation strategy. This involves rotating employees through different tasks so that they are better able to understand the project as a whole and identify potential problems. By taking these steps, you can reduce the prevention costs in your project and improve your bottom line.

4.2. Appraisal Cost

AC - Appraisal Costs involve the expense of inspecting, testing, and auditing products or processes to ensure conformance to specifications. These costs are incurred during the production process to identify defects. Appraisal costs are a specific category of quality control costs. Companies pay appraisal costs as part of the quality control process to ensure that their products and services meet customer expectations and regulatory requirements. These costs could include expenses for field tests and inspections. A classic appraisal cost would be what is spent to inspect materials delivered from suppliers. For example, let's say a music retailer gets a shipment of guitars from a major manufacturer.

Other examples of appraisal costs include:

Inspecting work-in-process materials, inspecting finished goods, the supplies used to conduct inspections, the inventory destroyed as part of the testing process, Supervision of the inspection staff, Depreciation of test equipment and software, Maintenance of any test equipment and

Appraisal cost include below ones:

Inspection of Incoming Materials, In-Process Testing and Monitoring and Final Audits and Equipment Maintenance

4.2.1 Strategies to Reduce Appraisal Costs

1. Implement Quality Management Systems (QMS)

Automation and **Data Analysis**: Leverage data analytics to identify trends and areas for improvement, minimizing unnecessary inspections.

2. Improve Training and Processes

Employee Training and **Standard Operating Procedures (SOPs)**: Develop clear SOPs to streamline inspection processes and reduce time spent on evaluations.

3. Optimize Supplier Relationships

- **Supplier Audits** and **Partnerships**: Build strong relationships with suppliers to foster a culture of quality, which can lead to fewer defects.

4.3. Internal Failure Costs

IFC - Internal Failure Costs arise when a product or service fails to meet quality standards before it is delivered to the customer, such as the expense associated with scrap or rework. Internal failure cost refers to a type of cost of quality related to product failures discovered by an organization before any product leaves the manufacturing unit or factory. Determining such costs helps companies understand the extent to which the manufactured products meet the set quality standards. Given below is a list of such costs that businesses must be able to monitor:

1. **Rework and Rectification,**

2. Wasted Resources,

3. Delayed Deliveries,

4. **Increased Inspection Costs,**

5. Loss of Employee Morale,

6. **Opportunity Costs,**

7. Scrap,

8. Failure Analysis,

9. Supplier Side Cost,

10.Retesting and

11.Modifying Process:

Example: The company spends $80,000 on rework, $50,000 on scrap, $20,000 on retesting, and $30,000 on downtime. The total internal failure costs are $180,000.

4.3.1 Identifying Common Sources of Internal Failures

Identifying the common sources of these failures is not just a reactive measure; it's a proactive strategy that can save considerable time and resources. By understanding where and how these breakdowns typically occur, organizations can implement targeted improvements that bolster their bottom line and elevate their market position.Here's an in-depth look at common sources of internal failures:

1. Insufficient training of workers. Poor responsibilities,
2. If required eliminate the night shift activities for final product packaging,
3. Poor morale of employees, and lack of personnel and equipment performance assessment,
4. The lack of application of Modern Supply Chain Management,
5. Ineffective and inefficient quality control processes
6. Poor product design
7. Lack of standardization of processes such us product standards and lack of strategy, plans and procedures,
8. Poor supplier quality, Equipment Failure, Lack of Communication, Insufficient Resources and Unclear Objectives and Goals

4.3.2 Strategies to Reduce Internal Failure Costs

Implementing effective strategies can help minimize internal failure costs. Here are some key approaches:

1.Process Optimization

2.Standardization: Establish clear procedures to reduce variability in production.

3.Preventive Maintenance: Regularly maintain equipment to prevent breakdowns.

4.Quality Management Systems (QMS) 1. Training: 2. Data analysis: 3. Periodical performance assessment.

5.**Continuous Improvement. Lean Management** and **Feedback Loops**: Create systems for continuous feedback to identify and address issues promptly.

4.4. External Failure cost

EFC - External Failure Costs occur when a product defect is discovered after the item has been shipped to the customer. These external costs include warranty claims, product recalls, liability costs, and damage to brand reputation. An External Failure Cost is an expense incurred when customers discover defects in the product or service once it is delivered to them. It highlights the financial impact of post-delivery quality issues for businesses to address and minimize such occurrences. The transparency of customer behavioral against product and service quality must be analyzed in today modern environment where we have climate changes, consciously changed and improved technology, and political and geopolitical changes.

4.4.1 Strategies to Reduce External Failure Costs

To minimize external failure costs, companies can implement several strategies:

1. Improve Quality Control: Regular Inspections and Quality Audits to conduct to ensure compliance with quality standards.

2. Enhance Training and Development: Employee Training and Process Improvement: Encourage a culture of continuous improvement to enhance product quality.

3. Utilize Customer Feedback: Voice of the Customer: Actively seek and analyze customer feedback to identify areas for improvement and Responsive Adjustments: Make necessary adjustments based on customer insights to prevent future issues.

4. Implement Quality Management Systems (QMS): Automated Tracking: Use QMS software to monitor quality metrics and identify trends in defects. Data Analysis: Analyze quality data to pinpoint recurring issues and address root causes.

Additional activities to Reduce Total Cost of quality

- Identifying the systemic issues beforehand and take early corrective measures so that not much expense is made to deal with it at a later stage.
- In case entities plan to implement a change, they must consider change management tools to understand the repercussions of bringing about that change. These tools help figure out if the transition would be smooth or involve rough transformation for which the entities may have to remain prepared beforehand.
- Identifying operational errors and making sure they do not occur at a later stage. This is because such errors involve huge damage control cost, thereby making it a huge expense for the firms. Conducting training programs help entities have professionals who can identify and prevent such errors.

- Implementing various risk management techniques to avoid errors at advanced stages. To achieve this, the entities can ensure thorough audit management, proper financial reporting, and compliance with regulatory requirements.
- Enhancing or setting standards for suppliers' quality is an essential step that one may take to reduce quality costs. Specifying benchmark performance and enhancing communication with the supplier is a must to make sure they are providing standard quality supplies based on the quality standards that a firm ensures for its finished products.
- Process standardization**.** The first step in reducing quality costs is standardizing your processes.

IMPORTANCE

The determination of the cost of quality remains to be critical and varies for different organizations. If this cost is not measured and quantified, the organizations working in the competitive industries would never gain the upper hand and survive the ever-changing dynamic environment. Therefore, measuring it is necessary as it helps the business maintain a healthy and positive bottom line.

Some of the advantages of incurring the cost of quality include:

- It helps the organization to chalk out wrong and poor-quality output.
- It helps in problem-solving, wherein it performs cost and benefits analysis on quality and process improvement initiatives.
- The model or cost of quality helps in a single-point evaluation of quality performance.
- It further evaluates the costs of failures and appraises them accordingly.

Example: In manufacturing company for Total Quality costs:

Total Quality Activity	**Monthly Cost**
Training Programs	$6,000
Supplier Audits	$4,000
In-Process Inspections	$5,000
Scrap & Rework	$18,000(Previously the cost were $ 22,000)
Customer Warranty Claims	$8,000
Audit Prep Time	$2,500
Manual Documentation	$3,500
Equipment Downtime	$10,000 (Previously the cost were $14,000)
Service activities	$2,000
Total Cost of Quality	**$59,000**

CONCLUSION.

With ever increasingly evolving business environment, intensified awareness and concerns of Health, Safety and work environmental issues, additionally the lack of raw materials and spare parts, geopolitical and economic issues have prompted organizations to use various efficiency improvement tools. It is clear that one of the lean methodology tools does have significant positive impacts on organizations performance when effectively implemented. The new Lean 8S Methodology can have positive outcome the organization performance. It is noticeable that the goal of 8S function is broad and diverse. When successfully applied, the work environment improves reduce waste in different forms, organize work areas, promotes hygiene as well as

team cohesion, the complete gains of 8S cannot be envisioned in firms, if the obstructions related, completely understood, addressed and removed. The lean 8S methodology has become the base for any lean method to be applied for quality improvement and reducing total production cost.8S methodology is a continuous improvement tool for increase total quality and should be constantly monitored and evaluated.

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