Journal of Information Systems Engineering and Management
2023, 8(4)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

Quality Circle Methodology in Solving Industrial Problem: A Case Study on Pump Breakdown

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ARTICLE INFO

Received: 19 Sep 2023

Accepted: 26 Nov 2023

ABSTRACT

Quality Circle (QC) represents a participative management approach that involves employees in problem solving and continuous improvement process in organizations. This study examines QC through a case study that addresses frequent pump breakdowns in an industrial environment. The study describes the overall structure and functioning of Quality Circle with emphasis on the role of top management, steering committee, coordinators, facilitators, leaders and members. The case study shows how Quality Circle used an orderly approach to detect, examine and fix the common issue of failure in pump shafts. The team employed several strategies such as brainstorming, the ABC analysis, the Pareto analysis and cause-and-effect diagrams, to find the main issue. The main reason for shaft failure turned out to be the large weight of the coupling. Modifying the design and choosing a lightweight flexible replacement for the coupling helped bring down maintenance costs by Rs. 3,27,000 and improved pump functioning. This study points out that for Quality Circle initiatives to succeed, effective support from management, employee involvement and tools for quality improvement must be used. The research indicates that QC has the potential to boost quality, cut expenses and strengthen the overall performance of a company when introduced correctly and supported.

Keywords - Quality Circle, Structure, Case Study, Pump breakdown.

1 INTRODUCTION

A Quality Circle is a volunteer group composed of members who meet to discuss workplace and service improvements and present their ideas to management. These are related especially to the quality of output or service to improve the performance of the organization/department and motivate and enrich the work of employees [1] [2]. This group continuously carries out organization-wide control activities, self and mutual developments, and control and improvement within the workplace utilizing quality control techniques with all the members participating. Generally, six to twelve members participating as volunteers from the same work area make up a circle [3] [4]. The members receive training in problem-solving, statistical quality control, and group processes [5]. Quality Circle generally recommends solutions for quality and services that may be implemented by the management. Thus, the Quality Circle is not merely a suggestion system or a quality control group but extends beyond that because its activities are more comprehensive. Furthermore, it is not a taskforce because it can be made permanent in the organization or department [6].

2 OBJECTIVES OF QUALITY CIRCLE

Quality Circle aim to achieve both personal and organizational goals. They include [1] [7]-

1. Self-development
2. Mutual development
3. Improvement in quality
4. Waste reduction
5. Job satisfaction
6. Cost reduction
7. Team building

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8. Getting people involved
9. Improve participation
10. absenteeism and grievances

3 STRUCTURE OF QUALITY CIRCLE [8] [9]

A Quality Circle should have an appropriate structure for effective and efficient performance. The structure of a Quality Circle can be modified as per requirements. Figure 1 shows the structure of the Quality Circle. The structure may consist of the following elements:

3.1 Top Management

Top Management comprises the Chairman, Managing Director, Functional Directors, and other Directors on the Board. Top management is responsible for implementing the policy, laying guidelines, and reviewing the policy implementation and its results.

3.2 Steering Committee

A steering committee is a monitoring group of heads of various departments, headed by the head of the organization, to guide, review, and improve the functioning of Quality Circle. Through periodic and regular reviews, the committee makes the functional heads accountable for the 'Quality Circle' healthy functioning in their areas.

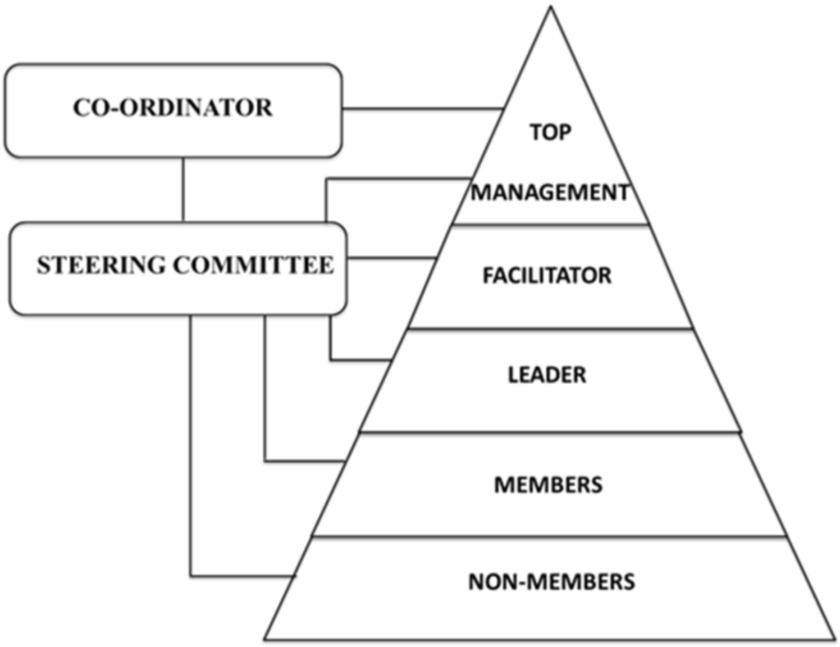

Figure 1: Structure of Quality Circle

3.3 Coordinator

The coordinator intersects with all members of QC. In QC set up, coordinators may be personal or administrative officers, who coordinate and supervise the work of facilitators and administer the program.

3.4 Facilitator

A nominated manager of an area who catalyzes and stimulates the Quality Circle. The facilitator trains members, leaders, and management and links all people in the organization.

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3.5 Leader

For a leader to play an effective role, they should be given the requisite education and training to lead and develop leadership qualities and skills. Since Quality Circle conceptually is also 'applied management' at the grassroots level, they are to be given training on management aspects.

3.6 Members

Employees of the organization become members of the group of their own volition and with a full understanding of the concept and philosophy of the Quality Circle. They ensure the necessary facilities are required for the effective operation of Quality Circle.

3.7 Non-members

In large organizations, some workers and supervisors may not like to join the circles for various reasons. Of course, their numbers may be small.

4 LAUNCHING QUALITY CIRCLE [9]

Launching Quality Circle (QC) successfully in an organization hinges on a genuine understanding and strong belief in participative management, especially from the upper management. If the Chief Executive and the leadership team don't fully commit, any initiative to implement Quality Circle is likely to be ineffective or short-lived. The launching Circles involve the following steps:

- Explain the concept to the employees and invite them to volunteer as member of Quality Circle.
- Form a steering committee, arrange training of co-ordinators, facilitators in basics of Quality circle to meet, implementation, techniques and operation later facilitator may provide training to circle leaders and circle members.
- A meeting should be fixed preferably one hour a week for the Quality Circle to meet.
- Formally inaugurate the Quality Circle.
- Arrange the necessary facilities for the Quality Circle meeting and its operation.
- Develop a structured training program for all participants, including: Trainer, steering committee members, Facilitator, Leader/Deputy leader, Member.

5 OPERATION OF QUALITY CIRCLE [10]

The operation of a Quality Circle involves a systematic, team-based approach to identify, analyze, and solve work-related problems. Figure 2 shows how a typical Quality Circle functions.

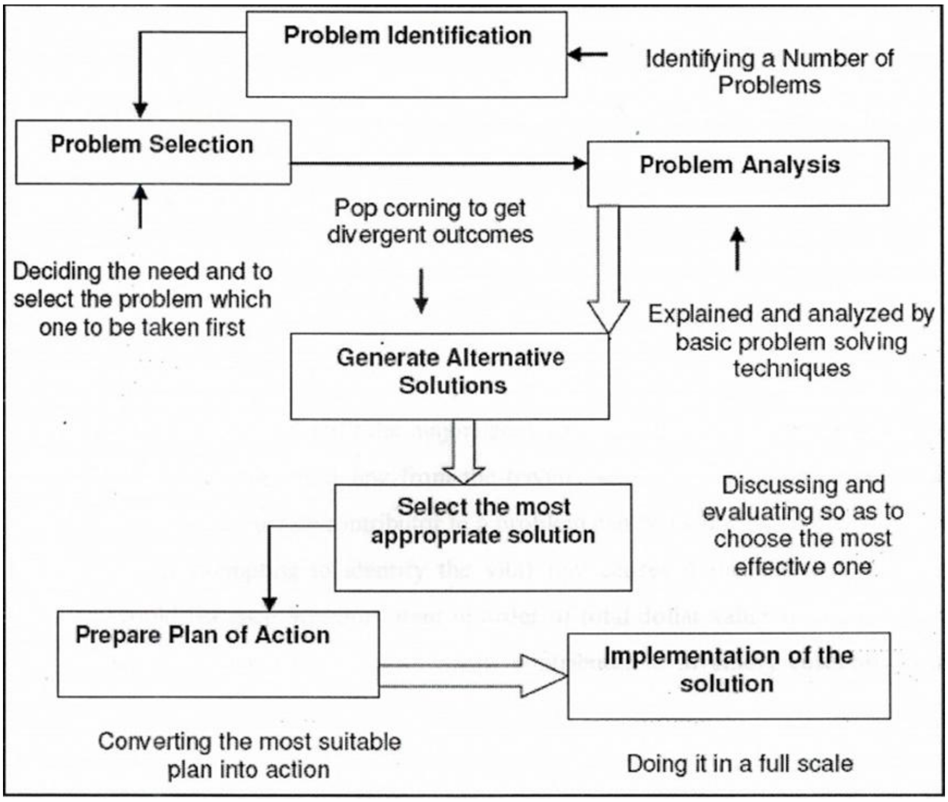

Figure 2: Operation of Quality Circle

6 BASIC PROBLEM-SOLVING TECHNIQUES [11]

The following techniques are most used to analyze and solve work related problems.

1. Brainstorming
2. ABC Analysis
3. Pareto Diagram
4. Cause & Effect Analysis (Fishbone diagram).
5. Data Collection.
6. Data Analysis.

6.1 Tools for Data Analysis

The following tools are most used for data presentation and analysis

1. Tables.
2. Bar Charts.
3. Histograms.
4. Line graphs.
5. Scatter grams.
6. Control Charts.

7 QUALITY CIRCLE- A CASE STUDY

Quality circle in India began at Bharat Heavy Electricals Limited (BHEL) and have grown to include a variety of service departments. Today, they're present in sectors like chemicals, pharmaceuticals, and traditional industries, including jute and textiles. Companies such as BASF, Hindustan Antibiotics, and Hero Honda are part of these initiatives. Additionally, organizations like State Apollo Hospital and Bank of Baroda have embraced quality circles, and they're even popping up in some rural projects and among families [7]. A case study of applying Quality Circle technique of a problem related to frequent breakdown of pump at an industrial concern is discussed in the following section.

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7.1 Identification of Problems

The following methods are used for identifying the problems.

1. Data from logbooks and history for recurring jobs.
2. Plant survey round/safety survey round by group members.
3. Group discussion

7.1.1 "A" Category Problem

1. Axial displacement.
2. Cooler leakage.
3. High vibrations.
4. Seal leakage.
5. Frequent breakdown of pump due to the shaft failure.
6. Spool piece leakage.
7. Speed hunting.
8. Water contamination in the oil console
9. Flow problem.
10. EOT Tripping Frequently.

7.1.2 "B" Category Problem

1. Oil spillage problem in lube oil drum storage area.
2. Spare part procurement procedure.
3. Suction air filter problem.
4. Communication between two departments
5. Improper history record keeping.
6. Spare storage problem.
7. Scrapper floor not proper
8. Tray choking.
9. Seal leakage.
10. Pump vibration problem.
11. Lack of coordination between two departments.
12. Oil circulation line choking.

7.1.3 "C" Category Problem

1. Insufficient tools.
2. Manpower shortages.
3. Stationary wastage.
4. Unbalanced distribution of responsibilities.
5. Required training is not Provided.

7.2 Categorization of Problem

The identified problems are categorized into A, B, C types depending on the involvement of other departments and management as shown in Table 1.

Table 1: A, B, C Analysis

Category	Description	No. of Problems
A	Problems related to team ownership area and to be solved by team itself	10

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B	Problems to be solved with help of another department	12
C	Problems need management involvement / support	05

7.3 Problem Selection Criteria

Considering the importance of the process, the following criteria are defined for the selection of problems:

- Performance improvement.
- Safety & environment.
- Machine availability.
- Energy consumption.
- Production cost.
- Easy operation.

7.4 Selection of Problem

Based on the problem selection criteria, only A-category problems were considered for improvement in the project, which are listed in Table 2.

Table 2: Presents Selection of Problems

Sr. No.	Problems
1	Axial displacement.
2	Cooler leakage.
3	High vibration.
4	Seal leakage.
5	Frequent breakdown of pump due to shaft failure.
6	Spool piece flange leakage.
7	Speed hunting.
8	Water contamination in oil console of.
9	Flow problem.
10	EOT Tripping frequently.

7.4.1 Rating given by QC members:

Rating 1 to 5 numbers are given to each A-category problem for proper identification of problems by QC members as shown in Table 3.

Table 3: Highlights Rating Given by QC Members

Members	Problems									
	01	02	03	04	05	06	07	08	09	10
QC member 1	04	02	03	04	05	02	01	01	03	04
QC member 2	03	03	03	03	04	03	01	01	02	03
QC member 3	04	04	03	04	04	01	02	01	03	03
QC member 4	02	02	02	03	05	02	01	01	03	04

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QC member 5	03	03	02	03	04	03	02	03	02	03
QC member 6	03	03	02	04	04	02	02	01	03	03
TOTAL. (Out of 30)	19	17	15	21	26	13	09	12	16	20
% Rating	64	57	50	70	87	43	30	40	54	67
Remarks	04	05	07	02	01	08	10	09	06	03

The highest rating of 87% was given to problem 5 by the QC members; hence, this problem was selected.

7.5 Definition of Problem:

Frequent breakdown of pumps due to shaft failure as shown in Figure 3, shaft failure, shaft breakage, and the production of high vibrations with abnormal sounds. Therefore, there is a loss of production.

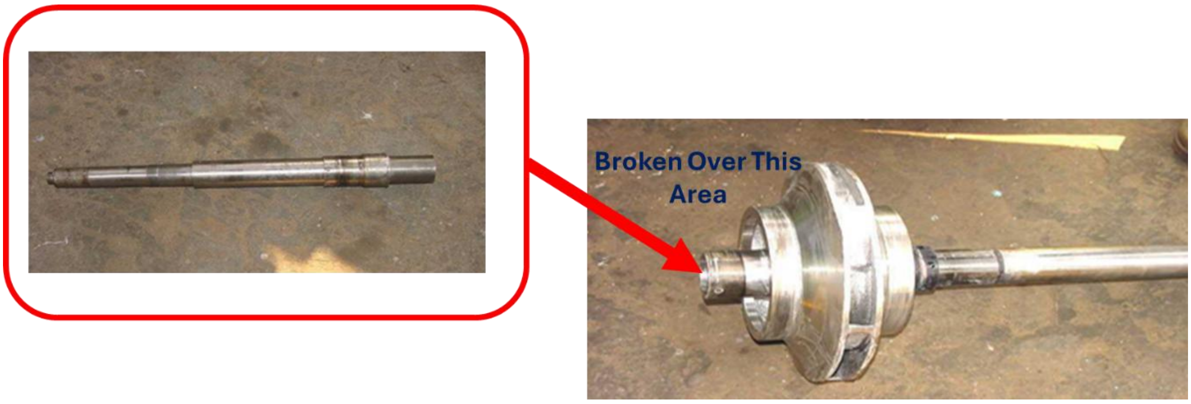

Figure 3: Broken Shaft

7.5.1 Reason for Selection of Problem

- Among the three pumps, one serves as a reserve. This pump plays a crucial role. If it fails, the plant may need to halt operations, leading to a production loss.
- The maintenance and inventory costs increase because of the excessive consumption of spares.
- It is a less reliable pump; therefore, it is in the critical equipment category.
- Pumps produce high vibrations with abnormal sounds.

7.5.2 Identification of Causes

The causes of the frequent breakdown of pumps due to shaft failure were identified with the help of brainstorming by QC members, as described below in Table 4.

Table 4: Presents Identification of Causes

Sr. No.	Causes
1	Shaft material and its strength
2	Bearings damaged
3	Higher coupling weight
4	Uneven partition of its flow in double suction
5	High flow rate than normal
6	Pump efficiency reduced
7	Cavitations
8	Foundation is not proper

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9	Turbulence in flow
10	Internal oil circulation problem
11	Uneven hydraulic forces
12	Pump speed is high

7.5.3 Why - Why Analysis [12]

It is a method of questioning that leads to the identification of the root cause(s) of problems. A why-why analysis was conducted to identify solutions to a problem that addressed its root cause(s) as shown in Figure 4.

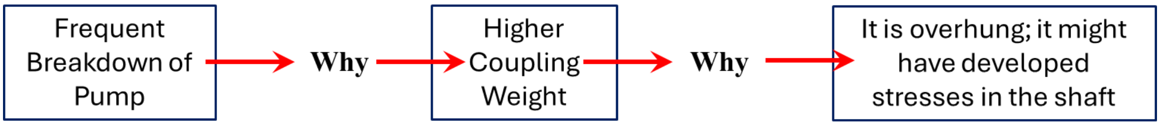

Figure 4: Why-Why Analysis

For better identification of root causes, the QC team decided to use a cause-and-effect diagram technique.

7.5.4 Causes & Effect Diagram (Fishbone diagram) [12]

The fishbone diagram identifies many possible causes of an effect or problem. This diagram helps in searching for the root causes, identifying areas where there may be problems, and comparing the relative importance of different causes. This diagram represents the relationship between a problem and its potential causes. It only deals with factors, not quantities. Figure 5 Case-and-effect diagram for shaft deflection.

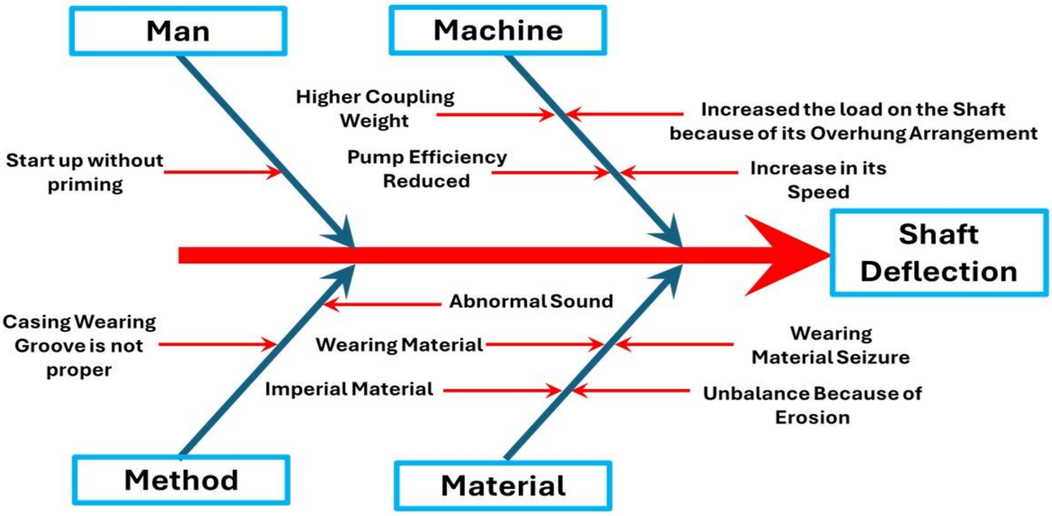

Figure 5: Cause & Effect Diagram for shaft deflection

7.6 Data Collection

One of the key areas in which circle members must concentrate is data collection. Once the problem is identified and selected as a Quality Circle problem, it is necessary for members to collect data to discover the magnitude of the problem. Historical information is useful but can be confusing. Therefore, it is always beneficial to collect new data and analyze them properly. So Quality circle members collected data for the cause of shaft deflection as shown in Table 5.

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Table 5: Data Collection

Sr. No.	Root cause	Occurrence (No. of times) In 6 months	Percentage Contribution	Cumulative %
1	Shaft breakage due to shaft loads because of higher coupling weights	05	50	50
2	Internal circulation problem	02	25	70
3	Bearing damage	01	10	80
4	Wearing seizure	01	10	90
5	Increase in its speed	01	05	100

After the data were collected, the Quality Circle members analyzed the data with the help of a Pareto chart.

7.6.1 Pareto Analysis [12]

A Pareto chart is used to identify the major factors that contribute to a problem and to distinguish the "vital few from the trivial many" causes. A Pareto chart is used when each separate contributor to a problem can be quantified. Figure 6 shows the Pareto diagram.

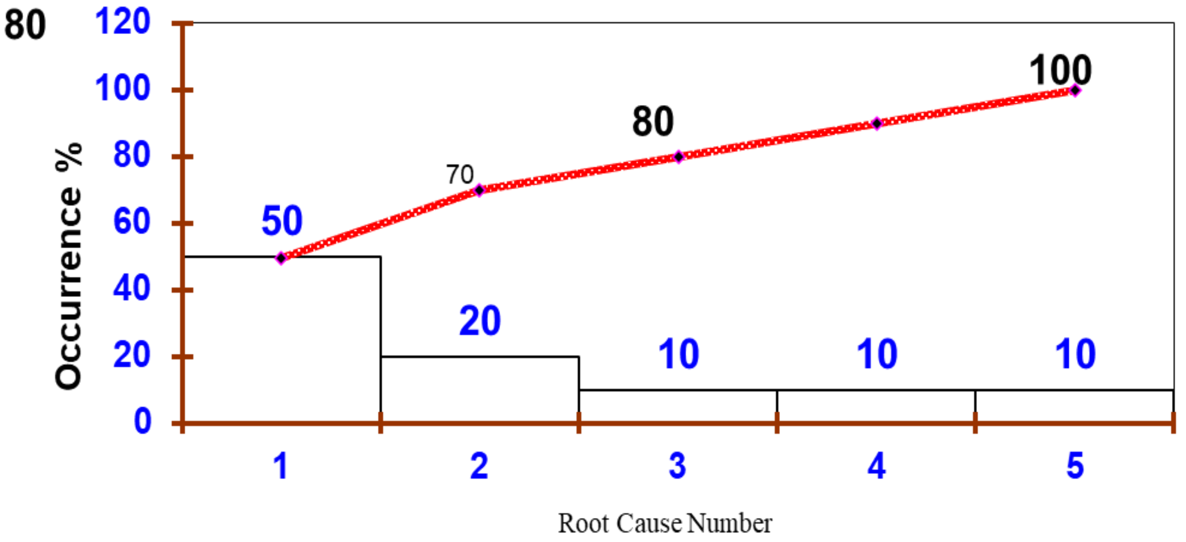

Figure 6: Pareto Analysis

7.7 Root Cause Selected for Implementation:

QC members successfully identified the root cause with the help of the cause-and-effect diagram and Pareto analysis, which is the coupling weight. By changing the coupling as shown in Figure 7 and Figure 8, this weight can be lowered. Addressing this element should improve general performance, hence raising process efficiency and effectiveness. Such changes might involve changing the materials used in the coupling or the design to perhaps lower the weight without sacrificing structural integrity. Lightweight flexible coupling is used for the coupling modification. The coupling weight has been reduced from 60.4 kgs to 18.2 kgs.

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Figure 7: Old Coupling

Figure 8: New coupling

7.8 Outcome

After implementing the above suggestions, considerable improvements in the cost reduction have been observed. The details of cost benefit analysis are shown in Table 6.

Table 6: Cost Benefit Analysis

Part Name	Qty. used in 3 months	Unit rate (rs)	Total Cost (rs) before Modification	Total Cost (rs) After Modification
Impeller	03	1,00,000	3,00,000	-
Bearings	06	10,000	60,000	-
Mechanical Seal	06	12,000	72,000	-
Shaft	03	20,000	60,000	-
Coupling	01	85,000	85,000	-
Flexible Coupling	01	2,50,000	-	2,50,000
TOTAL (RS)			**5,77,000**	**2,50,000**

7.9 Feedback:

1. After adopting the above-mentioned modifications, the vibrations of the pump decreased from 15 mm/s to 4 mm/s and boosted the pump efficiency and reliability.
2. The pump runs with sufficient discharge flow at lower speeds and energy consumption, fulfilling the process requirements.

7.10 Manpower Used:

Manpower used before modification and after modification is given below:

Technician: 02

Casual helper: 02

Days used: 06

Technician cost: Rs. 1500

Casual helper cost: Rs. 250

Total technician cost= Rs. *18,000* /-

Total casual helper cost= Rs. *3000* /-

Total manpower cost used= Rs 21,000 /-

7.11 Benefits obtained through implementation of Quality Circle are given below:

A. Before Modification

$$Cost\ of\ Spare\ Consumed: Rs. 5{,}77{,}000/-$$

$$Cost\ of\ manpower\ used:\ Rs. 21{,}000/-$$

$$Total\ Cost: 5{,}98{,}000\ /-$$

B. After Modification

$$Cost\ of\ spare\ consumed: Rs. 2{,}50{,}000\ /-$$

$$Cost\ of\ manpower\ used:\ Rs. 21{,}000/-$$

$$Total\ Cost: 2{,}71{,}000\ /-$$

C. Net benefit

$$Net\ benefit = \text{Before modification} - \text{After modification}$$

$$= \text{Rs.} 5{,}98{,}000 - \text{Rs.} 2{,}71{,}000$$

$$Net\ benefit = \text{Rs.} 3{,}27{,}000\ /-$$

7.12 Tangible benefits:

By implementing the Quality Circle, the maintenance cost saving is Rs. 3, 27,000/- and the pump is running with sufficient discharge flow and fulfills process requirement.

7.13 The intangible benefits obtained are as follows:

1. Appreciation to the team from management for this modification.
2. Smooth operation of the pump.
3. The urgency of maintaining the pump was reduced.
4. Improvement of self-confidence.

8 CONCLUSION

Quality circle is a participative philosophy around quality control and problem-solving at the grassroots level. The results of the present study support the value of using QC for quality improvement and organizational effectiveness in general. This study explores the importance of company, employee group (circle or non-circle), and time, as well as their interactions. The support of the different levels of management was found to be an important consideration for QC success. The QC members identified the root cause as the high coupling weight using cause-and-effect analysis and Pareto charts. By replacing the coupling with a lightweight flexible one, the maintenance cost was reduced by Rs. 3,27,000, and the pump performance improved significantly.

9 ABBREVIATIONS

QC: Quality Circle

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