# Maintenance Efficiency Optimization through Effective Leadership and Emotional Intelligence

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## ABSTRACT

This study examines the relationship between effective leadership, emotional intelligence (EI), and maintenance efficiency. It investigates the effects of leadership and EI initiatives on maintenance efficiency in three production facilities situated in Nigeria's Niger Delta region. Important metrics such as Mean Time Between Failure (MTBF), Mean Time to Repair (MTTR), Downtime hours (DT), and Failure rate (λ) were employed in this study. Results reveal significant improvements in the employed metrics across all three facilities following the implementation of effective leadership and EI strategies. The case study facilities, EOC, OPP, and KGP experienced average improvement values of -73.25, -89.75, and -75.00 respectively. Despite variations in the level of improvement, the facilities witnessed enhancements in MTTR, MTBF, DT, and λ. The negative average improvement values signify improvements in maintenance efficiency post-implementation. The findings emphasize the positive impact of leadership and EI initiatives on maintenance practices and continuous improvement in organizations. By investing in leadership development and EI training, organizations can improve operational efficiency, optimal reliability, and cost reduction. The integration of these skills has significantly enhanced maintenance efficiency in the facilities studied, highlighting their significance in maintenance-intensive industries.

**Keywords:** Emotional intelligence, Effective leadership, Baseline data, Post-intervention data, Maintenance efficiency, Performance improvement.

## INTRODUCTION

Organizations in all sectors of the economy are constantly looking for ways to increase productivity and improve operational efficiency in today's fast-paced, highly competitive business environment. Leadership is one of the most important tools for gaining a competitive edge, which increases worker productivity. A competent leader inspires followers, guaranteeing their self-assurance and productivity [1]. In the maintenance management field where asset availability and reliability are crucial, the need for effective leadership and EI has become apparent in determining success. The efficient operation of vital assets, the reduction of downtime, and the management of operating expenses are all greatly dependent on maintenance activities, nevertheless, conventional methods of maintenance management frequently ignore the significance of human elements like EI and effective leadership in favor of concentrating only on technical elements. Aware of this gap, progressive companies have started including EI training and leadership development in their maintenance plans to spur ongoing progress and unleash latent potential. Effective leadership entails using the proper combination of management, entrepreneurial, and leadership abilities at

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the appropriate moment and location to accomplish organizational goals [2]. Understanding a leader's cognitive complexity and relational ways to inspire their followership to develop leadership competencies are part of the continuous process of leadership maintenance [3], to be an effective maintenance leader, one must empower teams, provide clear expectations and goals, cultivate an environment of responsibility and ongoing learning, and encourage departmental cooperation.

High EI is a prerequisite for creating the right atmosphere for negotiating difficult maintenance challenges and achieving positive outcomes, leaders with high EI demonstrate self-awareness; empathy, effective communication, and interpersonal relationship management skills. Organizations may foster a work atmosphere that encourages creativity, cooperation, and high performance by coordinating leadership practices and EI competencies with maintenance objectives. These enhancements may improve overall organizational effectiveness, job satisfaction, and employee engagement. Although leadership and EI are increasingly recognized as important in maintenance management, empirical studies on the effects of EI and its sub-dimensions (emotional recognition, emotional facilitation, and emotional regulation) on efficiency optimization are lacking. However, it is well-established that EI has a positive impact on creativity, performance, and the development of leadership potential [4].

There are several works on EI and effective leadership implementation in organizations and systems but only cognitive and logical skills have historically been linked to intelligence, in their remerges, [5], [6], [7], [8], [9], and [10] demonstrated that successful project execution depends on having effective leadership that entails developing a strong team, managing resources, problem-solving, motivating, effective communication, risk assessment, delegating, flexibility, and conflict resolution in addition to having a clear vision. Teamwork is synchronized and the major goals are kept in mind when there is a clear vision. Teams that are driven by effective leadership are more likely to go above and beyond, which produces better results and expedites the completion of projects. By ensuring that everyone in the team is on the same page, effective communication helps to avoid misunderstandings and confrontations. Competent decision-making, effective resource management, and team building are attributes of leaders. They provide plans for risk mitigation and early risk identification, ensuring that the project moves forward despite uncertainty.

Similarly, [11], [12], [13], [14], [15], and [16] showed how EI implementation increased efficiency in various departments of an organization through self-awareness, empathy, self-regulation, motivation, social skills, expressiveness, and perceptiveness. Recognizing one's moods, feelings, and emotions as well as how these affect other people is a necessary component of self-awareness. Understanding other people's feelings entails empathy, which is essential for productive relationships in a variety of spheres of life. EI requires self-regulation since it enables people to consider their actions before acting on their emotions. Another essential component of emotional intelligence is motivation; since emotionally intelligent people are driven to control their emotions and behaviors to succeed over the long run.

This study aims to examine how EI and effective leadership influence maintenance effectiveness by assessing their impact on some key performance indicators (KPIs) that are associated with maintenance efficiency. It will specifically look at how these factors affect maintenance effectiveness in three industrial facilities: Ebocha Oil Centre (EOC), Kwale Gas Plant (KGP), and Okpai Power Plant (OPP), these facilities are situated in Nigeria's Niger Delta. Finding best practices for combining EI and effective leadership to improve maintenance performance, assessing the impact of emotional intelligence on teamwork and collaboration in maintenance departments, examining the relationship between leadership styles, maintenance efficiency, and examining the role of motivation, empowerment, and communication in fostering maintenance excellence are the key study objectives. The study provides recommendations to companies regarding the optimal ways to leverage leadership efforts and EI to optimize maintenance operations and reduce costs.

Many authors have carried out related research, however, none of this research has been extended to the

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present case study facilities.

## METHODS AND MATERIALS

The study looked at maintenance effectiveness in different situations. It examines the functionality of efficient leadership within maintenance teams or departments and how maintenance efficiency is driven by the integration of leadership and EI. It further identified important metrics such as MTBF, MTTR, Downtime hours, Failure rate, and factors that support efficient maintenance procedures. Three major corporations (Southwest Airlines, Toyota, and General Electric) were identified as having improved their maintenance process and overall organizational efficiency by implementing effective leadership and EI. Baseline and Post-intervention data were collected from the case study facilities, average improvement calculations were carried out on the metric data obtained, and analysis was instituted on the outcomes of the calculations to ascertain if the implementation of effective leadership and EI optimized maintenance efficiency in these facilities.

### A. Maintenance Efficiency

The effectiveness of maintenance operations in reaching intended results and making the best use of available resources is known as maintenance efficiency. It entails extending the life of equipment, decreasing operational disturbances, minimizing downtime, and improving reliability and performance. Preventive maintenance, routine inspections, prompt problem resolution, and resource management are all components of efficient maintenance procedures. By taking a proactive stance, costly malfunctions are avoided, equipment reliability is increased, and operational uptime is optimized. Schedule coordination is how integrated production and maintenance planning maximizes productivity and efficiency, planning can increase productivity, lower expenses, and improve operational efficiency, however, maintenance operations can be adversely affected by human error, leading to a decrease in performance [17]. To maximize asset utilization, reduce downtime, and optimize operations, it is imperative to comprehend maintenance efficiency in various industries. There has been great emphasis on the importance of metrics and variables influencing maintenance process efficiency in the contexts of manufacturing, software development, and transportation.

**1) Manufacturing:** For production to run smoothly, maintenance efficiency in manufacturing is essential. Total Equipment Effectiveness (OEE), MTBF, and MTTR are important indicators that support this efficiency. With fewer breakdowns and quicker repair times, higher MTBF and lower MTTR values signify improved maintenance efficiency. Predictive maintenance methods such as predictive analytics and condition monitoring minimize downtime by scheduling work according to the actual state of the equipment, thereby helping to identify possible breakdowns. The time needed for equipment repairs is decreased when spare parts are managed effectively, guaranteeing the timely availability of essential components. Maintenance efficiency is further enhanced by just-in-time inventory methods, vendor management, and smart spare part stocking, which reduce inventory costs and downtime.

**2) Transportation:** In the transportation sector, maintenance efficiency plays a crucial role in guaranteeing the availability, safety, and reliability of infrastructure, aircraft, and cars. Fleet availability, adherence to scheduled maintenance, safety, regulatory compliance, and technological integration are important criteria that influence efficiency. The percentage of cars or airplanes that are always in service is known as fleet availability. To maximize fleet availability, efficient scheduling, proactive inspection, and fast maintenance response times are crucial. Adherence to planned maintenance tasks averts unforeseen malfunctions and guarantees adherence to regulations. Risks are reduced and regulatory compliance is guaranteed by routine inspections, maintenance records trending, and adherence to safety requirements. By offering real-time insights into equipment health and optimizing maintenance schedules, technology integration—such as fleet

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management systems and predictive maintenance software—improves productivity.

**3) Software development:** In software development, maintenance efficiency refers to the management and updating of software systems to satisfy user requirements with the least amount of interruption and technical debt. MTTR, user input and collaboration, technical debt management, and change management procedures are important measures that affect maintenance efficiency. Software bug repair times are measured by MTTR, and efficient bug resolution procedures reduce user impact and downtime. Version control, release management, and automation deployment are a few examples of change management procedures that provide controlled and methodical changes, reducing interruptions and risks. Collaboration and input from users are crucial for ongoing development and meeting user needs. It is essential to proactively manage technical debt, such as code complexity and architectural flaws, to preserve software quality and lower maintenance costs. Frequent debt tracking, prioritization, and code reworking reduce the amount of technical debt that accumulates and guarantee long-term maintainability.

Industries differ in their approaches to maintenance efficiency, but they all aim to maximize productivity, reduce downtime, and guarantee reliability. In the settings of manufacturing, transportation, and software development, key measures like OEE, MTBF, MTTR, fleet availability, and scheduled maintenance compliance assist organizations in evaluating and enhancing maintenance efficiency. To maintain operations and satisfy customer expectations, proactive planning, technological integration, teamwork, and effective leadership are essential components of effective maintenance methods.

### B. Role of Emotional Intelligence in Driving Efficiency in Maintenance.

Emotional Intelligence plays a significant role in the effectiveness of maintenance professionals, impacting their ability to communicate effectively, solve problems efficiently, and make sound decisions within maintenance teams. EI skills such as self-awareness, empathy, and relationship management contribute to better performance in maintenance roles.

When it comes to taking on activities that are in line with their skill set and seeking support or training when necessary, maintenance professionals who possess high levels of self-awareness are better able to handle stress and emotions. They can also show empathy, which promotes improved cooperation and communication amongst maintenance teams by comprehending the viewpoints and worries of clients, supervisors, and co-workers. When faced with difficult work or obstacles, team members of sympathetic maintenance professionals receive support and motivation from their peers. This enhances morale and creates a positive team environment. Their proficiency in establishing rapport and trust with peers and stakeholders enables them to solve problems and make decisions more effectively. When maintenance professionals possess good relationship management abilities, they can effectively negotiate problems, facilitate compromise, and identify mutually beneficial solutions. Conflict resolution is a crucial aspect of maintenance teamwork. High EI maintenance professionals communicate effectively and sympathetically, ensuring that messages are understood and interpreted favourably by others.

Effective communication is essential in maintenance professionals, maintenance professionals can comprehend others' concerns, pinpoint underlying problems, and work together to find solutions when they actively listen, which is a crucial part of communicating effectively. EI has a substantial impact on how effective maintenance personnel are, when maintenance demands change, people with high EI can adapt and deal with uncertainty by changing their plans and priorities accordingly. Enhancing EI in maintenance personnel can result in higher job satisfaction, lower employee attrition, and better team performance.

### C. Role of Effective Leadership in Driving Efficiency in Maintenance

To guarantee peak performance, reduce downtime, and maximize asset utilization, maintenance teams' or

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departments' leadership must play a key role in fostering efficiency. Maintenance leaders have a significant influence on the culture, procedures, and output of their teams through a variety of strategies, such as resource allocation, motivation, communication, and strategic decision-making. By establishing clear expectations, beliefs, and standards, maintenance leaders play a critical role in forming the culture of their teams; they put efficiency, quality, and safety first, promote proactive problem-solving, and put best practices into action; they efficiently allocate resources, prioritize tasks, and find inefficiencies using data-driven insights; they promote collaboration, guidance, support, and feedback to boost performance; they also recognize and celebrate accomplishments. Lastly, they encourage accountability and ownership, which inspires teams to continuously do excellent work.

Team dynamics and productivity can be impacted by a variety of leadership philosophies. Transformational leaders cultivate a common goal, offer guidance, and stimulate creativity to enthuse and energize their groups. Servant leaders prioritize the needs of their team members and provide support for their growth and well-being, whereas transactional leaders concentrate on setting clear expectations, incentives, and consequences for performance. Efficiency in maintenance teams or departments can only be achieved through effective leadership, which improves performance, procedure optimization, and team culture.

### D. Integration of Leadership and Emotional Intelligence in Driving Efficiency in Maintenance.

To drive maintenance optimization and improve overall efficiency within maintenance teams, EI and effective leadership must be integrated. Through the process of self-evaluation, empathy cultivation, relationship management skill building, collaboration and teamwork promotion, and continuous improvement driving, maintenance leaders can improve their effectiveness as leaders and help make maintenance optimization efforts successful overall. Leadership development programs that include EI training workshops or coaching can assist leaders in understanding their emotional patterns and leadership behaviors. Leaders can also improve their self-awareness by participating in self-reflection exercises, personality assessments, or 360-degree feedback. Understanding the needs, worries, and viewpoints of the maintenance team requires empathy, and leaders who exhibit empathy foster a positive work atmosphere where team members feel appreciated, understood, and inspired. Building trust, encouraging collaboration, and resolving problems within maintenance teams all depend on effective relationship management. Relationship-savvy leaders build trusting relationships with their team members, encourage candid dialogue, and foster an environment of respect and cooperation.

Through the use of team-building activities, conflict-resolution approaches, and effective communication strategies, EI treatments can assist leaders in improving their relationship management abilities. Encouraging cooperation and teamwork is essential in optimizing productivity. Effective leaders create opportunities for communication, cooperation across functional lines, and collective problem-solving, leading to innovative solutions and continuous advancement. Leading continuous improvement is yet another essential responsibility of team leaders in maintenance, through the promotion of a growth mindset, acceptance of feedback, and encouragement of experimentation, leaders foster an atmosphere in which team members are enabled to recognize chances for innovation and optimization. By encouraging risk-taking and learning from mistakes, offering constructive criticism, and recognizing and celebrating accomplishments, EI interventions can foster a culture of continuous improvement. To promote overall efficiency within maintenance teams and drive maintenance optimization, leadership and EI must be integrated.

### E. Organisations that have Effectively Improved Maintenance through Initiatives in EI and Effective Leadership.

**1) Southwest Airlines (SWA):** A capable leader develops credibility over time as evidenced by the late Herb David Kelleher, the former CEO of SWA who was able to win over the respect and compassion of his team. This helped the company come together as a family, and they now actively listen to employees who

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are having personal issues and offer practical support [I8]. Though not always necessary, charisma is another admirable quality these executives at SWA have created, this attribute exemplifies the elegance of their leadership. SWA adopted a point-to-point strategy, assigning one supervisor for every ten to twelve frontline employees, this method enables supervisors to possess significant credibility and impact by engaging in the same duties as employees while acting as "player coaches" with managerial duties. This strategy has enabled SWA to excel in coaching and guiding by effectively addressing day-to-day concerns. Front-line staff is empowered to make operational decisions under Southwest's corporate philosophy, which promotes decision-making within the organization. SWA also gives its workers the avenue to succeed and the assistance they need [19]. The late Colleen Barrett, a former executive vice president for customers, emphasized that working for SWA is more than just a job; it's a chance for people to be genuine, Barrett thinks that warmer hospitality and better service result from believing in people until they prove they shouldn't be trusted. Even Kelleher's well-known parties inspire success in their staff members because they feel their efforts improve public hospitality and service.

**2) General Electric (GE):** Through the promotion of emotional intelligence, Peter Drucker's management and leadership philosophy had a significant impact on GE's evolution. He urged leaders to control their own emotions while directing that of others. Welch provided a clear and confident example of this by capitalizing on his strengths and making up for his shortcomings. Eventually, these characteristics served as the cornerstone for the first of Goleman's five emotional intelligence competencies [20]. Under Jack Welch's leadership, GE radically reorganized the company between 1981 and 2001, providing each division a new organizational structure, diversifying policies, and motivating the workforce. Welch's encouragement of others, his setting of expectations, and his attention to all levels of management further characterize his "Pacesetting" and "Coaching" leadership styles, as defined by Goleman's Six Leadership Styles. He also subscribes to Theories X and Y, contending that employees ought to be motivated, they should also take responsibility for their actions, and apply ingenuity to solve problems. Welch once said, "If you can't eat short-term, you can't grow long-term." GE's success results from both the value it provides to its stakeholders and the empire it has amassed over the years. Welch's management approach has enabled GE to continue being a corporation for the people, drawing revenue from many industries and holding its own against formidable Asian and American rivals. Welch led GE to extraordinary success, which speaks for itself. The key to GE's success is nurturing leaders—not squashing them, but helping them grow, coaching, and providing feedback. When Welch retired in 2000, he had six or eight well-trained candidates who were ready to take over as GE's next CEO. He had a long and lasting legacy at GE. GE's financial success story since Welch became CEO has despite criticism, ultimately demonstrated that he made the right decisions at the right time, GE reported an astounding $8.20 billion in net income on $90.8 billion in revenues in 1997 [21]. Furthermore, Fortune magazine named GE the "most-admired company in America" after surveying 12,600 executives, business leaders, and industrial analysts about their favorite company, also, Jack Welch was once considered the world's most valuable CEO [22]. These high rankings were primarily attributable to the general appreciation for Jack Welch's leadership, who has revolutionized management while maintaining GE's size, agility, and enormous profitability.

**3) Toyota:** Toyota has effectively implemented a leadership strategy, which has enhanced the efficiency of its production and maintenance procedures. Unlike managers in the West, Toyota Way leaders possess both a deep understanding of the task and the capacity to guide, develop, and coach others [23]. Toyota wants to consistently increase performance, therefore it focuses on bolstering the Toyota Production System, creating and nurturing capable individuals, and embedding the Toyota culture in every employee. Years are spent by Toyota nurturing executives who embody the company's values in all of their words, deeds, and ideas. Known as "servant leadership," this style of leadership involves giving senior leaders less direct control. Toyota looks for leaders who exemplify the following principles: respect, genchi genbutsu, kaizen, challenge, and coordination. Toyota invests a lot of time and energy in properly selecting and training potential hires. Toyota has put in place a variety of training and development initiatives to help employees

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perform well and produce higher-quality goods. These are usually long-term, continuous programs that begin with "fundamental skills" and place participants in teams led by a group leader and a team leader. By breaking the job down into small work components, the Toyota job instruction training approach teaches the job piece by piece. Individual members also receive full-time support until they feel at ease in their roles.

### F. Performance Improvement Concerning Baseline Data, Post-intervention Value, and Associated Metrics.

Performance improvement (PI) is the process of measuring and enhancing a system or process' effectiveness and efficiency by following improvement initiatives. Investing in business analytics can enhance an organization's overall performance, which in turn can ultimately increase the organization's business value [24]. Transitioning from the baseline value (BV) to the post-implementation value (PIV) requires intentional interventions and efforts. BV gives a sense of the present performance level, serves as a benchmark for assessing the results of subsequent interventions, and helps set realistic targets for progress, adjusting the results for indicator category and baseline indicator value may help improve the validity of intervention comparisons in systematic reviews on enhancing performance that include multiple indicators in the same analysis [25]. PIV, on the other hand, gives the performance scenario after interventions, indicating the effectiveness of the changes and computing the value added or gained. This contributes to determining whether desired outcomes have been achieved and helps assess how successful improvements have been. The following metrics were employed in this study: MTTR, MTBF, Downtime hours, and Failure rate. In this study, Average Performance Improvement is denoted as $PI_{ave}$, the sum of Performance Improvement as $PI_{sum,}$ and the number of metrics as N. Also, $m_1$= $MTTR_{piv}$-$MTTR_{bv}$, $m_2$= $MTBF_{piv}$-$MTBF_{bv}$, $m_3$= $DT_{piv}$-$DT_{bv}$ and $m_4$= $\lambda_{piv}$-$\lambda_{bv}$, it follow that,

$$PI_{sum} = m_1 + m_2 + m_3 + m_4 \quad (1)$$

$$PI_{ave} = \frac{P_{sum}}{N} \quad (2)$$

The MTTR is the average amount of time required to fix or restore a piece of equipment to normal operation after a malfunction or failure. This accounts for the time required to locate the problem, replace the problematic parts, make the necessary repairs, and conduct the necessary testing and inspections before resuming operation. The MTTR is a crucial metric that operators and maintenance personnel should monitor to ensure optimal reliability and availability.

The MTBF is the average time interval between two consecutive failures or the expected operating time of an equipment before it breaks down. A higher MTBF suggests that the plant is well-maintained and reliable.

The failure rate of an asset is the frequency with which it performs below expected levels or is not used to its full potential. It is frequently expressed as the number of failures per unit of time or use and is a helpful metric for assessing the reliability and effectiveness of a system. A low failure rate indicates improved quality and reliability, whereas a high failure rate suggests low quality, flaws in the design, or insufficient maintenance.

Downtime hours refers to the period that a machine, system, or service is unavailable or not operating. This downtime may be caused by planned upgrades, technical issues, equipment failure, and maintenance procedures. Measuring and monitoring downtime hours is frequently used to assess system reliability and availability, and identify areas that require improvements.

### G. Implementation of Effective Leadership and EI – Case Study.

The case study investigates the vital roles that EI and effective leadership play in the development of

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organizations. The study looks at a real-world scenario where the use of EI concepts and leadership techniques results in a major transformation of three manufacturing facilities EOC, QPP, and KGP. This case study is a great tool for companies trying to increase the efficacy of their leadership and leverage EI. It provides useful insights and doable solutions that may be tailored to different organizational circumstances by giving a thorough explanation of the implementation process and its results.

Table 1 and Table 2 present the baseline and post-intervention data obtained from the various facility databases in the year 2022, Table 3 shows the average performance improvement calculated from Equation 1 and Equation 2. It also summarized the calculations for each facility, including improvements in MTTR, MTBF, Downtime, Failure rate, Improvement sum, and Average improvement. Negative values indicate improvements in the respective metrics.

## RESULTS AND DISCUSSION

TABLE I BASELINE VALUE (BEFORE IMPLEMENTATION)

| KP1 | Metrics yearly average | | |
|---|---|---|---|
| | EOC | OPP | KGP |
| MTTR (hours) | 18 | 17 | 21 |
| MTBF (hours) | 177 | 137 | 193 |
| Downtime (hours) | 800 | 950 | 850 |
| Failure rate per year | 0.0056 | 0.0071 | 0.0052 |

TABLE II POST-IMPLEMENTATION VALUE (AFTER IMPLEMENTATION)

| KP1 | Metrics yearly average | | |
|---|---|---|---|
| | EOC | OPP | KGP |
| MTTR (hours) | 14 | 11 | 14 |
| MTBF (hours) | 288 | 164 | 223 |
| Downtime (hours) | 400 | 570 | 520 |
| Failure rate per year | 0.0035 | 0.0061 | 0/0045 |

TABLE III SUMMARY OF AVERAGE IMPROVEMENT CALCULATION

| Facility | MTTR (hours) $MTTR_{piv} - MTTR_{bv}$ | MTBF (hours) $MTBF_{piv} - MTBF_{bv}$ | Downtime (hours) $DT_{piv} - DT_{bv}$ | Failure rate $\lambda_{piv}$-$\lambda_{bv}$ | Improvement sum $m_1 + m_2 + m_3 + m_4$ | Average improvement $\frac{P_{sum}}{N}$ |
|---|---|---|---|---|---|---|
| EOC | -4 | 111 | -400 | -0.0021 | -293 | -73.25 |
| OPP | -6 | 27 | -380 | -0.0010 | -359 | -89.75 |
| KGP | -7 | 30 | -330 | -0.0007 | -300 | -75.00 |

After implementing effective leadership and EI initiatives, each facility showed clear improvements in performance across all KPIs. As a result, maintenance efficiency was significantly enhanced.

The study outcomes showed that EOC experienced improvements in all metrics after implementing effective

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leadership and EI. Reductions in MTTR (from 18 to 14) and downtime (from 800 to 400) were the most significant improvements. Additionally, a notable increase in MTBF (from 177 to 288) indicated longer intervals between failures. This suggests that the implementation led to more efficient maintenance practices and reduced downtime, ultimately enhancing overall operational performance. EOC demonstrated an average improvement of -73.25 in the various metrics, signifying a notable reliability and maintenance efficiency increase. This progress aligns with the favorable shift noted in MTTR, MTBF, downtime, and failure rate per year for EOC.

Similar to EOC, OPP also experienced improvements across all metrics after the implementation. The most significant improvements were observed in MTTR (from 17 to 11) and downtime (from 950 to 570). While the increase in MTBF (from 137 to 164) was not as substantial as in EOC, it still indicates a positive impact on system reliability. The decrease in failure rate (from 0.0071 to 0.0061) further emphasizes the effectiveness of the implemented strategies in reducing maintenance-related issues. OPP witnessed the highest average improvement of -89.75, reflecting substantial enhancements in maintenance-related metrics post-implementation. This improvement aligns with the positive changes observed in MTTR, MTBF, downtime, and failure rate per year for OPP.

KGP also witnessed improvements in all post-implementation metrics. The most significant improvements were in MTTR (from 21 to 14) and downtime (from 850 to 520). While the increase in MTBF (from 193 to 223) was moderate, it still indicates enhanced system reliability. Moreover, the decrease in failure rate per year (from 0.0052 to 0.0045) highlights the effectiveness of the implemented strategies in reducing the frequency of failures. KGP experienced an average improvement of -75.00, indicating notable enhancements in maintenance efficiency and reliability following the implementation. This improvement corresponds with the positive changes observed in MTTR, MTBF, downtime, and failure rate per year for KGP.

## CONCLUSIONS

By using empirical operational data from three production facilities; KGP, OPP, and EOC, this study demonstrated how EI and effective leadership maximized maintenance efficiency in these facilities. The study's findings indicated that KGP had a -75.00 improvement value, OPP had a -89.75 value, and EOC had a -73.25 value, after implementing performance improvement interventions. The maintenance-related metrics for all three facilities showed reasonable improvements as demonstrated by the negative average improvement values. The three facilities saw considerable annual improvements in MTTR, MTBF, Downtime, and Failure rate, although the average improvement varied slightly across them. These enhancements demonstrate how successful it is to apply EI and effective leadership techniques to optimize maintenance efficiency and promote an improvement-oriented culture within an organization. The findings imply that firms in maintenance-intensive industries can have observable improvements in terms of operational efficiency, reliability, and cost savings by investing in EI training and leadership developments. The analysis shows that the application of effective leadership and EI resulted in significant increases in maintenance efficiency across the three facilities.

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