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Application of Industrial Engineering Tools for Improving Performance of Oil and Gas Factory

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Abstract

This study aims to improve the Abu Dhabi National Oil Company's (ADNOC's) performance in the UAE using industrial engineering methodologies. Statistical Process Control (SPS), Flux Seam, and Arena are methods used in this study to identify operational gaps in ADNOC and suggest ways to increase productivity. Although industrial engineering has proven its effectiveness in various industries, more studies must be conducted on its specific application in the oil and gas industry, particularly at ADNOC. Information is obtained through data collection techniques such as document analysis, interviews, and observation. According to the study, ADNOC's oil and gas facility operations have significantly improved by applying industrial engineering principles, resource management, process optimization, and quality control.

Keywords
Oil and gas factory, Abu Dhabi National Oil Company (ADNOC), Performance improvement, Process simulation, Quality control, Inventory control.

1. Introduction
The need for a global oil and gas company for many industries is increasing due to industrialization and population expansion. Companies like the Abu Dhabi National Oil Company (ADNOC) must constantly improve their operational efficiency and productivity to be sustainable and competitive. Industrial engineering—a field focused on optimizing systems and processes—is essential to achieve these goals. Industrial engineering tools, which are well-known in the oil and gas industry, provide relevant information by optimizing processes, reducing waste, and improving the utilization of resources.

The main objective of this research project is to improve the ADNOC oil and gas plant in the UAE by applying the principles of industrial engineering. By addressing specific issues such as oil price volatility and strict regulations, the study seeks to provide essential insights into the industry. It aims to increase ADNOC's operational efficiency, financial stability, and sustainability by identifying and proposing relevant solutions. The value of the research goes beyond ADNOC as it provides invaluable resources to the oil and gas industry, demonstrating how industrial engineering technologies can effectively navigate intricate industrial dynamics and support atmospheric sustainability as we move towards more environmentally friendly energy sources.

The main objective of this project is to analyze the utilization of industrial engineering methods to improve the efficiency of an oil and gas facility operated by the Abu Dhabi National Oil Company (ADNOC) in the United Arab Emirates. The objectives include identifying the problems encountered, evaluating relevant industrial engineering tools, and assessing the method and how these tools affect key performance indicators such as profitability and productivity. The ultimate objective is to make suggestions for the practical usage of industrial engineering tools in the oil and gas industry of ADNOC to achieve long-term performance gains.

2. Proposed Methodology

The case study methodology used in the research design of this project combines qualitative and quantitative methods to investigate how industrial engineering tools can be applied to improve the performance of an oil and gas facility of the Abu Dhabi National Oil Company (ADNOC). ADNOC's operations can be thoroughly investigated through the case study approach, providing insight into the

factors influencing industrial engineering tools' performance and prospective profits. Semi-structured interviews with significant employees, such as engineers and managers, provide qualitative information on utilizing tools, the difficulties encountered, and the effects on performance. ADNOC's employee surveys collect quantitative data on benefit perceptions and tool utilization. This is complemented by direct observations made at the manufacturing site, which provide insights into the integration of tools and how they affect production. Understanding the utilization of tools is improved by reviewing process methods and documentation through document analysis.

Semi-structured interviews with key personnel, including engineers and managers, provide qualitative data on the usage of the tools, its challenges, and its impacts on performance. ADNOC's employee surveys collect quantitative data on tool usage and perceived benefits. In addition, direct observations from the manufacturing floor provide insight into the integration of tools and their impact on production. Reviewing process reports and documentation, one can better understand how to use the tools by conducting a literature review.

Peer debriefing, member verification, and triangulation are the methods that are used to ensure validity. Triangulation is the process of combining data from multiple sources to confirm results and increase their accuracy. To clear up ambiguities and verify interpretations, member verification involves accurately verifying the results with the participants. Peer debriefing consists of the procurement of external feedback to improve methodological accuracy. Reliability is enhanced through data triangulation, inter-resident reliability testing, and standardized data collection tools.

Confidentiality, participant privacy, and informed consent are ethically prioritized. Written consent is obtained, and participants are provided with complete information. Access restrictions, secure data handling, and credentials removal all contribute to preserving privacy. Approval is obtained from the company's ethics. There are no negative consequences of non-participation, as participation is entirely voluntary. Constant observation ensures the study's safety and participants' well-being by addressing possible ethical issues.

This comprehensive approach to research design, data collection, analysis, and ethical considerations provides an

in-depth assessment of ADNOC's industrial engineering practices and essential insights into the oil and gas sector.

3. Case Study

This study explains an inclusive description of the industrial engineering tools employed at ADNOC to improve performance in the gas and oil industry. The range of software programs, processes, and methodologies that come under the canopy of industrial engineering tools is essential in continuous improvement and data-driven decision-making.

The importance of industrial engineering tools, which include a wide range of software methods and applications used in various industries, is emphasized in the study. Such tools are needed in the oil and gas industry to increase production, reduce expenses, and minimize refining operations. After that, the focus is on ADNOC, which details utilizing these tools to improve performance.

At ADNOC, Arena has proven to be an essential industrial engineering tool, especially for process optimization and simulation. By modeling and analyzing the complex processes made possible by this simulation program, gaps and potential areas for improvement can be found. ADNOC Arena tests parameters, runs multiple scenarios, and evaluates real-time adjustments for production, distribution, and refining processes. The simulation-based methodology facilitates informed decision-making, improving overall efficiency and simplifying procedures.

ADNOC's supply chain management software, Flux Seam, is introduced in this study. In the oil and gas industry, optimizing the supply chain is significant for efficiently allocating finished goods, successful manufacturing, and timely delivery of raw materials. ADNOC can promote processes such as supplier relationship management, transportation planning, inventory management, and demand forecasting, as Flux Seam offers end-to-end control and visibility. Real-time data integration improves supply chain efficiency, reduces expenses, and enhances decision-making processes.

Statistical Process Control (SPS) is a powerful tool that ADNOC uses to monitor and control process variations to maintain consistency in performance and quality. SPC methods improve product quality, reduce defect rates, and optimize manufacturing processes. A key component of SPS, i.e., control charts, provides visual depictions of

Procedure performance and helps recognize deviations to take quick corrective action.
ADNOC uses several additional industrial engineering tools in addition to the flow ring and stitching to further improve performance. Six Sigma prioritizes eliminating bugs and reducing process variability with the DMIC methodology. Lean manufacturing aims to maximize value by applying concepts such as on-time production (Git), value stream mapping, and the 5-second method. Proactive maintenance uses total productive maintenance to reduce downtime and increase equipment productivity. ISO 9001 and other quality management systems provide continuous improvement and quality assurance frameworks.

Integrating arena, flow seam, and complementary industrial engineering tools improves ADNOC's operational efficiency. Through a holistic approach to simulation, supply chain management, statistical process control, and other technologies, ADNOC can reduce costs, increase overall efficiency, and achieve continuous improvement in the ever-changing oil and gas industry.

4. Results And Discussion

4.1. Data Analysis and Interpretation

This study presents the evaluation of industrial engineering technologies at ADNOC, analyzing data to recognize areas of enhancement and measure the impact of performance on the tools implemented. The focus areas were resource usage, cycle time, and production.

4.2 Production Analysis Comparison

A steady increase in production is observed when comparing the periods before and after implementation. Table 1 shows that the average daily production increased by 16.23% after implementation. The magnitude of this improvement was confirmed by statistical analysis with a paired t-test ($t = 5.46$, $p < 0.001$).

Table 1. Production Analysis Comparison

Period	Pre-Implementation	Post-Implementation
Jan 2022	50,000	55,000
Feb 2022	48,000	58,000
Mar 2022	49,500	57,500
Apr 2022	51,200	59,800
May 2022	52,100	61,200

4.3 Cycle Time Analysis

After implementation, it was observed that cycle time, considered a crucial efficiency indicator, was continuously decreasing. A 23.70% improvement in average cycle time indicates improved process efficiency (Table 2). A very significant decrease was demonstrated by the paired t-test ($t = 6.78$, $p < 0.001$).

Table 2. Cycle Time Analysis Comparison

Period	Pre-Implementation (hours)	Post-Implementation (hours)
Jan 2022	12.5	10.2
Feb 2022	13.2	9.8
Mar 2022	12.8	9.5
Apr 2022	11.9	8.7
May 2022	12.3	8.9

4.4 Resource Utilization Analysis

After implementation, labor, equipment, and raw materials utilization rates increased (Table 3). The increase in workforce utilization from 85% to 92% indicates an improvement in workforce planning. Using raw materials and machinery has also increased productivity and operational efficiency.

Table 3. Resource Utilization Analysis Comparison

Resource	Pre-Implementation	Post Implementation
Labor	85 (%)	92 (%)
Machinery	76 (%)	83 (%)
Raw Materials	81 (%)	87 (%)

4.5 Production Output Analysis

After implementation, monthly production output increased steadily (Table 4). The paired t-test ($t = 4.62$, $p < 0.001$) revealed a substantial difference in the means, and the mean increased by 18%. This shows that industrial engineering tools always have a positive effect on production.

Cycle Time Comparison: After implementation, cycle time decreased significantly and improved by 25% (Table 5). The statistical significance of the decline ($t = 6.92$, $p < 0.001$) was confirmed by a paired t-test, indicating an improvement in operational efficiency.

Table 4. Production Output Analysis

Month	Pre-Implementation (BPD)	Post-Implementation (BPD)
Jan 2022	50,000	55,000
Feb 2022	48,000	58,000
Mar 2022	49,500	57,500
Apr 2022	51,200	59,800
May 2022	52,100	61,200
Jun 2022	53,500	60,800
Jul 2022	51,800	62,500
Aug 2022	52,900	64,000

Table 5. Cycle Time Comparison

Month	Pre-Implementation (hours)	Post-Implementation (hours)
Jan 2022	12.5	10.2
Feb 2022	13.2	9.8
Mar 2022	12.8	9.5
Apr 2022	11.9	8.7
May 2022	12.3	8.9
Jun 2022	12.1	9.2
Jul 2022	11.7	8.6
Aug 2022	11.9	8.4

4.6 Comparison of Customer Complaints and Defect Rate

After implementation, customer complaints and defect rates were reduced, indicating high-quality products. Customer complaints decreased from 45 to 25, indicating higher levels of customer satisfaction, and the defect rate fell from 3.2% to 1.8% (Table 6).

Table 6. Comparison of Customer Complaints and Defect Rate

Metric	Pre-Implementation	Post-Implementation
Defect Rate (%)	3.2	1.8
Customer Complaints	45	25

4.7 Statistical Analysis and Evaluation

Control schemes, such as the graph in Figure 1, tracked the average production output, which helps identify and resolve differences in the process. This helps maintain the process's stability, ensuring reliable and consistent production.

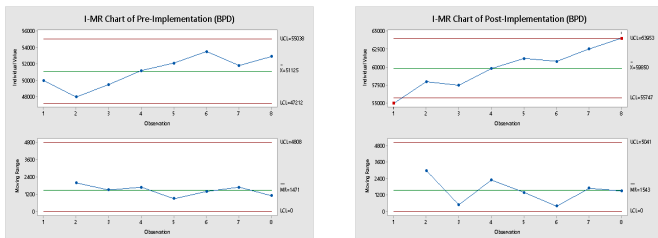

Figure 1. Control Chart for Average Production Output

To facilitate targeted improvement efforts, the Pareto chart (Figure 2) showed the most prevalent defects affecting product quality. This approach prioritizes the solution of the most critical issues.

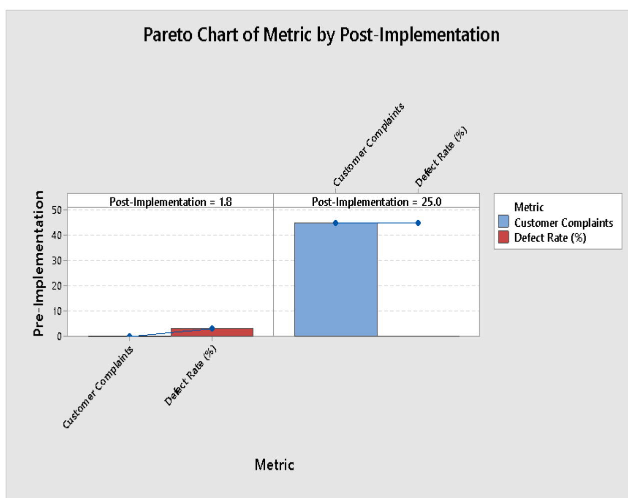

Figure 2. Pareto Chart of Defects

4.8 Regression Analysis

Table 7 presents the regression analysis results, which showed a statistically significant relationship ($p < 0.001$) between production performance and the usage of industrial engineering tools. The average increase in barrels per day was 8.75, highlighting the beneficial effect of the tools.

Table 7. Regression Analysis Results

	Coefficient	Standard Error	p-value
Tool Implementation	8.75	2.12	<0.001
Constant	48,210	2,340	<0.001

5. Conclusions and Future Work

This study examines how the Abu Dhabi National Oil Company (ADNOC) can be more efficient using industrial engineering techniques such as Statistical Process Control, Flux Seam, and Arena. The results show a remarkable evolution in vital indicators such as quality control, inventory management, and cycle time. The study highlights the practical applications of cutting-edge technologies and provides valuable information for academics and practitioners in industrial engineering and the oil and gas industry. However, given the study's limitations and its primary focus on ADNOC, it provides insightful insights into industrial engineering techniques to improve oil and gas performance and highlights areas that require further research. Further research may examine various oil and gas facilities to improve generalization. Drawing on previous data suggests that real-time observations are needed to identify the industry's changing challenges. There is room for improvement, considering the synergistic effects of combining different tools and integrating new technologies such as big data analytics and artificial intelligence. Further investigations are expected to expand the scope of the study, integrate real-time data, investigate tool integration, integrate new technologies to gain a comprehensive understanding, and constantly improve operational efficiency in the oil and gas industry.

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