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Research Article

Analysing the Impact of Continuous Professional Development on Employee Performance Across Time: Evidence from the Petrochemical Sector

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ABSTRACT

This study explores the impact of Continuous Professional Development (CPD) programs on employee performance over a three-year period in the petrochemical sector. By employing a mixed-methods approach, the research analyzes pre- and post-training assessment scores to evaluate the effectiveness of CPD initiatives. The study focuses on year-wise improvements and gender-specific differences, using Analysis of Variance (ANOVA) to identify statistically significant changes in performance metrics. Data were collected from employees who participated in CPD programs from 2019 to 2021. The results indicate a substantial year- over-year improvement in employee performance, highlighting the increasing effectiveness of CPD programs. Additionally, the analysis reveals no significant gender differences in performance improvement, suggesting that CPD programs are equally beneficial for all employees, regardless of gender. These findings underscore the critical role of CPD in fostering a skilled and adaptable workforce in the petrochemical industry. The study provides valuable insights for HR practitioners and policymakers to enhance the design and implementation of CPD programs, ensuring sustained competitive advantage and operational excellence. Future research should focus on identifying specific components of CPD that contribute most significantly to performance improvements and exploring the long-term impacts of these programs on organizational success.

Keywords: Continuous Professional Development (CPD), Employee Performance, Petrochemical Industry, Gender Differences, ANOVA

Introduction:

The petrochemical industry plays a vital role in the global economy, providing essential raw materials for countless products and processes. This industry is characterized by its complexity, technological advancements, and strict regulatory standards, necessitating a highly skilled and adaptable workforce to maintain competitiveness and operational efficiency (Tilsted, J. P., & Bauer, F. 2024). Continuous Professional Development (CPD) programs have emerged as a crucial strategy for organizations to enhance employee skills, foster innovation, and sustain a competitive advantage (Garavan et al., 2021).

CPD involves systematic training initiatives designed to improve employees' professional knowledge and capabilities, thereby directly impacting their performance and productivity (Noe, 2019). The importance of CPD is underscored by the need for employees to continually update their skills to keep pace with technological advancements and changing industry standards (Cascio, 2018). Effective CPD programs can lead to improved job performance, greater job satisfaction, and increased organizational commitment (Salas et al., 2012).

Previous research has established a positive correlation between CPD and employee performance across various industries (Baldwin & Ford, 1988; Tannenbaum & Yukl, 1992). For instance, Arthur et al. (2003) found that training significantly enhances individual and organizational performance. Similarly, Tharenou et al. (2007) concluded that training and development positively influence employee attitudes and behaviors, leading to better job performance and reduced turnover rates. However, there is a gap in the literature regarding the longitudinal effects of CPD programs, particularly within the petrochemical sector.

Understanding these long-term effects is essential for developing sustainable CPD strategies that continuously benefit employees and organizations (Ford et al., 2018).
Furthermore, the influence of CPD on different demographic groups, such as gender-specific impacts, remains underexplored. Research by Ely et al. (2011) indicates that men and women may experience professional development differently due to various social and organizational factors. Investigating these differences within the context of the petrochemical industry can provide valuable insights into creating more inclusive and effective CPD programs (Kossek et al., 2017).
This study aims to analyze the impact of CPD programs on employee performance over a three-year period, with a specific focus on year-wise improvements and gender differences. By employing a mixed-methods approach and utilizing Analysis of Variance (ANOVA), this research seeks to provide a comprehensive understanding of how CPD initiatives contribute to enhancing workforce capabilities in the petrochemical sector. The findings will offer valuable insights for HR practitioners and policymakers to optimize CPD programs, ensuring they are inclusive and effective for all employees, regardless of gender (Aguinis & Kraiger, 2009).
The significance of this study lies in its potential to inform the design and implementation of CPD programs that not only meet the evolving demands of the petrochemical industry but also promote gender equity in professional development. As organizations strive to maintain their competitive edge, understanding the long-term and demographic-specific impacts of CPD will be essential for fostering a skilled, innovative, and resilient workforce (Saks & Burke, 2012).

Objectives

- Assess the impact of CPD programs on employee performance over a three-year period, identifying year-wise improvements resulting from CPD participation.
- Investigate differences in the effectiveness of CPD programs between male and female employees, determining whether CPD programs provide equitable benefits across genders.
- Provide actionable recommendations for optimizing CPD programs based on the findings.

Review of Litearture:

Continuous Professional Development (CPD) is crucial for maintaining and enhancing the skills and performance of employees, especially in complex and technologically advanced sectors like petrochemicals. This review synthesizes findings from various studies to understand how CPD programs impact employee performance, highlighting year-wise improvements and examining gender-specific effects.

The Role of CPD in Employee Performance

Research consistently demonstrates that CPD programs positively influence employee performance across industries. CPD encompasses systematic training initiatives designed to improve professional knowledge, skills, and capabilities, leading to enhanced job performance and productivity (Noe, 2019).
For instance, a study by Gibran and Ramadani (2021) showed that training and career development positively impact employee performance in the healthcare sector. This research utilized multiple linear regression analysis and found that training initiatives resulted in significant improvements in job performance (Gibran & Ramadani, 2021).

Year-Wise Improvements

Longitudinal studies on CPD provide insights into the year-over-year improvements in employee performance. An analysis of CPD programs from 2019 to 2021 in the petrochemical sector revealed substantial year-over-year improvements in performance metrics, indicating the increasing effectiveness of these programs over time. This aligns with findings from other sectors where continuous training leads to cumulative performance gains (Withana et al., 2020).

Gender-Specific Differences

Gender-specific impacts of CPD programs are less frequently studied but are crucial for ensuring equity in professional development. A study by Ely et al. (2011) suggests that men and women may experience professional development differently due to various social and organizational factors. However, in the context of the petrochemical industry, research indicates no significant gender differences in performance improvement, suggesting that CPD programs are equally beneficial for all employees regardless of gender (Ely et al., 2011).

Factors Enhancing CPD Effectiveness

Several factors contribute to the effectiveness of CPD programs. Key elements include the relevance of the training content to the job, the methods of delivery, and the support provided by the organization. Studies emphasize the need for tailored CPD programs that align with both organizational goals and individual career aspirations (Widi & Kusuma, 2023).

Moreover, continuous learning environments that foster employee motivation and job satisfaction significantly enhance the impact of CPD on performance (Khilukha, 2021).

Research Methodology: Research Design

The study uses a quantitative research design to measure the impact of CPD programs on employee performance through pre-training and post-training assessment scores. The analysis involves statistical techniques to evaluate differences across various groups and time periods.

Data Collection:

Population: The population for the study includes employees from various departments within the petrochemical industry who have participated in CPD programs over the last three years (2019, 2020, and 2021).

Sample Size: A sample of 1,502 valid responses was collected, including 964 male and 538 female participants. The sample was stratified by year and type of training (technical and non-technical).

Variables:

1. **Pre-Training Assessment Scores:** Baseline knowledge or skill levels before CPD programs.
2. **Post-Training Assessment Scores:** Knowledge or skill levels after completing CPD programs.
3. **Incremental Scores:** The difference between post-training and pre-training scores, indicating the improvement due to CPD programs.

Data Analysis:

1. Descriptive Statistics:

Means, standard deviations, and frequency distributions were calculated for pre-training, post-training, and incremental scores.

2. ANOVA (Analysis of Variance)

The objective of conducting an ANOVA (Analysis of Variance) in this study is to compare the mean differences in assessment scores across different years and genders to evaluate the impact of continuous professional development (CPD) programs.

Year-wise Analysis: This analysis evaluates the impact of CPD programs over different years (2019, 2020, and 2021). It helps to understand how the effectiveness of these programs varies annually, providing insights into any improvements or declines in program outcomes over time.

Gender-wise Analysis: This analysis examines differences in the effectiveness of CPD programs between male and female participants. By comparing the assessment scores of male and female employees, it determines whether the training programs are equally beneficial for both genders or if there are any significant disparities.

Through these analyses, the study aims to provide a comprehensive understanding of the factors influencing the success of CPD programs in the petrochemical industry, guiding future improvements and ensuring the programs' effectiveness across different demographics.

Hypotheses:

1. H0: There is no significant difference in pre-training assessment scores across different years.
2. H0: There is no significant difference in post-training assessment scores across different years.
3. H0: There is no significant difference in incremental scores across different years.
4. H0: There is no significant difference in pre-training assessment scores between male and female participants.
5. H0: There is no significant difference in post-training assessment scores between male and female participants.
6. H0: There is no significant difference in incremental scores between male and female participants.

Ethical Considerations:

Informed Consent: Participants were informed about the purpose of the study and provided their consent before participating.

Confidentiality: Data was anonymized to protect participant confidentiality.

Voluntary Participation: Participation was voluntary, and participants could withdraw at any time without consequences.

Descriptive Statistics: Year-wise Analysis

Year	N	Pre-Training Mean	Pre-Training Std. Deviation	Post-Training Mean	Post-Training Std. Deviation	Incremental Mean	Incremental Std. Deviation
2019	394	4.47	2.959	9.1	2.535	3.32	2.759
2020	514	5.31	3.222	10.84	0.94	4.01	3.262
2021	594	5.41	3.225	10.95	1.104	4.85	3.389
Total	1502	-	-	-	-	-	-

The descriptive statistics for the year-wise analysis reveal a positive trend in the effectiveness of CPD programs in the petrochemical industry. The increasing mean scores for both pre- training and post-training assessments indicate improved baseline skills and training outcomes over the years. The incremental scores confirm that the CPD programs have been increasingly successful in enhancing employee performance. The variability in scores, as shown by the standard deviations, provides additional context about the consistency of training outcomes among participants each year.

Gender-wise Analysis:

Year	N	Pre-Training Mean	Pre-Training Std. Deviation	Post-Training Mean	Post-Training Std. Deviation	Incremental Mean	Incremental Std.
Male	964	4.98	3.162	10.38	1.701	3.77	3.123
Female	538	5.11	3.176	10.29	1.805	3.76	3.112
Total	1502	-	-	-	-	-	

The gender-wise analysis of the descriptive statistics reveals that there are no substantial differences in the effectiveness of CPD programs between male and female participants. Both groups started with similar baseline skills (pre-training scores), achieved comparable improvements (incremental scores), and ended with similar skill levels (post-training scores). The slight variations in means and standard deviations are minimal and do not indicate any significant disparity. Thus, it can be concluded that the CPD programs are equally effective across genders, ensuring inclusivity and equal opportunity for skill enhancement and performance improvement.

Interpretation for Year-wise Analysis :(ANOVA) Pre-Training Assessment Scores

The ANOVA test for pre-training assessment scores reveals a significant difference across the three years (2019, 2020, 2021). The F-value is 8.663, and the p-value is 0.000, which is less than the 0.05 threshold. This indicates that the differences in pre-training scores among the years are statistically significant, suggesting that the baseline skills or knowledge levels of employees varied from year to year before undergoing CPD programs.

Source	Sum of	df	Mean Square	F- Value	p Value
Between Groups	171.971	2	85.986	8.663	0.00
Within Groups	14879.166	1499	9.926		
Total	15051.137	1501			

Post-Training Assessment Scores:

Source	Sum of Squares	df	Mean Square	F- Value	p Value
Between Groups	834.724	2	417.362	169.003	0.00
Within Groups	3701.861	1499	2.47		
Total	4536.586	1501			

The ANOVA test for post-training assessment scores also shows significant differences across the three years. The F-value is 169.003, and the p-value is 0.000, indicating a highly significant result. This means that the post-training scores significantly differed between the years, suggesting that the effectiveness of the CPD programs varied year by year.

Incremental Scores:

Source	Sum of Squares	df	Mean Square	F- Value	p Value
Between Groups	113.44	2	56.72	5.872	0.003
Within Groups	14479.931	1499	9.66		
Total	14593.372	1501			

The ANOVA test for incremental scores, which represent the difference between post- training and pre-training scores, shows significant differences as well. The F-value is 5.872, and the p-value is 0.003, which is below the 0.05 threshold. This indicates that the improvement in scores due to CPD programs significantly varied across the years. This suggests that the CPD programs' impact on skill or knowledge improvement differed depending on the year.

Interpretation for Gender-wise Analysis :(ANOVA) Pre-Training Assessment Scores

The F-statistic for the pre-training assessment scores is 0.562 with a p-value of 0.454. Since the p-value is greater than 0.05, we fail to reject the null hypothesis. This indicates that there is no statistically significant difference in pre-training assessment scores between male and female participants. Both genders have similar baseline knowledge or skills before undergoing the CPD programs.

Source	Sum of	df	Mean Square	F- Value	p Value
Between Groups	5.634	1	5.634	0.562	0.45
Within Groups	15045.503	1500	10.03		
Total	15051.137	1501			

Post-Training Assessment Scores:

Source	Sum of Squares	df	Mean Square	F- Value	p Value
Between Groups	2.602	1	2.602	0.861	0.05
Within Groups	4533.984	1500	3.023		
Total	4536.586	1501			

The F-statistic for the post-training assessment scores is 0.861 with a p-value of 0.054. Again, since the p-value is greater than 0.05, we fail to reject the null hypothesis. This means there is no statistically significant difference in post-training assessment scores between male and female participants. Both genders benefited equally from the CPD programs.

Incremental Scores:

Source	Sum of Squares	df	Mean Square	F- Value	p Value
Between Groups	0.033	1	0.033	0.003	0.95
Within Groups	14593.339	1500	9.729		
Total	14593.372	1501			

The F-statistic for the incremental scores (difference between post-training and pre-training scores) is 0.003 with a p-value of 0.954. Since the p-value is much greater than 0.05, we fail to reject the null hypothesis. This indicates that there is no statistically significant difference in the improvement (incremental scores) between male and female participants. Both genders show similar levels of improvement as a result of the CPD programs.

Major Findings of the Research:

1. Effectiveness of CPD Programs Over Time

- The ANOVA results for year-wise analysis indicate significant differences in pre- training, post-training,

and incremental scores across the years 2019, 2020, and 2021.
- This suggests that the effectiveness of CPD programs has varied over time, with noticeable improvements in participant performance and skills each year. This variation could be due to changes in the curriculum, delivery methods, or participant selection processes.

2. Baseline Knowledge and Skills
- The pre-training assessment scores showed similar mean values for both male (4.98) and female (5.11) participants, indicating that both genders had comparable baseline knowledge and skills before participating in the CPD programs.
- This similarity in baseline scores suggests that there is no significant gender bias in the initial skill levels of participants selected for the CPD programs.

3. Impact on Post-Training Performance
- Post-training assessment scores revealed that both male and female participants achieved comparable levels of performance after completing the CPD programs. Males had a mean score of 10.38, while females had a mean score of 10.29.
- The small difference in mean scores indicates that the CPD programs were equally effective in enhancing the knowledge and skills of both male and female participants.

4. Improvement Due to CPD Programs
- The incremental scores, which measure the improvement from pre-training to post- training, were nearly identical for male (3.77) and female (3.76) participants.
- This indicates that both genders experienced similar levels of improvement as a result of the CPD programs, highlighting the programs' ability to provide consistent benefits across different demographics.

5. Inclusivity and Equal Effectiveness
- The gender-wise analysis showed no significant differences in pre-training, post- training, or incremental scores between male and female participants. This demonstrates that the CPD programs are inclusive and equally effective for all participants, regardless of gender.
- The similar standard deviations for both genders further support the consistency in program effectiveness.

6. Continuous Improvement in CPD Programs
- The year-wise analysis indicated that there have been continuous improvements in the effectiveness of the CPD programs over the years. Participants in 2021 showed higher post-training and incremental scores compared to those in 2019 and 2020.
- This suggests that the CPD programs are evolving and improving, possibly due to feedback, iterative enhancements in program content, and better alignment with industry needs.

7. High Overall Effectiveness
- The consistently high post-training scores across all years and both genders indicate that the CPD programs are highly effective in enhancing employee performance and skills.
- The overall effectiveness of the CPD programs is evident in the significant improvements in participant scores from pre-training to post-training.

Recommendations

To maximize the effectiveness of continuous professional development (CPD) programs, it is recommended to continuously update and improve the curriculum to align with industry standards and emerging trends, incorporating feedback from participants and experts. Implementing longitudinal studies can help establish causal relationships and understand long-term impacts on career development and organizational success. Ensuring inclusivity and accessibility for all employees, regardless of gender, age, or background, can foster a diverse and skilled workforce. Complementing self-reported data with objective performance metrics will provide a more accurate assessment of program effectiveness. Regular assessments and feedback mechanisms should be in place to monitor and enhance program relevance and impact. Leveraging advanced technologies such as e-learning platforms and AI-driven personalized learning experiences can increase engagement and flexibility. Promoting a culture of continuous learning and development, along with evaluating external factors influencing program outcomes, will further strengthen the resilience and adaptability of CPD initiatives.

Limitations

Despite the positive findings, this research has several limitations. The reliance on self- reported data for assessment scores may introduce bias, as participants might overestimate or underestimate their skills and

improvements. The study's cross-sectional design limits the ability to establish causality between CPD programs and performance improvements, as it captures data at a single point in time rather than longitudinally. Additionally, the sample, while substantial, may not fully represent the entire petrochemical industry, potentially limiting the generalizability of the results. Finally, external factors such as changes in workplace environment, management practices, and technological advancements were not controlled for, which could influence the outcomes of the CPD programs independently of the training itself.

Conclusion

This research aimed to evaluate the impact of continuous professional development (CPD) programs on employee performance and innovation within the petrochemical industry. The analysis focused on pre-training, post-training, and incremental assessment scores over three years (2019, 2020, and 2021), comparing these scores between male and female participants. The year-wise analysis revealed significant variations in assessment scores, indicating that the CPD programs have not only been effective but have also improved over time. This improvement could be attributed to iterative feedback, enhancements in curriculum design, and better alignment with industry requirements, demonstrating the programs' ability to adapt and increase their effectiveness, thereby contributing to sustained improvements in employee performance and innovation capacity.

The analysis of pre-training assessment scores showed that both male and female participants had comparable baseline knowledge and skills before undergoing CPD training, suggesting an unbiased and inclusive selection process that ensures equal opportunity for skill enhancement across genders. Post-training assessment scores indicated that both male and female participants achieved similar levels of performance after completing the CPD programs, with statistically insignificant differences in mean scores between genders. This finding highlights that the CPD programs are designed and implemented to ensure equitable outcomes for all participants, enhancing skills and knowledge uniformly.

The incremental scores, reflecting the improvement from pre-training to post-training, were nearly identical for both male and female participants. This indicates that the CPD programs provided consistent benefits across genders, with both groups experiencing similar levels of skill and performance enhancement. These findings reinforce the notion that CPD programs are equitable and effective, ensuring that all employees, regardless of gender, receive the same quality of training and opportunities for professional growth. In conclusion, the CPD programs in the petrochemical industry have proven to be highly effective, inclusive, and continuously improving, making a significant contribution to employee performance and organizational innovation.

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