MJIT 2023 Malaysian Journal of Industrial Technology

A STUDY ON CRITICAL SUCCESS FACTORS OF CONTINUOUS IMPROVEMENT IN OIL AND GAS INDUSTRIES

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ARTICLE INFO

Handling Editor: Rahimah Mahat

Article History:
Received 21 October 2023
Received in revised form 2 November 2023
Accepted 29 December 2023
Available online 2 December 2023

Keywords:
Critical Success Factors; Continuous Improvement; Oil and Gas Sector; CSFs Level; Conceptual CSFs

ABSTRACT

The term "Critical Success Factors" (CSFs) refer to the vital aspects of a business that are necessary for its ongoing success in the market. Companies operating in industries such as petroleum and natural gas, including PETRONAS, fall within the scope of CSFs. This study aims to understand how oil and gas company management perceives the CSFs for continuous improvement. To gather quantitative data, a survey questionnaire will be administered to PETRONAS employees and the collected information will be analysed using the Statistical Package for the Social Sciences (SPSS). The objective of this research is to provide insights into the critical factors necessary for effective continuous improvement within PETRONAS, facilitating informed decision-making and prioritization of improvement efforts within the organization.

1.0 Introduction

Critical success factors (CSFs) are the key factors that ensure competitive performance for a business according to Fryer et al., (2007) [1]. They focus on how an organization can achieve a competitive advantage and are the processes and actions that management can control to accomplish organizational goals. Alhaqbani, (2017) [2] mentioned CSFs are associated with organizational culture and contribute to the likelihood of facilitating continuous improvement (CI) activities. PETRONAS, Malaysia's national oil corporation, is responsible for developing and adding value to the country's oil and gas resources. Continuous improvement is a strategic approach aimed at evaluating and changing organizational processes, methods, and practices to improve efficiency and effectiveness as stated by Formento et al., (2013) [3]. This study seeks to identify the CSFs that contribute to PETRONAS' success in continuous improvement initiatives, building upon their ongoing improvement efforts. By understanding these CSFs, the research aims to uncover the factors that enable PETRONAS to achieve success in their continuous improvement journey. The problem statement revolves around the lack of research and evidence regarding the Critical Success Factors (CSFs) for successful continuous improvement (CI) in the oil and gas industry, particularly in the case of PETRONAS. While continuous improvement is a well-known concept in organizations, there is a dearth of published information on the specific CSFs for CI in PETRONAS. This knowledge gap prompts the need for further study and the development of a thesis.

The objectives of the study include identifying essential factors for successful CI implementation, determining CSF levels for CI, and developing a conceptual CSFs measurement model specific to the PETRONAS industry. The scope of this research is limited to identify the Critical Success Factors (CSFs) of continuous improvement which focusses on oil and gas industry. The context of this study is limited to PETRONAS organization which covers all its vendors in Malaysia. This research will help PETRONAS adopt continuous improvement by referencing critical success factors (CSFs) and the experiences of other organizations with implementations. It presents a framework for successfully implementing CI in the oil and gas industry and identifies factors that support PETRONAS's continuous improvement, providing new possibilities for future empirical research. This study will help PETRONAS develop a deeper grasp of the CI idea and empower them to pinpoint and measure areas where they can improve.

2.0 Literature Review

As published by García et al. in 2013 [4], Critical Success Factors (CSFs) have been widely used since 1961 to identify the key elements necessary for a company's development and performance. CSFs are defined as a limited number of areas where achieving success is crucial for an individual, team, or organization to reach their stated goals in a competitive environment. Ahmad and Elhuni (2014) [5] state successful applications of CSFs include lean manufacturing and Six Sigma projects, total quality management, ISO 9001 implementation, project environments, ERP systems, information technology governance, innovation in the manufacturing industry, collaboration between private and public sectors, and supply chain management. It is important to identify and prioritize the appropriate CSFs to optimize the effectiveness of continuous improvement initiatives. Based on the literature review of the critical success factors, 29 factors were derived to construct the questionnaire of this study. These 29 factors discovered were then being group into six constructs to develop the initial conceptual model for critical success factors of continuous improvement in PETRONAS.

2.1 Top Management Leadership

Effective leadership is essential for the success of continuous improvement initiatives. As published by Stelson et al. in 2017 [6], a qualified leader who possesses charisma, conviction, and the ability to inspire trust is necessary to guide the implementation of continuous improvement. Stakeholder satisfaction is essential for a company's success, both internally and externally. Executive leadership plays a key role in evaluating project ideas and selecting those with the greatest merit and feasibility. Mehdi Sheikhzadeh (2012) [7] highlighted that thorough research during project selection helps identify potential bottlenecks and mitigate risks and aligns project appraisals with the organization's overall goals and objectives, resulting in efficient project execution and maximizing return on investment.

2.2 Work environment

A healthy working environment is essential for safe and profitable operations in the oil and gas sector. Corresponding to Fox and Boaz (2014) [8], organizational culture, which evolves over time, plays a significant role in maintaining an organization's relevance and long-term performance. Continuous improvement is essential for sustained business success, driving innovation, improving product development, customer service, and profitability, and providing a competitive advantage (Karim & Arif-Uz-Zaman, 2013) [9]. Employee attitudes contribute to the success of continuous improvement initiatives. Effective supplier management is critical for successful production processes and supply chain efficiency. Collaboration and partnerships are increasingly valued, offering benefits such as cost reduction, increased efficiency, skill utilization, program strengthening, and leadership development. Mutual trust and clear communication are essential for successful collaborations.

2.3 Education and training

In the highly competitive oil and petrol industry, implementing a strategy for continuous improvement is essential to stay ahead of rivals and provide value and customer satisfaction. To support development and learning, companies should invest in continuous improvement training for their employees. This training helps execute systematic approaches, maintain organized workplaces, follow standard operating procedures, and implement quality management. As mentioned by Raziq and Maulabakhsh (2015) [10], managers and owners need to demonstrate commitment by offering training and support to cultivate a team mentality and boost quality. Employees need competencies to integrate new approaches and adapt to changing conditions, and education and training programs equip employees with the skills to achieve operational excellence and customer satisfaction. Continuous improvement training enhances professional performance, enables the fulfilment of client needs, and keeps the company ahead of competitors.

2.4 Customer-focused

Customer focus is essential for successful continuous improvement (CI) implementation. Understanding customer needs and behaviour allows organizations to strategically align their operations to deliver the best possible customer experience. The collection of customer feedback, handling complaints, and implementing corrective actions are crucial aspects of customer relationship management in CI. Wu et al. (2013) [11] emphasized that customer feedback helps companies assess their effectiveness in delivering quality services and increase customer loyalty and retention. By focusing on customers, organizations can identify service quality gaps and improvement opportunities to enhance customer experiences. Continuous collection of customer feedback provides insights into product and service quality, enabling organizations to improve their processes and meet customer requirements. Anticipating and fulfilling customer needs through continuous improvement efforts enhances customer loyalty and retention. Customer opinions and experiences play a vital role in the CI process.

2.5 Operational management

Continuous improvement in the oil and gas industry focuses on maximizing operational effectiveness and profitability. Before implementing continuous improvement (CI), organizations must prioritize customer needs and satisfaction. By understanding customer behavior, organizations can align their strategies and operations to deliver the best possible customer experience. Customer feedback is crucial in evaluating performance and identifying areas for improvement. Operational management plays a vital role in CI by ensuring efficient resource utilization and overseeing day-to-day activities. According to Lin et al. (2015) [12], resource availability and demand need to be balanced to optimize decision-making and workload distribution. Standardization is another important aspect, as it reduces costs, improves safety, and establishes best practices. Continuous improvement tools, such as value stream mapping, help visualize processes and eliminate non-value-added steps. Root Cause Analysis helps identify the underlying causes of problems, enabling effective solutions. Tools like Kanban, PDSA cycle, and DMAIC framework aid in task management, scientific experimentation, and problem-solving (Pereira et al., 2014) [13]. While standardization is important, organizations should strike a balance to foster innovation and avoid hindering productivity. Documented CI standards for processes ensure consistency and provide clear instructions for task completion. Risk analysis is essential in identifying and managing potential hazards to organizational success. It is used across various industries, including oil and gas, to evaluate financial viability, ensure safety, and enhance project controls.

2.6 Good teamwork

Teamwork is the collaborative effort of individuals coming together to achieve predetermined goals and objectives. It involves dynamic and adaptable interactions among team members. Efficient teamwork results in timely and cost-effective completion of organizational tasks. Pointed by Tkachenko and Fedosyuk (2021) [14], by emphasizing cooperation over individual contributions, teams can achieve superior outcomes compared to individual efforts alone. In organizations, teams play a crucial role in analyzing and diagnosing problems, as well as exploiting opportunities. Encouraging employee participation and establishing clear rules for group formation contribute to organizational success (Gratton and Erickson, 2007) [15]. A study in the oil and fuel industry demonstrated that teamwork positively impacts task completion, mission efficiency, learning, and skill development. Factors influencing teamwork effectiveness include communication, coordination, fairness, mutual assistance, and group cohesion. Effective communication, coordination, motivation, and collaboration are key determinants of successful organizational activities. Leaders should foster a productive work environment, promote face-to-face communication, and cultivate a culture of respect where team members value each other's unique qualities. By prioritizing these aspects, organizations can enhance teamwork and overall performance.

3.0 Methodology

The researcher chose to conduct a quantitative study using a structured questionnaire as the primary tool. It was developed based on a review of prior research in the field highlighting the critical success factors for continuous improvement, with a major emphasis on the oil and petrol sector. The questionnaire instrument had four primary components: demographic information, measurement variables, 6 categories, and a five-point Likert scale. The cut-off value of the Likert scales was established as follows: Strongly disagree (1.0 to 1.5), disagree (1.5 to 2.5), neutral (2.5 to 3.5), agree (3.5 to 4.5), and strongly agree (>4.5 to 5.0). According to the most recent data, the present population of PETRONAS is approximately 50,000 people, and the sample size for this study will be 381 respondents. This study involves conceptual model construction. Questionnaires are developed from this framework. Sub-issues within each component are used to create questionnaires.

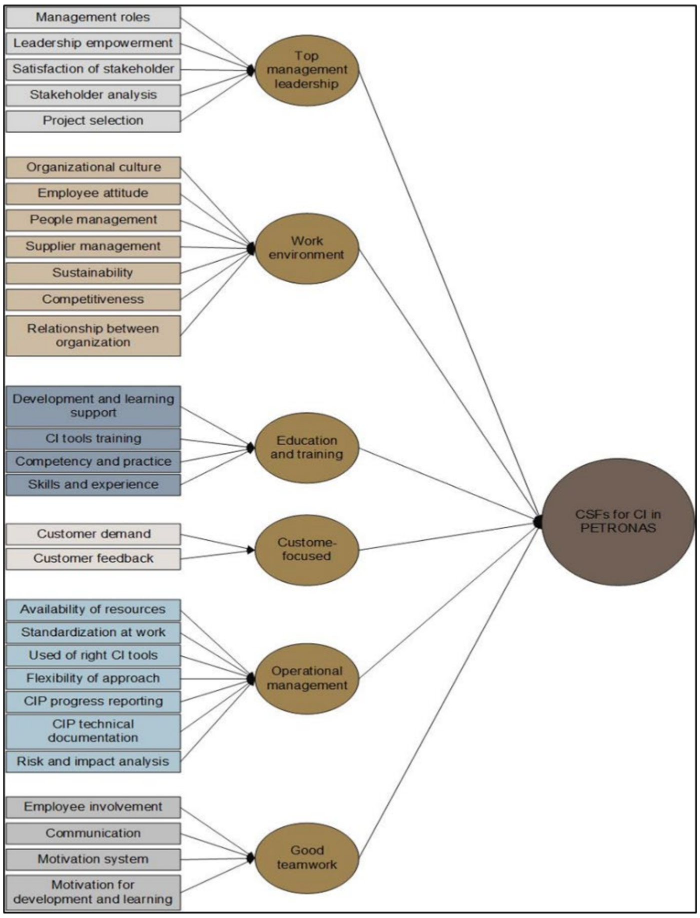

Figure 1. Conceptual framework

4.0 Result and Discussion

The findings and results have been obtained using the quantitative research approach. The information was obtained from the employees working for Petronas SDN. BHD. That includes all their vendor partners.

4.1 Reliability Test

A reliability test was conducted on a survey with 381 respondents, and all 29 questions showed excellent internal consistency with a Cronbach's Alpha value of 0.860, indicating that no items need to be removed for further analysis.

Table 1. Reliability Statistics for Full Survey

Reliability Statistics	
Cronbach's Alpha	N of Items
.860	29

4.2 Treatment Outliers

The treatment of outliers in data analysis involves deciding whether to keep or eliminate them based on the specific analysis and research objectives. Univariate analysis, which focuses on one variable at a time, is used to examine the distribution and features of a variable, detect outliers, and test theories. In the survey, univariate analysis identified one outlier item and respondent that needed to be removed. The univariate outlier is determined using SPSS by looking at the standardized Z-value of each construct, and an outlier is identified. For this survey, only one standard score was not within +/- 4 standard deviations and the item and respondent number 49 needs to be deleted. Multivariate screening analysis, which examines the relationships between multiple factors simultaneously, identified several outliers based on a p-value lower than 0.05 using the Mahalanobis d-square distance method. Consequently, multiple items and respondents were considered outliers and should be removed from the data. As multivariate, respondent number 32, 49, 61, 70, 80, 195, 211, 212,2 13, 230, 244, 249, 294, 298, 300, 301, 311, 312, 318, 326 and 363 should be removed and considered as outliers.

4.3 Non-response Bias

The reliability test is important to ensure that the data is free from any non-response bias. To investigate the existence of non-response bias, the study classified the first fifty respondents as early responders and the remaining fifty as late responders. ANOVA is used to find out if there are statistically significant differences in group means and identify which groups are significantly different from one another. If the Sig. value is greater than 0.05, there is no statistically significant difference between early and late respondents. The data in the Table 2 shows that there was no statistically significant difference (Sig. values > 0.05).

Table 2. Analysis of variance (ANOVA)

Tests of Homogeneity of Variances					
		Levene Statistic	df1	df2	Sig.
Gender	Based on Mean	.168	1	98	.683
	Based on Median	.042	1	98	.838
	Based on Median and with adjusted df	.042	1	97.988	.838
	Based on trimmed mean	.168	1	98	.683
Level of education	Based on Mean	.668	1	98	.416
	Based on Median	.372	1	98	.543
	Based on Median and with adjusted df	.372	1	97.924	.543
	Based on trimmed mean	.713	1	98	.401
Current position level	Based on Mean	.195	1	98	.660
	Based on Median	.025	1	98	.875
	Based on Median and with adjusted df	.025	1	74.111	.876
	Based on trimmed mean	.194	1	98	.661
Length of service	Based on Mean	1.263	1	98	.264
	Based on Median	.447	1	98	.505
	Based on Median and with adjusted df	.447	1	95.142	.505
	Based on trimmed mean	.880	1	98	.351

Next, the chi-square test is a statistical test that is used to find out if there is a strong link between two categorical factors. In the data analysis, results are provided in Table 3, and there is no statistically significant difference between early and late respondents (p>0.05), hence there is no non-response bias.

Table 3. Summary of Chi-square test for non-response bias

Items	x^2 value	df	p-value	Significant
Gender	0.043	1	0.836	Not significant
Level of education	0.405	1	0.817	Not significant
Current position level	6.781	3	0.079	Not significant
Length of service	2.798	3	0.424	Not significant

The T-test was used to determine whether there were statistically significant differences between early and late respondents regarding the construct. There is no statistically significant difference between early and late respondents' selection views, as shown by the T-test findings given in Table 4, where the p-value is greater than 0.05.

Table 4. T-test for non-response bias

Items	µ early response	µ late response	t-value	df	p-value	Significant
Top management leadership	4.78	4.72	0.688	98	0.493	Not significant
Work environment	4.66	4.76	-1.098	98	0.275	Not significant
Education and training	4.74	4.76	-0.229	98	0.820	Not significant
Customer-focused	4.76	4.86	-0.867	98	0.545	Not significant
Operational management	4.78	4.72	0.688	98	0.493	Not significant
Good teamwork	4.66	4.76	-1.098	98	0.275	Not significant

4.4 Common Method Bias

Common method bias is a measurement bias that can occur when only one method is used to collect data for a research study. This can cause the real relationship between variables to be overestimated or underestimated, as the results may be influenced by items that have nothing to do with the construct being evaluated. SPSS factor analysis was used to examine the common method variance, and the results indicated that the ratio of the variance of the principal factor to the total variance was only 26.05%, which is less than 50%. It was stated that the common method variance exists if one principal factor accounts for more than fifty percent of the total variance, so the result is accepted.

Table 5. Summary of Common Method Bias

The highest percentage variance of principles factor (A)	**Total Percentage variance (B)**	**Ratio (R) (R = A/B) R < 50%**	**Results**
24.399	93.655	26.05%	Accepted

4.5 Normality Test

The normality test of data skewness and kurtosis was performed to assess the multivariate normality of the observed variables. Two measurement requirements must be met to assess whether or not the data are normal: the Critical ratio (CR) for skewness within +/- 3 and the Critical ratio (CR) for kurtosis within +/- 7. According to the data shown in Table 6, researchers did not identify any abnormalities, indicating that the distribution of the data is normal.

Table 6. Skewness and Kurtosis

Descriptive Statistics											
	N	Minimum	Maximum	Mean	Std. Deviation	Skewness			Kurtosis		
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	CR skewness	Statistic	Std. Error	CR kurtosis
TML1	360	3	5	4.86	0.430	-3.096	0.129	-0.042	9.082	0.256	0.028
TML2	360	3	5	4.76	0.513	-2.022	0.129	-0.064	3.253	0.256	0.079
TML3	360	3	5	4.66	0.580	-1.498	0.129	-0.086	1.224	0.256	0.210
TML4	360	3	5	4.70	0.546	-1.682	0.129	-0.076	1.896	0.256	0.135
TML5	360	3	5	4.67	0.567	-1.537	0.129	-0.084	1.380	0.256	0.186
WE1	360	3	5	4.69	0.562	-1.622	0.129	-0.079	1.651	0.256	0.155
WE2	360	3	5	4.66	0.641	-1.653	0.129	-0.078	1.390	0.256	0.184
WE3	360	3	5	4.86	0.430	-3.096	0.129	-0.042	9.082	0.256	0.028
WE4	360	3	5	4.67	0.567	-1.537	0.129	-0.084	1.380	0.256	0.186
WE5	360	3	5	4.76	0.513	-2.022	0.129	-0.064	3.253	0.256	0.079
WE6	360	3	5	4.67	0.596	-1.630	0.129	-0.079	1.541	0.256	0.166
WE7	360	3	5	4.64	0.600	-1.446	0.129	-0.089	1.013	0.256	0.253
ET1	360	3	5	4.57	0.607	-1.107	0.129	-0.116	0.192	0.256	1.334
ET2	360	3	5	4.67	0.554	-1.431	0.129	-0.090	1.098	0.256	0.234
ET3	360	3	5	4.57	0.607	-1.107	0.129	-0.116	0.192	0.256	1.334
ET4	360	3	5	4.67	0.554	-1.431	0.129	-0.090	1.098	0.256	0.234
CF1	360	3	5	4.57	0.607	-1.107	0.129	-0.116	0.192	0.256	1.334
CF2	360	3	5	4.67	0.554	-1.431	0.129	-0.090	1.098	0.256	0.234
OM1	360	3	5	4.86	0.430	-3.096	0.129	-0.042	9.082	0.256	0.028
OM2	360	3	5	4.76	0.513	-2.022	0.129	-0.064	3.253	0.256	0.079
OM3	360	3	5	4.66	0.580	-1.498	0.129	-0.086	1.224	0.256	0.210
OM4	360	3	5	4.70	0.546	-1.682	0.129	-0.076	1.896	0.256	0.135
OM5	360	3	5	4.67	0.567	-1.537	0.129	-0.084	1.380	0.256	0.186
OM6	360	3	5	4.76	0.513	-2.022	0.129	-0.064	3.253	0.256	0.079
OM7	360	3	5	4.70	0.546	-1.682	0.129	-0.076	1.896	0.256	0.135
GT1	360	3	5	4.67	0.554	-1.431	0.129	-0.090	1.098	0.256	0.234
GT2	360	3	5	4.57	0.607	-1.107	0.129	-0.116	0.192	0.256	1.334
GT3	360	3	5	4.57	0.607	-1.107	0.129	-0.116	0.192	0.256	1.334
GT4	360	3	5	4.67	0.554	-1.431	0.129	-0.090	1.098	0.256	0.234
Valid N (listwise)	360										

4.6 Exploratory Factor Analysis

Exploratory Factor Analysis (EFA) is a statistical technique used to identify the underlying structure of a set of observable variables or indicators. In Table 7 below, Kaiser-Mayer-Olkin has a value of 0.714, which indicates that the sample is sufficient and that the proportion of variances in variables can be attributed to underlying factors. Bartlett's sphericity test value of 0.00 is also less than 0.05, demonstrating the significance of the analysis.

Table 7. KMO and Bartlett's Test of Sphericity

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.714
Bartlett's Test of Sphericity	Approx. Chi-Square	1251.922
	df	378
	Sig.	.000

According to Table 8, eight new components have been generated after EFA procedures (Rotated component matrix). It demonstrates that items were connected to the eight factors. Any factor loading below 0.5 should be eliminated, and according to the results presented below, factor WE2 has been excluded as it denotes insignificant or repeated factors.

Table 8. Rotated factor Varimax with Kaiser normalization

Rotated Component Matrix[a]								
	Component							
	1	2	3	4	5	6	7	8
CF1		.999						
CF2	.971							
ET1		.999						
ET2	.971							
ET3		.999						
ET4	.971							
GT1	.971							
GT2		.999						
GT3		.999						
GT4	.971							
OM1						.988		
OM2			.953					
OM3							.992	
OM4					.986			
OM5				.963				
OM6			.953					
OM7					.986			
TML1						.988		
TML2			.953					
TML3							.992	
TML4					.986			
TML5				.963				
WE1								.887
WE2								
WE3						.988		
WE4				.963				
WE5			.953					
WE6				.763				
WE7				.523				
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.[a]								
a. Rotation converged in 6 iterations.								

After EFA analysis being done, a new construct had been developed after undergone the rotated component matrix. According to Figure 2, 28 of the 29 original items were inserted into 8 factors, while 1 item was excluded. The new construct then being develop as a new conceptual model for the critical success factors of continuous improvement in PETRONAS.

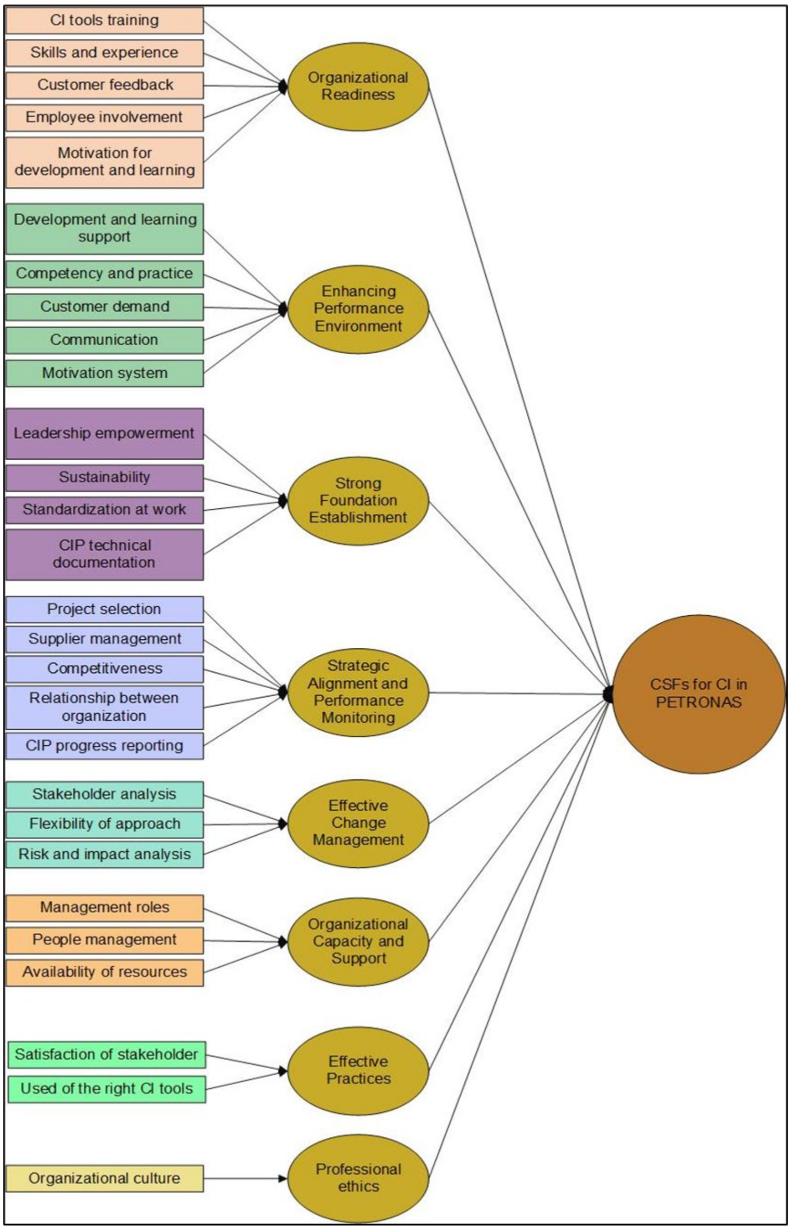

Figure 2. New conceptual model after rotated component matrix

4.7 Friedman Test

The Friedman test was carried out to rank a list of factors from highest to lowest by preference or significance. The significant value for the Friedman test is less than 0.05 (p-value 0.05), indicating that there are distributional differences between the conditions. With a p-value of 0.000, it can be concluded that the Friedman test shown in Table 9 below is significant.

Table 9. Friedman test statistics

Test Statistics	
N	360
Chi-Square	97.197
df	7
Asymp. Sig.	.000
a. Friedman Test	

According to Table 10, the highest-ranked critical success factor for Petronas's continuous improvement is organizational capacity and support. This strongly suggests that the absence of this factor could prevent the organization from achieving continuous improvement success. Next, establishing a solid foundation is the second most important factor, followed by effective change management. The fourth factor is the organization's implementation of professional ethics. Next is organizational readiness, then effective practices, and finally an environment that enhances performance. Strategic alignment and performance surveillance are ranked last.

Table 10. Mean rank of Friedman test

Ranks	
	Mean Rank
AVGOCS	5.14
AVGSFE	4.76
AVGECM	4.58
AVGPE	4.51
AVGOR	4.43
AVGEP	4.43
AVGEPE	4.10
AVGSAPM	4.04

5.0 Conclusion and Recommendation

In conclusion, the three research objectives were accomplished. The researchers identified 29 critical success factors (CSFs) for continuous improvement (CI) at PETRONAS. After data analysis, 28 CSFs were found to be essential for successful CI implementation, categorized into organizational readiness, performance environment, foundation establishment, strategic alignment, change management, organizational support, effective practices, and professional ethics. These 28 CSFs achieved the objectives of achieving continuous improvement at PETRONAS. The researchers found that the most important contributors to Petronas' success at implementing continuous improvement fall into one of eight categories, each of which contains 28 individual elements. Critical success aspects of Petronas' continuous improvement were ranked or rated among all these categories, and the Friedman test was performed in SPSS on all of these levels. This resulted in the researchers achieving the second objective by evaluating CSFs levels of CI in the Petronas organization. The researcher also established an early conceptual model for CSFs of CI in Petronas using preliminary elements from the literature review. After distributing a questionnaire to Petronas employees and analysing the results with SPSS, the researcher revised the model to reflect the newly identified CSFs of CI.

Based on the findings of the exploratory factor analysis, the researcher created a new conceptual model. This achieved the third objective of developing a conceptual model for CSFs of CI in Petronas.

For the recommendation, researchers should conduct longitudinal studies and comparative studies to measure the long-term benefits of continuous improvement programs in the oil and gas industry. These studies involve collecting data from the same individuals or subjects over an extended period to observe changes, trends, and relationships between variables. Comparative studies can be conducted to evaluate the effectiveness of different continuous improvement approaches such as Lean, Six Sigma, or Total Quality Management. Future researchers should explore industry-specific factors that impact the success of continuous improvement in the oil and gas industry, such as regulatory compliance, complex supplier chains, safety regulations, and project management complexities. This knowledge can contribute to the development of effective strategies and practices, ultimately driving improved performance in this sector.

6.0 Acknowledgement

The researcher would like to acknowledge the supervisor, Ts. Dr. Mohd Amran bin Mohd Daril, and the co-supervisor, Mr. Mohd Jalaluddin bin Mohamad, for their assistance, encouragement, excellent ideas, and support throughout their four years of school. Parents, relatives, and classmates are appreciated for their assistance, encouragement, excellent ideas, and support. Additionally, gratitude to the other lecturers at UniKL MITEC who provided helpful information, suggestions, and advice during the work on the Final Year Project. The purpose of this report for Universiti Kuala Lumpur Malaysian Institute of Industrial Technology (UniKL MITEC) was to assist researcher in completing the Bachelor of Engineering Technology (Quality Engineering) with Honors undergraduate program.

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