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Future-Proofing Tech and Energy Organizations: The Strategic Role of Competence and Quality in Driving Innovation and Overcoming Failures

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ABSTRACT

The Oil and Gas Industry (OGI) plays a vital role in sustaining a strong national economy, with its efficiency and competitiveness heavily shaped by the adoption of innovative technologies. Thus, the strategic role of competence and quality in driving innovation within the OGI is explored in this study. A quantitative approach is undertaken, and data is obtained from 260 middle- and senior-level executives spread across 15 registered and operational Oil and Gas (O&G) companies in the United Kingdom. To explore the relationship between innovation capabilities and performance outcomes, correlation, and Regression Analysis (RA) are undertaken. As per the findings, competence, particularly through structured feedback mechanisms and failure analysis, has a significant positive relationship with the quality of output performance. Also, in mitigating innovation failures and improving subsequent innovations, the structured feedback mechanisms are the most influential factors. As per the findings, developing innovation competencies enhances performance and sustainability in the O&G sector.

Keywords: Innovation, Failures, Competitiveness, Quality, Oil and Gas industry.

1. INTRODUCTION

Quality is the key to success and survival for any organization in a competitive business environment. Companies adopt several quality practices as a part of their strategic business plans to remain competent in the global environment [1, 2]. The fuel and energy complex's essential component is the O&G sector, which represents the national economy's foundation. The augmentation in unconventional O&G production will require a rising requirement for modern technology that can work well in stiff terrains under special production conditions. Innovation has been considered a key to effective competition among firms and growth in the market since the beginning of the last century. The organization of the innovation inside the companies evolved from secret R&D departments to research and innovation systems collaborating networks from those initial ideas. In the O&G sector, developing innovative direction is the only way to preserve along with keep advantageous positions in the home market and abroad [3, 4, and 5]. The most important trends shaping innovation in the OGI are depicted in Figure 1.

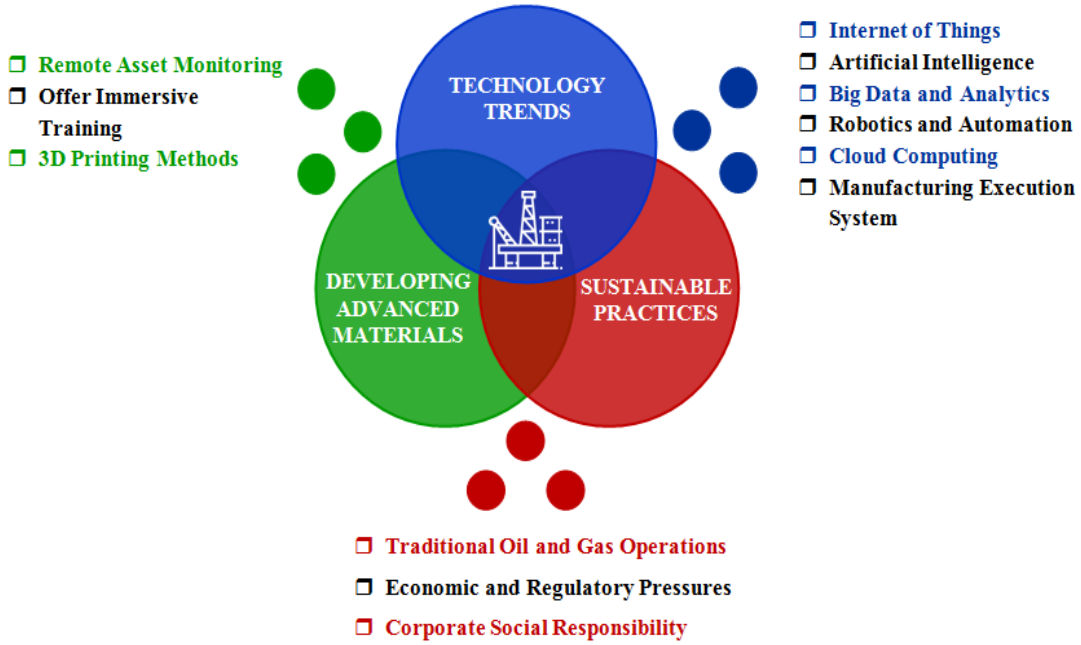

Figure 1: Role of innovation in oil and gas industry

1.1 Problem statement

Significant challenges are faced by O&G companies in harnessing innovation capabilities to augment organizational productivity [6, 7]. Primarily, the focus of the earlier research was conceptualizing breakthrough innovation. Scholars have begun focusing on competence's role in innovation as the depth of research has increased in recent years. Existing research pays limited attention to the relation betwixt innovation failures on productivity along with performance in the OGI [8, 9, and 10]. Also, there is a scarcity of studies that discover the relation betwixt firms' innovation capabilities and the quality of subsequent innovations. Also, the impact of innovation failures on the quality of subsequent innovations is still underdeveloped, and the results are still inconclusive. Therefore, this study examines the strategic role of competence and quality in driving innovation and overcoming failures in the OGI to fill this gap.

1.2 Research objective

Examining the relation betwixt firms' innovation capabilities and the quality of subsequent innovations is the research's primary objective. Also, the impact of innovation failures is examined on productivity and performance in the OGI.

Specific Objectives:

1. To explore the relation between innovation capabilities along with the quality of output performance in the OGI.
2. To analyze the relation between innovation capabilities and the quantity of output in the OGI.
3. To appraise innovation capabilities' impact on productivity performance in the OGI.
4. To evaluate how a firm's innovation failures influence the quality of subsequent innovations.

1.3 Purpose of the study

This research examines the strategic role of competence in innovation within the OGI's specific context. The study highlights innovations' significance in addressing and mitigating failures while focusing on the OGI. The present research focuses on adding valuable insights into the quality of products and productivity toward a sustainable business by providing an in-

depth exploration of technological innovations and policy initiatives.

1.4 Structure of the paper

Here is the format of the remaining part: the relevant literature of a study is elucidated in Section 2. Then, in Section 3, the research design, data collection and procedures, data analysis, along with ethical considerations are explained. Then, Section 4 lays down the complete results and analyses of the study. Lastly, in Section 5, the study conclusion, limitations, and future scope are summarized.

2. LITERATURE REVIEW

It was conducted to understand the present research in the 4th Industrial Revolution. This review aided in offering a basic knowledge of the topics discussed along with helping to identify areas of inconsistency and the requirement for additional research. Also, it covered the strategic role, quality and innovation, and firms' innovation failures.

[11] aimed to explore innovation failure knowledge in the failure experience timing context. This study's primary dataset was drawn from the Pharma projects and sourced from the commercial database that captured information regarding the R&DD process. By employing descriptive analysis, the study results were analyzed. Finally, the study concluded that the firms were more likely to learn as of early-stage innovation failures when analogized to late-stage ones. This study faced several limitations. Initially, the distinction betwixt early-stage along with late-stage might not be as evident in other industries. Then, as firms could fail at any time, innovation failure timing was continuous during the innovation process.

[12] investigated issues of oil companies' innovative development under consideration of the actual state, forecast, along with prospects for an end to the innovation pause as protracted. All study data were taken on the basis of secondary sources: data from statistical information, authoritative consulting and rating agencies, international economic organizations, along with publications in scientific literature. By using various statistical analyses, comparative analyses, and methods of economic analysis, the study results were analyzed. Here, the hypothesis generated was confirmed. In the meantime, the confirmation didn't result in optimism regarding forecasting results. Certainly, low innovative activity was depicted by most oil companies, enduring to engender along a wide trajectory.

[13] discovered the thin line between successful and unsuccessful open innovation projects. Applying thematic analysis, the authors interviewed 27 managers along with owners in Italian SMEs in the manufacturing sector. A study showed that most interviewees were unwilling to name the failure cases. Triggers and setbacks defining the (un) success of the project were marked inversely centered on the firm's technological intensity. Meanwhile, the study resorted to SMEs' small sample as of a specific geographic zone along with the industrial sector.

[14] showed the failure-innovation performance relation employing quantile regression evidence as of SME industries in Korea. From 2016 to 2020, the empirical data was taken from 300 employees as of the survey on the technology of SMEs published by the Ministry of SMEs along with Startups in Korea using a stratified sampling method. The study revealed that only companies surpassing a certain level of innovativeness are likely to gain value from their experiences of failure. At various levels of innovation performance, the relation betwixt failure along with innovation performance was also different. Here, Certain limitations occurred. Initially, the study didn't take numerous kinds of failures and their impacts. Then, within the Korean institutional context, the study considered sample firms; the outcomes could differ in other national along with cultural contexts.

[15] analyzed environmental optimization and firms' re-innovation decision-making after failure. For depicting the theoretical model, a case study was conducted in Zhengzhou, China. Next, a game model betwixt government departments along with firms with failed innovation was built by utilizing the evolutionary game approach. The firms' re-innovation behavior choice was impacted by re-innovation and subjective perception of risk benefits after failure. Also, the upsurge in re-innovation income promoted the behavior of re-innovation after failure and increase firms' competitiveness. Meanwhile, re-innovation cost reduction had a limited impact on firms' re-innovation behavior choice.

[16] discovered innovative decisions' role in developing O&G companies. Also, it explored developing and adopting innovative decisions' importance in every O&G company's operating segment. Based on a qualitative analysis, forecasting in all operating segments of advanced technologies in the field was analyzed. Lastly, the research demonstrated that developing an integrated system of preparation and realization of innovative managerial decisions on the level of O and G companies enabled the formation of the fundamental mechanism for the timely application of innovation.

[17] elucidated process innovation capability and the indigenous O&G companies' performance in South-South Nigeria. By using 33 indigenous O&G companies in Rivers State, primary data was gathered through a census sampling technique. Based on a cross-sectional research survey design, the result of the study was analyzed. As per the study, there was a positive and key relation betwixt process innovation capability along with the performance of indigenous O&G companies. Here, it was also found that market innovation significantly played an essential role in indigenous O&G companies' performance.

3. RESEARCH METHODOLOGY

3.1 Research design

Planning a study enables the researcher to structure and execute it effectively, ensuring the achievement of the desired outcomes. The study examines the strategic role of competence in driving innovation and enhancing the quality of outputs within the OGI. Competence is operationalized as a firm's ability to utilize organizational knowledge, skills, and adaptive capabilities to achieve high-quality innovation outputs. The research strategy, which lays out the research methodology's principles for the given study, is termed the research design. This study adopts a quantitative analysis with a descriptive survey design. A descriptive design determines the frequency with something occurring or the relationship between variables. Thus, in Figure 2, the design of the conceptual framework of the research phases is shown.

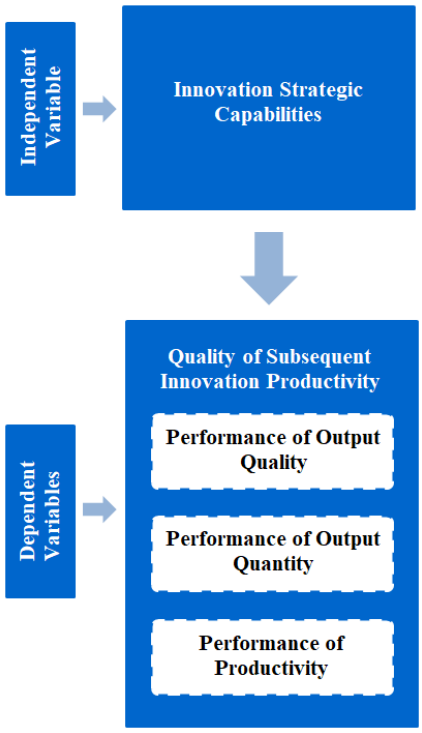

Figure 2: Conceptual design of research study

3.2 Population and Sampling

Fifteen (15) registered and functional O&G companies in the United Kingdom (UK) are encompassed in this study. These companies register with the Department of Petroleum

Resources. Middle- along with senior-level executives are encompassed in respondents. The study's target population could be taken as an immeasurable population. Regarding gender who are above 18 years, male and female respondents are included. The population's representatives are the samples, which are chosen randomly. In determining the sample size, there is no single and precise way; hence, several inadequacies exist for deciding on sample size. The data generated will be more accurate if the research's sampling size is larger. When respondents are accessible at a specific time and place, the researcher employs a non-probability sampling technique, specifically convenience sampling. This technique involves using the first available primary data source for the research without imposing additional criteria. Thus, 300 questionnaires are distributed among these questionnaires, and 260 respondents are selected based on the convenience sampling technique.

3.3 Data type and collection technique

The study is appraised centered on the data collected as of primary sources via the questionnaire. The researcher has employed primary data for attaining the above objectives along with answering research questions even though this study is supported by theoretical and empirical literature and secondary data from the organization. From middle- and senior-level executives, primary data are collected. From published journals, company reports, and websites, secondary data are collected. Questionnaires are deployed as a quantitative data collection instrument, which aids in covering larger target groups when weighed against the interview, given the quality along with the chance of no response. A 5-point Likert-Scale (that is, "Strongly Disagree to Strongly Agree") is deployed in the questionnaire. Strongly Disagree (1), Disagree (2), neutral (3), Agree (4), and Strongly Agree (5) are the ratings that ratings deployed for ordinal scale measurement and to engender data suitable for quantitative analysis.

3.4 Variables used

Here, the independent variable of Innovation Strategic Capabilities (ISC) and the dependent variables of Performance of Output Quality (PQL), Performance of Output Quantity (PQN), and Performance of Productivity (PP) are used.

3.5 Validity and Reliability of Research Instruments

To establish the research instrument's construct validity, content validity, and reliability, enormous tests are performed. Then, for testing the instrument's reliability, Cronbach's Alpha (CA) coefficient is used.

3.6 Data analysis

This study permits the researcher to gather accurate and relevant data for the research objective. This study encompassed the open- along with closed-ended questionnaires. To analyze the strategic role of competence in driving quality, the study employs RA to measure the relationship between competence-related factors (e.g., employee expertise and organizational learning) and quality performance (PQL). Descriptive statistics are also used to assess respondents' perceptions of the role of competence in enhancing quality. The responses are analyzed with descriptive statistics to get the statistical results from the respondents, and the studied variables are described in depth. Therefore, through various statistical tools, the interpretation of data has been analyzed. Also, the study's hypothesis has been generated by using RA for detecting the association betwixt firms' innovation failures and the quality of subsequent innovations. Also, for determining the key relation betwixt the variables, RA is used. Regression and correlation models are structured to specifically identify the following:

The direct impact of competence on quality (PQL).

The mediating role of structured feedback mechanisms in strengthening competence to improve quality.

3.7 Ethical considerations

From the participants, informed consent is obtained verbally after they give detailed information on the study. To conduct the study approvals were granted verbally. All the methods are carried out following relevant guidelines and regulations. Likewise, throughout the study, information's strict privacy and confidentially are maintained.

4. RESULT AND DISCUSSION

Here, this section reports on the research findings, analyzing the relationships among innovation capabilities and performance outcome variables, such as quality, quantity, and productivity. It also discusses the influence of innovation failure on the quality of subsequent innovations. Using statistical methodologies, such as EFA, CFA, correlation, and RA, this study's results confirm its constructs and significant relationships between them, thus understanding innovation capabilities and their impact on organizational performance in the OGI.

4.1 Strategic Role of Competence in Quality of Innovations

The link between the strategic role of competence in enhancing innovation quality within the OGI is examined in this study. Competence is operationalized as integrating organizational expertise, structured feedback mechanisms, failure analysis, adaptive strategies, and continuous learning. The influence scores of these factors, which are central to driving quality outcomes, are depicted in Figure 3. As per the results, organizational competence, through the integration of structured feedback mechanisms and adaptive strategies, directly enhances the quality of innovation. This competence enables firms to refine their processes continuously, learn from failures, and implement corrective measures that drive higher-quality outputs.

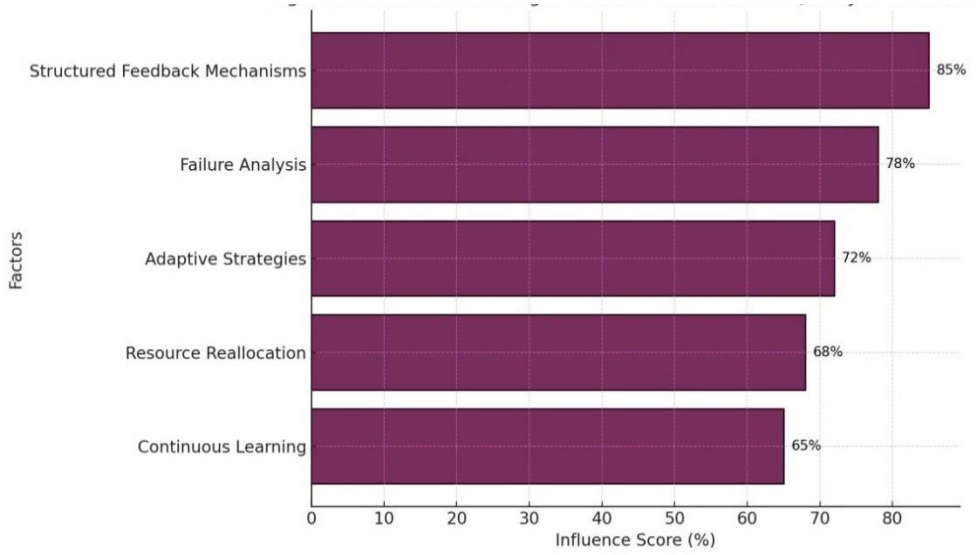

Figure 3.1: Influence Scores of Competence-Related Factors on Innovation Quality

Structured feedback mechanisms (85%) and failure analysis (78%) are the most influential components and key drivers of organizational competence that directly impact the quality of innovations, which is depicted in Figure 3. These elements adopt a culture of constant improvement along with learning, which is critical to sustaining high output quality standards.

4.2 Measures and construct validation

EFA and CFA analyses and reliability analyses are carried out in order to verify the constructs. In Table 1, summarized results are given.

Table 1: Analysis of EFA, CFA, and reliability analysis

Factors	No. of items	Factor loadings	CA	CR
Innovation capabilities	2	0.924	0.943	0.950
Performance of quality output	3	0.917	0.924	0.926
Performance of quantity output	3	0.916	0.892	0.898
Performance of productivity	2	0.909	0.867	0.875

The validity and reliability of the constructs used in the study are depicted in Table 1. The values of all factor loadings exceed 0.9 and point to strong associations between observed variables and latent constructs. CA and CR are found to be more than the threshold value of 0.7. These findings authenticate that the instrument can measure the capabilities related to innovation and performance outcomes. The high factor loadings for innovation capabilities (0.924) and quality performance (0.917) confirm the strong relationship between competence-related factors and innovation outcomes. These results validate the strategic importance of competence in achieving quality enhancements. This validation highlights the importance of competence-related constructs, such as employee expertise and organizational learning, in achieving measurable quality improvements. These results highlight competence as a foundational element within the larger framework of innovative strategic capabilities.

4.3 Descriptive statistics and correlations

To understand the relationships between variables, descriptive statistics along with correlations are calculated. The results are presented in Table 2.

Table 2: Analysis of descriptive statistics, correlations, and reliabilities

Variables	Mean	SD	1	2	3	4
ISC	3.72	1.29	1			
PQL	3.70	1.38	0.891*	1		
PQN	3.67	1.65	0.870**	0.866**	1	
PP	3.59	1.57	0.856*	0843*	0.811*	1

***P = < 0.05 and **P = <0.01.**

The descriptive statistics along with correlations amongst the study variables are presented in Table 2. Moderate agreement among respondents regarding the presence of innovation capabilities and their impact on output performance is indicated by the mean scores. Strong correlations (e.g., ISC and PQL: r = 0.891; ISC and PQN: r = 0.870) indicate that innovation capabilities significantly influence quality and quantity performance. Lower correlations with productivity (ISC and PP: r = 0.856) suggest a weaker, though still significant, relationship. As per the descriptive statistics, respondents recognize the strategic role of competence-related factors, such as feedback mechanisms and continuous learning, in driving superior quality outputs. The high correlation between ISC and PQL ($r = 0.891$, $p < 0.05$) validates this perception and confirms the importance of leveraging organizational competence to achieve innovation success.

4.4 Hypothesis development and analysis

To test the hypotheses, RA is conducted, which is shown in Table 3.

Table 3: Regression analysis

Error	B	Std.	β
Constant	33.74	3.167	11
Innovation capabilities	0.190*	0.085	0.128
Performance of quality output	0.149*	0.051	0.115
Performance of quantity output	0.104*	0.048	0.102
Performance of productivity	0.062*	0.053	0.066

R^2 = 0.192, ΔR^2 = 0.198, *p < 0.05 and F = 5.911.

H1: There is a positive and significant relationship between innovation capabilities and the performance of quality output.

Innovation capabilities significantly influence the quality of output (β = 0.128, p < 0.05). This supports H1, indicating that firms with higher innovation capabilities produce higher-quality outputs. These findings further highlight that developing and integrating competence-driven mechanisms, such as structured feedback loops and adaptive strategies, significantly enhance innovation quality. Firms that actively prioritize competence in their strategic innovation frameworks are better positioned to achieve consistent and superior quality outcomes.

H2: There is a positive and significant relationship between innovation capabilities and the performance of quantity output.

The results confirm a positive relationship (β = 0.102, p < 0.05), supporting H2. Firms with strong innovation capabilities can scale their operations effectively, increasing output volume.

H3: There is a positive and significant relationship between innovation capabilities and productivity performance.

Although significant, the impact on productivity is weaker (β = 0.066, p < 0.05). This suggests that while innovation capabilities enhance productivity, other factors (e.g., market dynamics or operational efficiency) may also play a role.

19.8% of the variance in performance metrics (R^2 = 0.192, ΔR^2 = 0.198) are explained by the overall model. As per the F-statistic (5.911, p < 0.05), the model is statistically significant. The RA further confirms the strategic role of competence in driving quality (β = 0.128, p < 0.05). Structured feedback mechanisms and failure analysis act as mediating factors that amplify the impact of competence on quality outcomes. These findings demonstrate that firms with higher organizational expertise and adaptive capabilities are better equipped to achieve innovation success.

5. CONCLUSION

Here, the strategic role of competence and quality in driving innovation and overcoming failures in the OGI is analyzed. Likewise, it examined the relationship that exists between firms' capabilities for innovation and the quality that subsequent innovations possess. As per the RA, positive and significant relationships are indicated between innovation capacities and output performance (β = 0.128). The findings had important practical implications for managers, practitioners, and government organizations overseeing technological and energy initiatives. Specifically, enhancing innovation capabilities improved performance outcomes and supported sustainable industry growth. Nevertheless, there are certain limitations that offer avenues for future research. Initially, relying on an online quantitative survey resulted in inaccuracies due to rushed responses or lack of awareness. Then, the findings' generalizability was influenced as the sample size was limited. The study highlighted the pivotal role of competence in developing innovation quality. For translating competence into actionable outcomes, structured feedback mechanisms

and failure analysis emerged as critical tools, driving continuous improvements in quality, and mitigating innovation failures. In the future, the study will examine specific dimensions of competence, such as leadership capabilities and cross-functional collaboration, to further understand their impact on innovation quality.

Declaration by Author

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Conflict of Interest: No conflicts of interest declared.

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