

Humans Capital Strategies, Skills Development, and Workforce Transformation Need to Build Resilient and Future-Ready Downstream Organizations in Oil and Gas

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ABSTRACT

Digital transformation has emerged as a critical paradigm in the energy and oil & gas sector, reshaping how organizations operate and deliver value. This transformation is characterized by the integration of digital technologies into all aspects of operations, fundamentally altering business processes, organizational culture, and customer interactions. However, the oil and gas industry faces numerous challenges, ranging from strict regulatory requirements to the need for enhanced operational efficiency. These challenges have pushed companies to follow any strategy. The human capital strategy, skills development, and workforce transformation have become very important in helping oil and gas organizations operate for many years in sustainable ways and remain competitive. This review uses a systematic review methodology to investigate existing studies of 80 research articles that explore workforce transformation in the downstream oil and gas industry. The significance of this review is to improve operational efficiency, employee adaptability, and organizational resilience through innovation capabilities. Results show that organizations that invest in continuous learning and development, strategic talent management, digital skills enhancement, and adaptive leadership are

more resilient to changing industrial conditions. Resilience in downstream oil and gas organizations is dependent on an integrated human capital framework with elements of technological readiness, employee empowerment, and leadership development.

Keywords: *Oil and Gas, Human Capital Strategies, Workforce Transformation, Skills Development, Talent Management, Organizational Resilience, and Future-Ready Workforce.*

1. INTRODUCTION

Digital transformation has become indispensable for maintaining competitiveness and optimizing operations in the rapidly evolving oil and gas sector. The oil and gas industry is transforming profoundly by integrating digital technologies to enhance sustainability, operational efficiency, and competitiveness. However, the sector continues to tackle persistent challenges, including fluctuating oil prices, the demand for a stable fuel supply, and increasingly stringent environmental regulations [1]. The downstream segment is responsible for refining, marketing, and distribution of petroleum products [2]. By investing in human capital, oil companies cultivate a culture of innovation, resilience, and

operational excellence essential for sustainable growth and development [3]. Acquiring such strategies may assist oil & gas leaders in promoting human capital development training activities to increase employees' productivity in their organizations [4]. In oil and gas, Industry 4.0 is characterized by advanced data analytics, Artificial Intelligence (AI), and the Internet of Things (IoT), while Industry 5.0 emphasizes human-machine collaboration and environmental stewardship [5]. Additionally, oil & gas leaders must prioritize the reskilling and upskilling of their workforce to prepare them for digital transformation, which includes developing digital skills crucial for the adoption and effective use of advanced technologies. Digital technology training programs allow employees to build their competence and become better prepared for the digital transformation of their workflows. In addition, digital competency is important as employees need to have the ability to work effectively with digital tools on a daily basis. Additionally, several important aspects of effective digital transformation leadership are dependent on employee empowerment, digital knowledge and experience, collaborative work culture, innovation, and industrial partnership ecosystems [6]. Thus, emerging resilient and future-ready downstream organizations need a planned incorporation of human capital management, skills development, workforce transformation, and digital innovation to explore evolving industrial demands and confirm long-term sustainability in the oil and gas sector.

In this review, the human capital management practices in downstream oil and gas organizations, training and competency development frameworks, and workforce transformation strategies are included in the scope of the review. The review's objective is to investigate the existing studies associated with the human capital strategies, skills development initiatives, and workforce transformation practices in the oil and gas industry. The findings from this review may

provide practical applications in various areas of the oil and gas sector, such as human resource management, workforce planning, employee training, and competency development programs. Certain limitations may affect the results of this review, including limited empirical data availability specific to the definitive industry, the rapidly evolving technological landscape may introduce challenges in the long-term relevance of many review findings, and the difficulty of generalizing results from one segment of the oil and gas sector to all other segments.

A structure of balanced-review sections is given as follows: In Section 2, the research methodology is explained; in Section 3, the literature review is explored; in Section 4, the review summary is described; in Section 5, the conclusion is provided with future research.

2. RESEARCH METHODOLOGY

In this systematic review, the literature review methodology is used to explore the interrelationship between human capital strategies, skills development, Workforce transformation, and organizational resilience in the field of the downstream oil & gas sector. In this approach, the research studies related to workforce transformation and human capital management in the oil and gas industry are discussed. Also, under the research methodology, the RQs, article selection strategy, database sources, inclusion and exclusion criteria, and PRISMA review process are presented.

2.1. DEVELOPED RQs

Defining specific questions helps to narrow down the broad themes of workforce transformation and skills development into specific, measurable inquiries. RQs include:

1. What are the significances of the downstream oil and gas sector?
2. What are the types of theory used related to the objective?
3. Mention the human capital strategies used in the downstream oil and gas sector.

4. What is the importance of training and competency development in Oil & Gas?
5. How is the workforce transformation in Downstream Oil and Gas Organizations?

2.2. Article Selection Strategy

In a systematic review, the selection of articles is significant because only related studies are included in the systematic review process. This kind of strategy assists the researchers in recognizing correct research studies that particularly explore the workforce transformation, employee capability development, organizational resilience, digital transformation, and human capital management in the downstream oil and gas sector. This strategy is of 2 types: inclusion and exclusion criteria.

2.3. Database Sources

Databases, including Scopus, Science Direct, IEEE Xplore, and Web of Science, were used to find literature related to the relationship between human capital strategies, skills development, Workforce transformation, and organizational resilience in the field of the downstream oil & gas sector.

2.4 Inclusion and Exclusion Criteria

The inclusion criteria of research studies published between 2017 and 2026 focused on human capital management related to developing employee competency, transforming the workforce, adopting digital skills, adapting to Industry 4.0 and Industry 5.0, building organizational resilience, and developing leaders and training them within the oil and gas industry. All studies that were unrelated to developing human capital strategies or workforce development within the oil and gas industry were excluded from the review. Also, excluded were any articles that were published prior to 2017, not peer-reviewed, duplicates of another study, incomplete, or written in a language other than English.

2.5 PRISMA Review Process

The screening and selection of the articles followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, so that there was a structured, transparent, and systematic process for the review. Figure 1 shows the PRISMA flowchart of the article selection process.

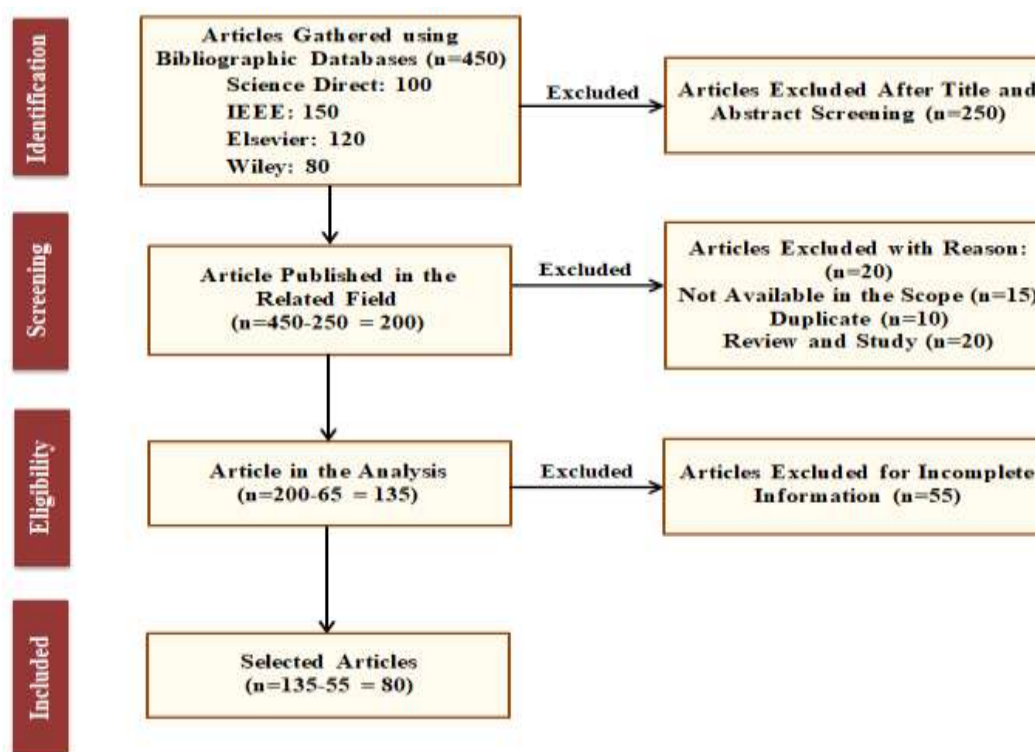


Figure 1: PRISMA framework

3. CONCEPTUAL AND INDUSTRY BACKGROUND

The downstream oil and gas sector's primary function is to convert crude oil into usable forms through the processes of refining, preparing for transportation, and distributing finished products to their final destinations [7]. Downstream oil and gas has traditionally been an industry, where firms have increased market power and established barriers to entry. The forces of digitalization, environmental sustainability, global competition, fluctuations in crude oil prices, and rapidly changing expectations for workforces are now creating challenges [8]. To respond to these challenges, there is a need to develop effective human capital strategies that support organizations' ability to respond to rapidly changing market conditions. Human capital strategies employed in the downstream oil and gas industry include: workforce planning, employee development, succession planning, diversity and inclusion, employee engagement, and performance management [9]. The development of employee skills is increasingly important due to rapid technological advancement associated with digital technology. Workforce transformation in the downstream is affected by energy transition, sustainability, and the growing need for agility and technology [10].

3.1. Overview of the Downstream Oil and Gas Sector

The downstream oil and gas industry involves the final stages of processing and selling petroleum products. This sector includes refining crude oil into usable products like gasoline, diesel, and jet fuel, producing petrochemicals used in a variety of consumer and industrial products, and distributing and marketing these refined products to consumers and businesses [11]. Human error, including exhaustion, distraction, and insufficient training, was the main cause of accidents in downstream oil and gas construction projects (refineries, petrochemical plants, and pipelines). The study investigated the major safety elements

that led to accidents in downstream oil and gas development projects [12]. The results provided insights into the important safety factors in Malaysia's oil and gas construction sector and could help advance the field's theoretical and practical aspects of construction safety. Supply Chain Sustainability (SCS), which examined environmental, social, and economic effects beyond simply procuring oil, was crucial to downstream oil and gas refining, processing, and distribution—aside from accidents. The study [13] examined the SCS practices of oil servicing companies in Nigeria's oil and gas industry's downstream sector. The findings demonstrated that oil servicing firms' supply chain management strategies for creating, manufacturing, selling, shipping, and maintaining their clients' products rarely take sustainability standards into account. Further, the Safety Risk Factors (SRFs) and adaptation measures were explored in the downstream oil and gas industry in the study [14]. It was found that SRFs, such as fire and explosion hazards, were the most critical, followed by slips, trips, and falls, confined space, motor and vehicle accidents, and injuries. The study revealed that increasing safety awareness and empowering key staff might be an effective way of mitigating the safety risks.

Additionally, the innovation and competitive advantage in Nigeria's deregulated downstream sector of the oil and gas industry were explored [15]. Study [15] showed a positive relationship between process innovation, marketing innovation, business model innovation, and competitive advantage, with marketing innovation indicating the strongest effect. Also, the community engagement, health and safety costs, and financial performance of listed natural resource and downstream oil and gas firms in Nigeria were investigated in the study [16]. Data were sourced from the annual reports and financial statements of thirteen firms listed on the Nigerian exchange group. The findings revealed that neither community engagement nor health and safety costs individually exerted a

statistically significant effect on return on assets. Further, the effect of corporate environmental performance and community engagement on the financial performance of listed extractive industries firms and downstream oil and gas firms in Nigeria was explained in the study [17]. Study [17] found that both corporate environmental performance cost and community engagement cost were not significant in affecting the return on assets of sample firms. Moreover, the implementation of the fourth industrial revolution 4.0 technologies in Tanzania's downstream oil and gas industries was explained in the study [18]. The results indicated that oil and gas industries in Tanzania were not adequately implementing these technologies, as they were at the medium level, necessitating more effort on their integration into downstream oil and gas operations to reach the highest level of their implementation.

Also, environmental and economic reporting directly influenced the financial performance of listed downstream oil and gas companies, with studies showing that environmental sustainability reporting significantly influenced firm value and return on assets. In the study [19], the effect of environmental and economic reporting on the financial performance of listed oil and gas companies (downstream sector) in Nigeria was explored. The results revealed that environmental reporting and economic reporting had insignificant and significant effects on the net profit margin of listed oil and gas companies in Nigeria, respectively. The study [20] then examined the operational effectiveness and adoption of the Digital Supply Chain (DSC) by downstream oil and gas industries in Rivers State. The correlation was positive, suggesting that the use of DSC chains improved decentralized management.

The results of the study [20] showed a strong beneficial relationship between operational efficiency and DSC adoption of downstream oil and gas firms in Rivers State. This outcome was consistent with an increasing amount of research that emphasized how digital technologies could improve supply chain performance, especially in intricate and logistically demanding industries like oil and gas. Further, it is essential to discuss the most significant parameters and insights used in the research studies of the downstream oil and gas sector, which are tabulated in Table 1.

In Table 1, most studies employed descriptive statistics, correlation analysis, regression analysis, and structural equation modeling to evaluate relationships between operational practices and organizational performance. Sample sizes ranged from 9 companies to 263 participants, indicating variation in the study's scope. Significant p-values below 0.05 in several studies, such as those by Ahsan, *et al* [12]., Sunday, *et al* [17]., Mwinyi, *et al* [18]., and Roseline, *et al* [20]., indicated statistically meaningful relationships between the examined variables. Mean values, such as ROA and operational indicators, demonstrated moderate organizational performance across firms. Correlation coefficients varied with Roseline, *et al* [20], showing a strong positive correlation (0.717). The studies collectively highlighted major challenges, including infrastructure deficits, high operational costs, price volatility, inadequate ESG reporting standards, legacy system integration, and balancing community engagement with profitability and sustainability goals.

Table 1: Most significant parameters and insights used in the research studies of the downstream oil and gas sector

Author's name	Methods used	Samples	Mean values	Significance (p-value)	F-statistic	Correlation coefficient	Standard Deviation (SD)	Chi-square value	Challenges
Ahsan, <i>et al</i> [12]	Exploratory Factor Analysis (EFA) and Structural Equation Modeling (SEM)	263 legitimate participants	Nil	Less than 0.05	Nil	Nil	Nil	11520.7	Managing high-risk operations and overcoming cost-driven shortcuts
Ifere, <i>et al</i> [15]	Descriptive statistics	81 senior management employees	4.24	Nil	Nil	Nil	0.85	Nil	Intense price volatility and infrastructure deficits impacted distribution efficiency
Karimu, <i>et al</i> [16]	Descriptive statistics, correlation analysis, variance inflation factor tests, and Hausman specification test	13 firms	Return On Assets (ROA): 3.894 per cent	0.3631	7.943	0.0736	8.561	8.784	Balancing high, often mandatory, community engagement
Sunday, <i>et al</i> [17]	Descriptive statistics, correlation analysis, and random effect regression tests	12 firms	ROA: 4.24	Below the 0.05 level	80.77537	0.18	8.34	3.951629	Insignificant statistical impact of environmental/community costs on profitability
Mwinyi, <i>et al</i> [18]	Survey method	100 respondents	Refining (4.93), storage (4.73), transportation (4.17), and distribution (4.64)	p<0.05	Nil	Nil	0.372 (Strategic Infrastructure and Technology Investment)	Nil	Technical infrastructure deficits, high capital costs, and a lack of skilled human capital
Ibrahim, <i>et al</i> [19]	Descriptive statistics and correlation and regression analyses	9 companies	0.40741	0.6339	0	0.000738	4.297332	9.01789	Inconsistent reporting standards and a lack of mandatory and standardized ESG frameworks
Roseline, <i>et al</i> [20]	Pearson Product-Moment Correlation statistics	145 managers	Nil	p = 0.000 < 0.05	Nil	0.717	Nil	Nil	High initial costs and legacy system integration

3.2 Theoretical Foundations

There are 3 types of theory used in the research objective. Human Capital Theory, Resource-Based View Theory, and Dynamic Capability Theory are the types of theories. These three theories are commonly integrated in the oil and gas industry to analyze competitive advantage.

Human Capital Theory

Human Capital Theory (HCT) in the oil and gas industry treats employee skills, knowledge, and experience as vital intangible assets that drive productivity, innovation, and safety [21]. HCT is a foundational concept in economics and sociology that emphasises the role of education, skills, and training in enhancing worker productivity and economic growth. In the research study [22], the manpower development programmes and employee productivity in selected oil and gas firms in Bayelsa State using HCT were explored. Based on these findings, the study recommended that oil and gas firms should increase and sustain investment in continuous manpower development programmes to further enhance employee productivity. Overall, the HCT provided a strong theoretical foundation for examining manpower development and its influence on productivity, particularly in the context of selected oil and gas firms in Bayelsa State.

Resource-Based View Theory

The Resource-Based View (RBV) in the oil and gas industry focuses on achieving sustainable competitive advantage by leveraging internal, unique, and valuable resources, such as high-quality reserves, advanced drilling technologies, and specialized technical expertise.

In a recent study on environmental accounting costs and financial performance for oil and gas companies in Nigeria, the interconnection between the Resource-Based-View Theory (RBV), Stakeholder Theory, and Legitimacy Theory was analyzed. The results indicated that there was a strong positive relationship between

environmental accountability costs and financial performance. Therefore, those companies that entered into environmental contracts eventually could receive higher levels of profitability [23]. The impact of strategic environmental management capabilities on the competitiveness of an oil and gas industry's supply chain, as an empirical evaluation of the natural resource-based view of firms, was examined in the study [24]. The findings showed that the O&G companies' environmental competitiveness was positively impacted by the three SEMCs.

Dynamic Capability Theory

Dynamic capability theory in the oil and gas industry focuses on how companies sense opportunities/threats, seize advanced opportunities, and reconfigure assets to sustain competitive advantage amidst high volatility, energy transitions, and technological shifts.

In the research study [25], the achievement of agility and dynamic capabilities on sustainable performance, with the evidence from the oil and gas sector, was explored. Research found that TMT commitment and leadership agility development of field agile leaders, directly and indirectly, played a significant role in the Indonesian oil and gas sector. Leadership agility development had a strong influence on the field. Further, in the study [26], the knowledge management and dynamic capabilities of the upstream oil and gas sector in the era of normal, with the moderating effect of innovation strategy, were investigated. Findings revealed that innovation strategy significantly moderated the relationship between knowledge management and dynamic capabilities of the upstream oil and gas sector.

4. LITERATURE REVIEW AND THEMATIC ANALYSIS

4.1. Human Capital Strategies in Oil and Gas

Developing human capital is central to most oil & gas companies. Oil & gas companies rolled out many initiatives for the overall

development of the workforce that helped employees to keep up with the current technology, as well as business and soft skills [27]. The implementation of effective human capital development strategies became essential for organizations aimed at achieving sustainability. Research revealed that leadership practices significantly influenced sustainable human capital development by fostering a culture of learning and environmental responsibility [28].

In the study [29], the valuable sources of sustainable competitive advantage in the oil & gas sector through strategic human capital management were explored. Data gathered from the survey questionnaire were tallied and analyzed using SPSS. The findings revealed that the job compensation package and strategy dashboard were significantly correlated with employee skills and employee roles. Additionally, the impact of HR practices on employee retention in Oman's oil and gas industries was examined in the study [30]. This study's main objective was to examine the existing HRM practices used by Oman's oil and gas industries and evaluate strategies for retaining human resources in these businesses. The majority of respondents in Oman's oil and gas industry were found to support the company's personnel retention strategy and human resource practices. Furthermore, the strategic talent management and employee retention of oil and gas servicing firms in Rivers State were explored in the study [31]. The findings underscored the importance of structured recruitment, training, career development, and succession planning in fostering workforce stability within specialized and competitive industries. The strategic employee engagement and organizational sustainability of multinational oil and gas corporations in Rivers State, Nigeria, were also included in the study [32]. A standardized questionnaire on a 5-point Likert scale was used to gather primary data. According to a study [32], strategic employee engagement—in particular, leadership commitment and compensation

systems—was essential for improving financial sustainability. In order to maintain financial performance, oil and gas companies enhanced work-life balance programs, increased leadership engagement tactics, and put in place structured reward systems.

Moreover, the workplace diversity management and employee engagement in the oil and Gas industry in Nigeria were explored in the study [33]. Employee performance was positively influenced by cultural factors, and cultural diversity among employees could yield some valuable insights in an organization. Furthermore, in the study [34], the health, safety, and environment culture in the United Arab Emirates oil and gas industry was assessed. The findings revealed that the interviewees viewed HSE culture as a descriptive term, a causal phenomenon, a systemic approach, or a legal requirement/obligation. Additionally, in the study [35], the health and safety training and employee performance in oil and gas companies in Rivers State, Nigeria, were explained. The hypotheses were tested using the spearman rank order correlation coefficient. The findings of the study revealed that there was a significant and positive relationship between health and safety training and employee performance in oil and gas companies in Rivers State, Nigeria. Also, in the study [36], the enhancement of employees' performance via professional training and development in oil and gas companies operating in Yemen was explored. The results of the study showed that training had an obvious and positive effect on employee performance in Yemen's oil and gas companies, and their performance was influenced by the training. The relationship between training and employee performance affirmed that it was beneficial to implement a successful training program at oil and gas companies in Yemen.

Talent management in Oil and Gas (O&G) firms is a critical strategic function focused on attracting, developing, and retaining specialized skills amidst industry volatility, an aging workforce, and the energy transition. Talent management and workers'

commitment to oil & gas firms in Nigeria were explained in the study [37]. Talent management had a significant positive relationship with workers' commitment. It was concluded that talent management, measured in terms of talent attraction, talent development, and talent retention, promoted workers' commitment in oil and gas firms in Nigeria. In the other study [38], the talent management strategies on employee performance in the Nigerian oil and gas industry, as a comparative study of generational differences, were explored. Research findings indicated that corporations ought not to excessively concentrate on intergenerational disparities while formulating human resources management tactics. Other than talent management, the Corporate Social Responsibility (CSR) in the oil and gas industry was critical for managing Environmental, Social, and Governance (ESG) impacts, addressing climate change, and maintaining "social license to operate". The effect of CSR on corporate performance in the oil and gas industry was explored in the study [39]. Data were collected by means of a self-administered survey questionnaire. The study results showed that CSR to employee dimensions played an important role in corporate performance. Results of the study showed that employees preferred to work in socially responsible corporates were positively affected by CSR to society, the natural environment, next generations, non-governmental organizations, employees, and

customers. In the other study [40], the CSR and earnings per share of oil & gas companies in Nigeria were explained. The total enumeration sampling technique was adopted for the study, and descriptive and inferential statistics were used to analyze the data. CSR had no significant effect on the earnings per share of oil & gas companies in Nigeria. The study recommended that policies should be made for oil and gas companies to report mandatorily about their corporate social responsibilities in their annual reports. Finally, the sustaining oil and gas multinational operations through corporate social responsibility practices and the relationship between CSR and financial performance in the oil and gas sector were explored in the studies [41] & [42]. The Hausman test did not show any correlation between the unobserved person-specific random effects and the independent variables. Therefore, the random effects model was accepted for the estimation of the panel data model [41]. Outcomes of the study carried important managerial and practical implications for oil and gas firms, which fell in the business case. The study [42] only considered three dimensions for economic CSR, such as economic responsibility towards owners, economic responsibility towards customers, and economic citizenship. Furthermore, it is essential to explain the significance of human capital strategies in oil and gas in the discussed research studies, which is shown in Table 2.

Table 2: Significance of Human Capital Strategies in Oil and Gas in the discussed research studies

Methods	strategies	Samples	Cronbach's Alpha	t-statistics	Mean	Significance (p-value)	R Square	Standard error	Challenges	Ref
Questionnaire-based method	Employee retention	50 samples	0.976	Nil	Nil	0	0.997	0.04304	High turnover rates and balancing Omanization goals with the need for skilled expatriates	[30]
Quantitative research design	Talent management	302 study elements	above 0.70	11.065	0	0	0.579	0.428	High employee turnover and loss of technical expertise	[31]
Pearson correlation analysis and multiple regression technique	Employee Engagement	320 staff of Shell Petroleum Development Company (SPDC)	0.705	Nil	3.8362	p-value > 0.05	0.153787	0.795905	Ingrained ethnic, gender, and regional biases and complex communicational barriers	[33]
Quantitative technique	Employees' Performance	150 questionnaires	0.958	47.17	Nil	0	Nil	Nil	Limited financial resources and a lack of qualified training evaluation methods	[36]
Questionnaire-based method	CSR	339 usable responses	Nil	1.96	Nil	Less than 0.001	Nil	Nil	Aligning high operational emissions with sustainability goals	[39]
Enumeration sampling technique	CSR	8 oil and gas companies	Nil	1.77	Earnings Per Share (EPS): 0.756	0.4528	0.2579	Environmental Accounting (EA): 28.108	Balancing high operational costs was difficult	[40]
Mixed qualitative and quantitative techniques	CSR	9 oil and gas multinationals	Nil	0.773861	1	0.05	0.231583	0.045621	Managing the high costs of sustainable technology was difficult	[41]
Quantitative and survey method	CSR	26 oil and gas manufacturing and marketing companies	0.809	0.635	Nil	0	Nil	0.55792	Effectively measuring impact was difficult	[42]

The most widely used methods across the studies were questionnaire-based and quantitative approaches to assess strategy outcomes, such as employee retention, talent management, employee engagement, employee performance, and CSR. The sample sizes ranged from 8 companies to 339 respondents; thus, they included both large-scale and small-scale studies. Cronbach's Alpha from the above-mentioned studies demonstrated a high level of reliability with respect to the data collected. Therefore, there was good reliability associated with the data. Many of the studies also showed statistically significant relationships in establishing the effectiveness of human capital practices on organizational outcomes using t-statistics, p-values, and R-squared values. The common challenges reported were: high employee turnover, lack of technical skills, communication barriers, limited financial resources available to support human capital initiatives, and difficulties in measuring the financial impact of CSR on the organization.

4.2. Training and Competency Development in Oil & Gas

Training and competency development in the oil & gas industry focuses on creating a safe, technically proficient workforce through structured learning, covering upstream to downstream operations, HSE compliance, and digital transformation. Competency-based development is a significant part of training and development; also, it has been adopted in one form or another by a number of companies and industry organizations [43].

The transformation of the personnel training system for oil and gas projects in the Russian Arctic was investigated in the research paper [44]. The study's findings demonstrated that preparing employees for employment in the Arctic had unique requirements and frequently deviated from the general guidelines for guaranteeing the educational process. Global trends in "Arctic personnel" training demonstrated the need for an interdisciplinary approach, a foundational understanding of the natural sciences, and an

examination of the region's sociocultural peculiarities. The study [45] suggested that specific goals, intensive training, motivation, and skilled experts ought to achieve a successful competency model and competent employees. Furthermore, the well service rig utilization for competency-based training in the oil and gas energy sector was explored in the study [46]. The findings indicated that Rig #99 played a critical role in developing the competencies necessary for well service, aligning with the SKKNI standards, and fulfilling the demand for qualified personnel in Indonesia's oil and gas industry. Furthermore, the impact of intensive training and quality assessment on the core competency of oil and gas employees in Yemen Petroleum companies was explored in the study [47]. The result of data interpretation provided affirmation of a significant positive effect of intensive training on employees' core competence, with limited specific gaps in safety issues as well as troubleshooting, and recommended an action plan to bridge such gaps. Also, in the study [48], the training and development of human resources for the oil and gas industry in Indonesian good governance were explored. The purpose of the study was to ascertain, characterize, and evaluate how the Musi Banyuasin district's job seekers were served by the training. The study's findings indicated that the best possible training and development programs for job seekers in the Musi Banyuasin district provided the provision of apprenticeships and on-the-job training for qualified and certified human resources in the oil and gas industry. Finally, the green human resource competency mechanisms: moderator role between green supply chain and the oil and gas industry environmental performance and core competencies of a global oil and gas company as a qualitative analysis were investigated in the studies [49] & [50]. There was a significant moderating effect between EP and GSCM, with GHR competency mechanisms decreasing the occurrence of negative environmental impacts associated with O&G operations [49]. The study [50]

identified core competencies and highlighted the benefits of core competencies as well as the development of core competencies in an oil and gas company in Malaysia. Also, it is

essential to explain the significance of training and competency development in oil and gas in the discussed research studies, as shown in Table 3.

Table 3: Significance of training and competency development in Oil and Gas in the discussed research studies

Competency	Training	Samples	Location	Duration	Variance	Significance	Beta	Challenges	Ref
✓	✗	30 samples	Russian arctic	5-10 years	Nil	Nil	Nil	The energy sector was not used within the upstream sector.	[44]
✓	✓	350 trainees	Not specified	2 year	23.90%	0	0.04	There was no significant relationship between core competence and skill pool experts.	[45]
✓	✓	350 trainees	Yemen	5 years	23.90%	0.01	0.042	Limited specific gaps in safety issues.	[47]
✓	✗	606 participants	Indonesia	14-90 days	Nil	Nil	Nil	Absorption of local workers was very minimal.	[48]
✗	✓	254 participants	Not specified	Nil	0.42%	0.001	0.015	Limited samples in studies.	[49]
✗	✓	Not specified	Malaysia	4-5 years	Nil	0.999	Nil	Lack of studies on core competence.	[50]

✓: included and ✗: excluded

According to Table 3, the research conducted on training efficiency and workforce or employee competencies was related to two industries: energy and oil. There was a fairly large variation in sample sizes; the smallest variation was just 30, and the largest variation was 606 participants. Additionally, the duration of studies also varied widely, with study durations being as short as 14 to 90 days and as long as 10 years. The majority of studies reported moderate variance (e.g., 23.90% & 0.42%), indicating how competency and/or training impacted organizational outcomes. The majority of studies indicated some kind of relationship between competencies developed through training and examples of low to no correlation in training vs. competency development. There were a lot of common difficulties recognized across the published literature, including smaller sample sizes, a lack of research related to safety, and a weak

to no relationship between competency frameworks and expert skill pools in the industry.

4.3 Skills Development for Digitalization and Energy Transition

Skills development for the twin transition of digitalization and energy requires a multidisciplinary approach, blending technical expertise in renewable energy with digital proficiency in data analytics, AI, and smart systems. The rapid pace of technological change necessitates immediate action on upskilling, lifelong learning, and curriculum updates to bridge critical skill gaps [51].

In the research study [52], the skill gap bridged in energy transition towards a sustainable workforce development was explained. The findings showed that a successful energy transition required focused investments in education and training that

were tailored to the demands of the latest technologies. Additionally, the study's findings [53] contributed to the expanding amount of information regarding the energy sector's transformation. Other academics were given a thorough introduction to the variety of strategic tools that could be employed in a program for digital transformation by the overview of the strategic tools. Despite obstacles brought on by the industry's compartmentalized organizational structure, the study's results [54] also emphasized the vital need for cooperative efforts to close skill and expertise gaps.

Moreover, the sustainability-based strategic framework for digital transformation in the oil and gas industry was explored in the study [55]. The findings underscored the pivotal role of digital technologies in improving efficiency, safety, and sustainability. Also, they highlighted the importance of strong leadership and workforce development. Organizational resistance to change, a severe lack of digital skills, and the difficulties of integrating advanced technologies were among the issues noted. Additionally, the study examined digitalization and the future of employment using Canadian offshore oil and gas drilling jobs as a case study [56]. To evaluate the suggested algorithm's resilience to changes in the feature values and weighting factors, a sensitivity analysis was carried out. Only one job survived after 2058, followed by three distinct job merging pathways when feature values and weighting factors were altered by up to $\pm 20\%$ of their initial values, while the other jobs stayed the same. Finally, the management of a sustainable development of the oil and gas sector in the context of digitalization was explored in the study [57]. Based on the simulation results, interdependencies of two key aspects of the study, the sustainable development of the oil and gas sector and its digital transformation, were observed.

4.4 Workforce Transformation in Downstream Oil and Gas Organizations

Workforce transformation in the downstream oil and gas industry (refining,

petrochemicals, and distribution) is driven by three urgent needs: the need for companies to quickly integrate digital technology, the need to accelerate the energy transition, and the need to close the significant generational talent gap [58]. Companies are transitioning from rigid, volume-driven operations to flexible, technology-enabled operations, which ultimately require their workforces to quickly adapt in order to survive [59].

The effects of AI on the workforce of the future were examined in the research study [60], which focused on the oil and gas industry. The results of the study indicated that AI affected the workforce in both positive and negative ways. In addition to creating job opportunities in high-tech industries like data science, cybersecurity, and AI monitoring, automation took over more repetitive and ordinary work, which raised concerns about job losses. Furthermore, in the study [61], the industry transformation with digitalization and automation in oil and gas wells was explored. Results highlighted the potential for improved well performance, reduced environmental impact, and enhanced reservoir management through the integration of digitalization and automation in oil and gas wells. In the other study [62], the U.S. oil and gas extraction workforce with public data was investigated. It was shown that this workforce was divided between lead and specialized employers; also, the characteristics and working conditions of these two groups differed significantly. Similarly, the urgency of the fiscal pressures that faced Middle Eastern oil-producing states meant that policymakers no longer had the luxury of the slow pace of incremental change that characterized previous episodes of reform in GCC states [63]. Also, by facilitating the transfer of clean technology to developing countries destitute of advanced technological capabilities, operations in the manufacturing sector, the transport sector, and the oil and gas sector significantly reduced emissions in such countries [64]. Moreover, the research study [65] indicated that having a significant

number of women on senior executive teams could improve decision-making. Also, it is essential to explain the significance of workforce transformation in downstream oil and gas organizations in the discussed research studies, as shown in Table 4.

In Table 4, the significance of workforce transformation within downstream oil & gas entities is outlined through a variety of research endeavours and evaluations that have occurred throughout the world, including observational, applied research, and experimental evaluation methods. Examples of study sites included Malaysia, Abu Dhabi, Dubai, and the USA, with sample sizes ranging from single workforce groups to approximately 261,000 individuals. Findings indicated that there was a clear relationship between workforce transformation, operational efficiencies, and organizational sustainability in the upstream oil and gas industries. Conversely, major challenges for workforce transformation were technological adaptation challenges, data integration barriers, limited access to information, economic complexity constraints, workforce fluctuations, and poor internal networking systems.

4.5 Developing Organizational Resilience in Oil and Gas Organizations

Establishing organizational resilience for businesses within the oil and gas sector can be characterized to predict, respond, and recover from disruptions (operationally, environmentally, economically, and technologically) [66]. This also helps to develop any further resilience required by having a strategic focus that incorporates risk management, skilled workers, digital innovation, safe work cultures, and sustainable business practices into both their daily operation and long-term planning process [67].

The human resource succession planning and resilience of multinational oil and gas producing firms in Nigeria were investigated in the research study [68]. The results of this

study demonstrated a moderately significant positive correlation between the resilience of multinational oil and gas producing corporations in Nigeria and human resource succession planning. The resilience metric (situation awareness) was, in fact, greatly impacted by human resource succession planning. The results of the study [69] demonstrated that both organizational structure and adversity quotient had a significant direct positive effect on employee performance, and both significantly influenced work motivation. However, work motivation did not have a significant effect on employee performance, indicating that the mediating role of work motivation was not supported. Findings of the study [70] indicated the importance of strengthening mental resilience and social support in efforts to maintain the psychological well-being of oil and gas workers facing high work pressure. Furthermore, in the study [71], the competence planning and resilience of quoted oil and gas companies in South-South, Nigeria, were explained. Empirical findings revealed that there was a positive and significant relationship between competence planning and organizational resilience.

Moreover, the highly reliable organisations and sustainability risk management with the safety cultures in the Nigerian oil and gas supply chain sector were explored in the study [72]. The findings revealed that stakeholder risk perception influenced sustainability risk management. However, variations in risk prioritisation between internal and external stakeholders remained a challenge. At the end, the resilient organization with the lessons learned from the oil and gas sector in Qatar was explored in the study [73]. The results showed ten REIs contributing to the organization's resilience and the top four most important Resilience Dimensions (RDs). Also, it is essential to explain the organizational resilience in oil and gas organizations in the discussed research studies, as shown in Table 5.

Table 4: Importance of workforce transformation in downstream oil and gas organizations in the discussed research studies

Study Type	Location	Samples	Gender	Duration	Cost	O&G sector %	Age distribution	Challenges	Ref
Applied research study	Malaysia	385 individuals	Not specified	20 years	Nil	20%	18-24 years	Obstacles in data integration and technological uptake.	[60]
Observational study	Not specified	Not specified	Men and women	Not specified	Cost effective	Nil	Nil	Adaptability and maintenance constraints.	[61]
Experimental evaluation	United States	261805 workers	Not specified	2000-2022	Nil	Nil	Nil	Fluctuations in lead-specific workforces.	[62]
Applied research study	Abudhabi	54% Indians	Men	2000 to 2010	12-15% tax	12%	Nil	Limited freedom to access the information.	[63]
Applied research study	Dubai	Not specified	Not specified	2010 to 2019	Nil	10%	Nil	Limited economic complexity.	[64]
Observational study	Not specified	35% women graduates & 57% college graduates	Women	Not specified	15% interest returns	Nil	Graduates (over 18years)	Limited internal networks.	[65]

Table 5: Organizational Resilience in Oil and Gas Organizations in the discussed research studies

Study type	Location	Resilience	Samples	Cronbach Alpha	Significance (p-value)	SD	Correlation coefficient	Challenges	Ref
Analytical study	Nigeria	Corporate Organizational Resilience	52 oil and gas producing companies	0.7	Less than the level of significance (0.05)	1.556	0.502	Managing cultural differences was complex	[68]
Quantitative study	Indonesia	Organizational Resilience and Economic Resilience	80 respondents	0.899	p=0.003	Nil	0.379	Supply Chain Limitations and Local Capability	[69]
Analytical study	Not specified	Mental Resilience and Organizational Resilience	200 oil and gas workers	0.842	(p) > 0.05	Nil	0.521	High-stakes environments	[70]
Analytical study	Nigeria	Organizational Resilience	222 respondents	0.840	0.05	Nil	99% confidence interval	Volatility in oil prices and infrastructure deficits	[71]
Quantitative study	Nigeria	Organizational Resilience	441 stakeholders	Greater than 0.6	5%	0.064	Nil	Weak top-management commitment	[72]
Quantitative study	Qatar	Organizational Resilience	24 developed Resilience Engineering Indicators (REIs)	0.8	0.05	Nil	Nil	Managing risks associated with an aging workforce	[73]

Table 5 provides a summary comparison of findings from various studies focused on organizational resilience for oil and gas-related entities in different countries. Most researchers used analytical and quantitative research designs to evaluate resilience factors at the company level, employee level, and stakeholder level. The results indicated that Nigeria had the largest number of studies, which discussed topics like cultural variability, volatility in oil prices, deficiencies in infrastructure, and inadequate commitment from upper management within organizations. All of the studies, which reported data, had an acceptable level of reliability with the Cronbach Alpha values ranging from .700 to .899, indicating that the research instruments and methods used had adequate consistency. The correlation coefficient analysis provided for the resilience variables indicated moderate positive correlation between the variables, with correlation coefficients ranging from .379 to .521. Some of the most frequently reported common challenges were supply chain problems, risk created by an aging workforce, high-risk work environments, and local capability limitations.

4.6 Future-Ready Workforce Strategies in the oil and gas sector

Future-ready workforce strategies in the oil and gas sector focus on preparing employees and organizations to adapt to rapid technological advancements, energy transition demands, and evolving operational challenges. These strategies emphasize continuous upskilling and reskilling in areas like digital technologies, automation, artificial intelligence, cybersecurity, and sustainable energy practices to ensure workforce competitiveness and operational efficiency [74].

Factors impacting information sharing practices and their connection to organizational performance in the oil and gas sector were examined in the research study [75]. The findings of the study showed that there were important connections between the model constructs. The elements

influencing knowledge sharing practices in the OG business were better understood as a result of this research. These results demonstrated how knowledge-sharing strategies improved organizational performance by lowering costs, fostering organizational expansion, and providing intangible advantages. Additionally, the results of the study [76] supported the statistical significance, showing that the oil and gas industry could successfully address its sustainability difficulties and maintain its competitiveness in the market by embracing digital innovation and applying circular economy principles. Fatigue and mental health could function as risk factors, although occupational pressures had a detrimental impact on safety behavior in the study [77]. Furthermore, in the study [78], all dimensions of GHRM (Green training and development, Green recruitment and selection, Green rewards and compensation, and Green performance management) showed significant and positive relationships with corporate sustainability. Likewise, leader support mediated the relationship between GHRM and corporate sustainability in the oil and gas industry.

At the end, the quality management practices in the oil and gas industry and the diversity element that affected employee satisfaction in the workplace in the oil and gas industry were investigated in the research studies [79] & [80]. The results of this paper provided guidance for managers and practitioners in the oil and gas sector to implement the proposed 5-factor QMP model (Top management commitment, Employee involvement, Training and Development, Customer focus, and Supplier Quality Management), thereby improving organizational performance [79]. Analysis of study [80] indicated that there was a significant positive relationship between gender & ethnicity and education with employees' satisfaction towards diversity at working place. Also, it is essential to explain the future-ready workforce strategies in the oil and gas sector in the discussed research studies, as shown in Table 6.

Table 6: Future-Ready Workforce Strategies in the oil and gas sector in the discussed research studies

Location	Sample	Cronbach Alpha	Significance (p-value)	Future Work Strategies					Challenges	Ref
				Workforce diversity	Leadership Development	Knowledge Sharing	Digital Skills Development	Health, Safety, and Well-being		
Canada	89 valid anonymous responses	0.93	<0.001	✓	✓	✗	✗	✗	Common method variance and reverse causality issues	[74]
Malaysia	203 responses	0.869	p < 0.05	✗	✗	✓	✗	✗	The lack of knowledge sharing practices and the imminent loss of technical knowledge within the OG industry	[75]
Saudi Arabia	348 executives	0.783 to 0.983	Nil	✗	✗	✗	✓	✗	Proprietary data risks and Dual-mandate pressure	[76]
Kuwait	387 responses	Nil	0.01	✗	✗	✗	✗	✓	Roster and shift constraints	[77]
Nigeria	384 respondents	0.862	Nil	✗	✓	✗	✗	✗	Role conflict pressures	[78]
Nil	340 questionnaires	0.85	0.677	✗	✗	✓	✗	✗	Asset degradation risks	[79]
Saudi Arabia	400 employees	0.781	Nil	✓	✗	✗	✗	✗	Multi-national communication barriers	[80]

✓: included and ✗: excluded

This table looked at some of the studies on future-ready workforce strategies in the oil and gas industry across many parts of the world. These strategies included increasing the diversity of the workforce, developing leadership skills, sharing knowledge about the work that was done by the people within the organisation, having digital skills training to support technological advancement, and establishing best practice methods for supporting employee health, safety, and wellness. All studies were highly reliable with Cronbach's Alpha coefficients between 0.781 and 0.983. Additionally, the majority of the studies showed statistically significant results due to their p-values being statistically significant. Some of the common barriers to implementing these initiatives identified by the studies were communication barriers, role conflict pressures, business proprietary information risk, and ineffective knowledge-sharing practices.

5. REVIEW SUMMARY

A systematic review conducted a thorough investigation of 80 studies and determined that workforce transformation and the development of human capital were critical components that ensured the sustainability and resilience of downstream oil and gas companies. The majority of these studies focused on highlighting digital competence, adaptive leadership, continuous learning, and strategic planning as important factors for dealing with the effects of technological disruption and market uncertainty. Additionally, research confirmed that organisations that used reskilling and developed talented employees had more operational flexibility and innovation capacity than those that did not implement such strategies. However, agencies within the downstream sector still struggled with

difficulties in aligning workforce transformation initiatives with long-term goals of both sustainability and business strategy. Most of the existing literature investigated one or two of the isolated aspects of employee development (i.e., training, leadership, automation, or talent retention) rather than studies looking at all aspects as a whole when assessing the collective contribution of all these elements on an organisation's overall resiliency level. In addition, there were a few studies investigating region-specific workforce challenges and identifying the impacts of energy transition policies on downstream organisations' workforce capability.

Oil and gas companies in the downstream oil and gas sector were under pressure to prepare their workers for advanced technology and changes within the industry and society. While several organizations provided workforce transformation strategies in place, the lack of integrated implementation frameworks and performance metrics made them less than effective. The overall workforce transformation framework within the oil and gas companies in the downstream sector did not align with major human capital development, technological advancement, and organizational objectives. Many studies showed that companies were taking a fragmented approach to training and development. Consequently, training and development programs and initiatives did not meet operational requirements or the needs of the sector in the future. Furthermore, inadequate emphasis on organizational culture, lack of employee well-being, and lack of knowledge transfer systems were educational barriers in establishing resilient and future-ready downstream oil and gas organizations. Also, the search results of the review are shown via the graphical representation in Figure 2.

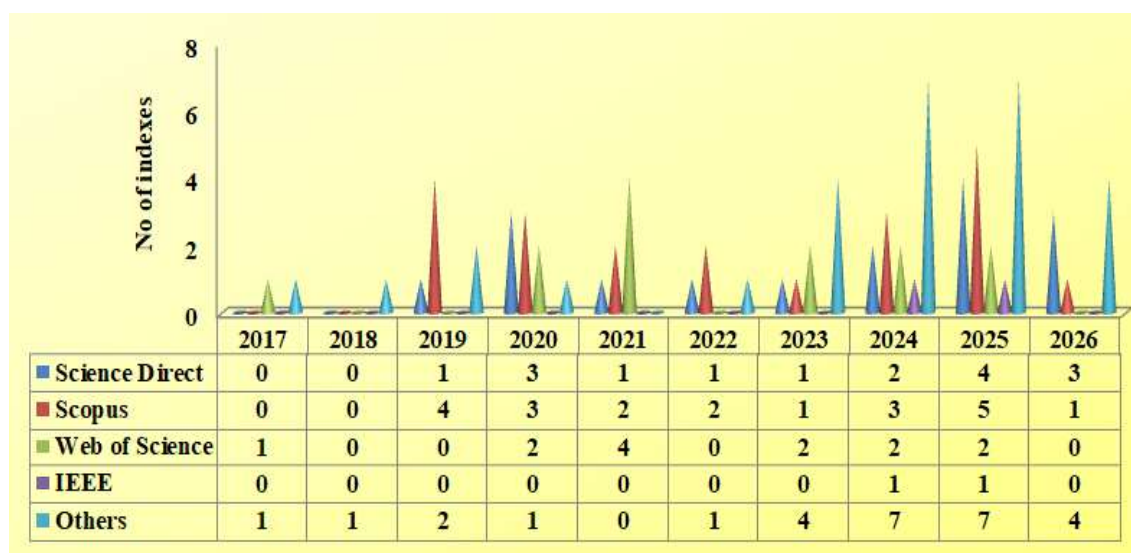


Figure 2: Graphical representation of the search results of the review

6. CONCLUSION

The systematic review investigated how human capital strategies, skills development, and workforce changes could help downstream oil and gas companies to prepare for an uncertain and unpredictable future. The review was carried out based on an extensive study of 80 articles examining how these types of businesses had adapted to advanced technologies, digitalization, sustainability, and changing workforce dynamics in the downstream space. The findings suggested that a transformational workforce varied significantly for an organization's long-term success. However, this review had some limitations. The study focused on the use of secondary research material. Hence, it did not necessarily reflect all trends in the industry; also, it didn't provide a comprehensive view of the workforce across all regions. The many different methodologies and organizational contexts among the studies reviewed made it difficult to compare their results directly. Future research will examine empirical studies of workforce transformation models, the effectiveness of digital reskilling, the adaptability of leadership, and measurable indicators of organizational resilience in the downstream petroleum industry. In addition, by conducting comparative studies of workforce development strategies across different areas and energy transition issues,

researchers will have a more robust understanding of how to prepare for the future in terms of the workforce.

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