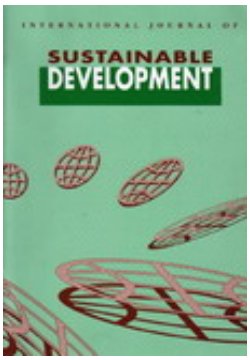
INDERSCIENCE PUBLISHERS
Linking academia, business and industry through research



International Journal of Sustainable Development

ISSN online: 1741-5268 - ISSN print: 0960-1406
https://www.inderscience.com/ijsd

Circular economy integration in oil and gas sector: case of MENA countries

Shikhar Dua, Krishna Kumar Dadsena

DOI: 10.1504/IJSD.2024.10066841

Article History:

Received:	05 March 2024
Last revised:	10 July 2024
Accepted:	09 August 2024
Published online:	03 December 2024

Copyright © 2025 Inderscience Enterprises Ltd.

Circular economy integration in oil and gas sector: case of MENA countries

Shikhar Dua* and Krishna Kumar Dadsena

Indian Institute of Management Ranchi,
Prabandhan Nagar, Nayasarai Rd.,
Ranchi, Jharkhand, 834004, India
Email: shikhar.dua@gmail.com
Email: krishnakumar.dadsena@iimranchi.ac.in
*Corresponding author

Abstract: One of the world's major concerns is the impact of climate change. This case study aims to use a qualitative approach to examine how the oil and gas industry in the Middle East and North African (MENA) countries has embraced the circular economy (CE) concept. Thematic analysis was adopted as the research method in this study. A purposeful intensity sampling method was adopted. Responses were obtained from fifteen oil and gas industry experts working in MENA countries through one on one interviews. The analysis of the interaction involving the adoption of the circular economy in the oil and gas industry in MENA countries revealed three main themes: 1) the organisation's inclination towards CE; 2) innovations in CE adoption; 3) external pressure to adopt CE. The results show that the MENA countries' oil and gas industries are making good progress toward adopting CE.

Keywords: circular economy; oil and gas; MENA; organisational factors; external pressure; innovations; thematic analysis.

Reference to this paper should be made as follows: Dua, S. and Dadsena, K.K. (2025) 'Circular economy integration in oil and gas sector: case of MENA countries', *Int. J. Sustainable Development*, Vol. 28, No. 1, pp.124–146.

Biographical notes: Shikhar Dua, a Research Scholar specialising in Operations Management at the IIM Ranchi, possesses a robust 15-year executive background in oil and gas operations. With a focus on operational excellence, his research interests centre on climate finance and circular economy models. As a seasoned professional he aims to contribute significantly to the discourse on sustainable operations and innovative financial strategies for climate resilience, leveraging both academic knowledge and extensive industry experience.

Krishna Kumar Dadsena holds his PhD from Indian Institute of Technology Kharagpur. Before joining Indian Institute of Management Ranchi, he worked as an Assistant Professor of Operations Management at ICFAI Business School (IBS), Hyderabad. His teaching areas are operations research, logistics and warehousing management, operations management, decision science. His current research areas are sustainable transportation management, digital supply chain, risk management, and circular economy.

Copyright © 2025 Inderscience Enterprises Ltd.

1 Introduction

Over 2,500 products are produced from crude oil by global petroleum refineries and petrochemical plants (Cholakov, 2009). Crude petroleum oil is processed in a petroleum refinery to produce valuable byproducts using different unit operations and processes. Increasing demand for oil, gas, and other energy sources is necessary to support the rising global population and emerging economy. Global energy consumption is expected to rise by 37% by 2035 compared to current levels, with oil and gas products playing a major role in this growth (BP, 2015). To address the hazardous and long-lasting characteristics of these pollutants, it is necessary to use efficient, practical, economical, and sustainable methods (Thorat and Sonwani, 2022). Tilsted et al. (2022) noted that the oil and gas firms are progressively adopting circular economy (CE) strategies because the industry faces the climate change issue and the new global trend towards green energy systems. The two elements, namely improved resistance as well as adaptation measures, remain crucial, to mitigate the effects of climate-related peaks and plunges as well as to ensure the transformation of infrastructure towards circularity (Razzaghi Asl, 2022). Katopodis and Sfetsos (2019) describe that there is a need for sectorial peculiarities in the oil and the gas industry that would improve the level of the preparedness and still incorporate CE principles for increasing infrastructure lifespan while reducing environmental harm.

The linear economic model which entails the three stages of extract, use and dispose which was proposed by Mandegari et al. (2017) creates a lot of impacts on the environment and energy security. CE in sustainability management is a development model that seeks to optimise resource usage by closing material loops by recycling, reusing, or recovering them to reduce the degree of waste generation and the negative impacts that may arise from it (Kirchherr et al., 2017; Geissdoerfer et al., 2017). The CE is an industrial economic model that decouples economic growth from resource use, waste generation, and wealth creation, making it a promising alternative. The excessive and continuous use of natural resources poses a danger to the Earth's ability to adjust to evolving resource demands. Collaborating companies, consumers, and governments in CE strive to emphasise environmentally friendly production and product recovery, prevent unintended environmental harm, and focus on a comprehensive product value chain and life cycle by supporting repair, reuse, and waste management (Ibn-Mohammed et al., 2021).

The application of CE is becoming popular globally in many industries including the oil and gas industry in order to facilitate a process of recycling, reuse and recovery of resources (Kirchherr et al., 2017; Geissdoerfer et al., 2017). In the context of the MENA region, it is revealed that CE principles can play a valuable role in the improvement of the oil and gas industry mainly in terms of developing operational efficiency, decreasing environmental pressures, and establishing economic sustainability (Dua and Jain, 2023). Moving from the linear business model that is based on the extraction and disposal of resources to the circular model creates an opportunity to meet growing environmental requirements and meet global sustainability trends, almost becoming a competitive advantage for the sector in the new energy market conditions (Murray et al., 2017). Therefore, CE practices such as resource efficiency as well as integration of waste to value positively impacts minimisation of the environmental impacts of oil and gas production including emissions of greenhouse gases as well as management of wastes. These practices help out in the diversification of the region's economy and foster environmental protection and sustainability (Stahel, 2016; Blomsma and Brennan, 2017).

Focused on the escalation of environmental consideration, the oil and sector is encouraged towards new ontological modes of practices of operations (Kadian, 2015). The International Energy Agency points out the shift from burning conventional fossil fuels to incorporation of renewable energy into the power generation network stressing that, applying CE concepts like recycling and using waste products and improving resource efficiency, would go a long way in reducing the impacts on the environment, and the energy sector in general can well fit into the sustainable development goals as set by the global leaders. Based on a McKinsey report (2020), the following steps are presented as actionable approaches to transition the industry on a CE: chasing carbon capture, utilisation and storage (CCUS), improving renewable energy. Both emissions reduction and resource loops help the industry to build an effective and sustainable energy future. Therefore, the oil and gas sector needs to attain not only the improvement of its infrastructural readiness and upcoming oil gluts but also the integration of CE strategies to support the sector's future development as well as meet the international climate goals (McKinsey, 2020). National governments have several chances to enhance their performance in the CE, aligning them with global environmental and sustainable development accords. The CE motivates various enterprises to generate more value without escalating their use of resources that are renewable via the creation of secondary goods and amenities (Zaleski and Chawla, 2020). Transitioning to a CE is essential for fostering an environmentally friendly, sustainable, and resource-efficient society. The zero-waste goal of the CE requires additional incentive factors outside the technology perspective (Tedesco and Stokes, 2017).

Though there is significant and identified potential in CE for supporting sustainable operation of oil and gas industry, there is a significant gap in systematic adoption of CE and integration into core operational strategies (Dua and Jain, 2023). There are very few research studies which explore the implementation challenge and opportunities within the MENA oil and gas industry with the exception of research conducted by Dua (2024) where they explored the CE and net zero approach for a climate resilient economy in MENA region. This research goal suggests the need to study the regional barriers that may hinder CE adoption, current practices and framework development that can cater to the unique socio-economic and regulatory contexts of MENA countries. This research aims to conduct a qualitative study using thematic analysis of CE principles adopted by MENA's oil and gas industry. The following research questions (RQ) were identified.

RQ1 What is the current state of CE adoption in the oil and gas industry in the MENA region?

RQ2 What are the various factors influencing the MENA region's CE adoption by the oil and gas industry?

Section 1 provides context by defining 'CE', providing an overview of the oil and gas business, and outlining the study's aims and questions. Section 2 offers a literature review. Section 3 explains our research methodology, sample demographics, and data collection procedure along with data analysis. Section 4 discusses the findings in view of existing literature along with implications in Section 5. Section 6 concludes and Section 7 of the article suggests limitations and areas for further study.

2 Literature review

2.1 Innovative engine driving the CE

In the process of progressive transition of sustainable development global efforts are being made in different fields to adapt novelties and new approaches. For instance, Hu (2023) stress on the need to transform the industrial structure of resource-based cities and call for an innovation-led transformation model that utilises technology to boost its impact. This corresponds to Di and Li's (2023) method of analysing innovation and entrepreneurship in the context of sustainable development which utilises improved algorithms to enhance accuracy and reliability. De Jesus et al. (2018) exclusively perform the study in order to understand and synthesis of the findings at the crossroad of eco-innovation and CE. This study found that to experience a successful transition to CE with technology and economics priority several based on eco-innovation clean congruence strategies were identified in different operative levels of the organisational structure. One of the other works by the same authors (De Jesus et al., 2019) explores the prospects of the 'transformative' eco-innovation which can result in the formation of the 'CE,' spells out the trade-offs that must be managed during the transition to this type of economy, and offers some suggestions on how this can be done. Systemic eco-innovation, driven by various policies, is said to have the potential to bring about significant change (De Jesus et al., 2019). Prior to the widespread implementation of the CE, the research identified technological growth and development as the most crucial criteria. Bag and Pretorius (2022) use institutional theory to investigate the main factors that improve performance in the CE inside small and medium-sized enterprises. The research done in South Africa primarily "focus on the relationships between institutional pressures, eco-innovation, green supply chain management practices, circular economy capability, big data driven supply chains, and performance for circular supply chains" [Bag and Pretorius, (2022), p.60].

2.2 Environment and CE

Zeng et al. (2017) examined the possibility of an eco-industrial zone and how the supply chain management(SCM) may involve concept from the CE to improve on the environmental effects. Based on the findings, the report provides recommendations of the factors affecting SCM for green production that the businesses in eco-Industrial parks might adopt. According to Neves et al. (2020), the concept of industrial symbiosis was proposed which is a strategy that allows organisational players to collaborate in an attempt to share limited resources. Therefore, sustainability rises, and this is beneficial to the bigger picture of the biosphere. Villarín and Merel (2020) present a global outlook in the significantly increasing waste water research to discuss the present challenges and paradigm shifts in order to argue the author's point that wastewater is a basic healthcare and environmental issue and therefore, its management has remained an issue even from ancient times. Consequently, it is noted that the question of the frequency of checking the composition of wastewater for potentially hazardous components should be superfluous. It is one of the significant scientific problems of qualifying the entire spectrum of the chemical and toxicological composition of wastewater. That is why the presented CE is useful for the environment, as other regional CE implementations enhance the beneficial outcomes mentioned by Scarpellini et al. (2019). In addition, since the peculiarities of

different countries' development can influence the spectrum of pro environmental behaviours, Canlas and Karpudewan (2023) offer a structured review of the development of the value-belief-norm theory based on the current state of research, which indicates a rather young trend in sociological studies of this issue. The findings of these studies can also underscore the importance of such measures as technological advancement and sound evaluation tools to encourage sustainable practice and align with the growing global concern for environmental conservation and sustainable development.

2.3 Climate change's effects and the CE

According to Ngan et al. (2019), there is a concern due to climate change, and as the population of the world increases, there are fewer resources to support this development hence the need for a drastic change to a sustainable development. The best strategy that is efficient and effective in the course of achieving sustainability in both the social and physical environment is the CE. The organisational leadership of the Frangipani Hotel in Langkawi, Malaysia has been discussed because the hotel's strategies to introduce a CE in accordance with the zero-waste concept for the development of the environmental and social conditions of the region are viewed as positive (Ahmed et al., 2021). In the paper of Ruokonen (2021) the directness of the climate change impact and social issues as perceived by the Finnish mining sector have been discussed. Finnish mining corporations are disregarding two worldwide trends: the objectives associated with fighting climate change and advancing the shift towards a CE, as demonstrated in the present research. Tcvetkov (2022) also provide a brief of near-far strategies' recommendations to increase the renewable energy share to reduce carbon intensity in the energy sector of resource-based nations. Strategies on how to draw the attention of resource-based economies in the transition are recommended and various approaches regarding the contemporary global endeavours towards shift towards sustainable energy are highlighted.

2.4 Implementing CE

The West has to engage in conceptual analysis about the issue, as China has prioritised the CE and the harmonisation between financial and environmental well-being as the foundation for economic development in its recent Five-year Plans. Governments as well as organisations are instructed on how to use the ideas of the CE. Murray et al.'s (2017) research reveals that the CE possesses intrinsic conflicts and limitations, despite its focus on process innovation and material recycling, which might enhance current corporate practices. In 2017, Heshmati performed an empirical research to evaluate the effectiveness of existing CE initiatives. He et al. (2018) studied the factors driving public resistance and support for chemical industrial park initiatives and endeavours in China. They specifically examined coastal towns located in environmentally sensitive regions with significant risks, where several chemical manufacturing parks are planned. Our research indicates that although participants expressed more satisfaction with the national policy, they showed less enthusiasm for the chemical manufacturing park approach at the local and regional levels. Mignacca et al. (2020) propose that modularisation will play a crucial role in promoting a 'CE' and enhancing sustainability within the context of a 'modular energy infrastructure'.

2.5 The manufacturing sector's CE

More and more firms view improvement of the concepts of the CE as an opportunity to navigate toward sustainability and the focus on fast growth of the eco-friendly products. Authorities, educational institutions, and scholars have pointed out that it is crucial to create a sustainable environmental course at the firm level and to implement it through an advanced environmental management system (EMS) to ensure the long-term stability of an organisation (Barón Dorado et al., 2022). Some of the research questions that have been established indicate that the Product-Service System (PSS) is effective in promoting environmentally sustainable management techniques and the CE. Some issues of concern for firms are therefore presented by a PSS and very little research examines how manufacturing businesses could develop sustainable goods through a Product oriented service system. This is especially the case in the agricultural equipment industry as identified by Kolling et al. (2022). The paper by Kolling et al. (2022) focused on assessing the strategies firms may adopt to validate the lifespan and life cycle management of products.

2.6 CE in oil and gas sector

Hees et al. (2019) describes that state-of-art catalysts and processing technologies enable the change of sophisticated and reusable petroleum derived products to meet CE and sustainable development goals. In the consideration of the fact that the global oil and gas reserves are gradually depleting, the industry has to reinvent itself for its survival. Jain et al. (2020) used the EMS to examine how organisational flexibility influences the effectiveness of the CE. Cherepovitsyn et al. (2018) propose that exploring underexplored oil and gas resources is crucial for the future sustainability of Russia's oil and gas industry due to the decreasing hydrocarbon reserves. Offshore platforms, when decommissioned or repurposed in a CE framework, lead to the acquisition of new information, reassessment of values, and adjustment of behaviours to align with sustainability goals, as described by Basile et al. (2021). This research seeks to provide a multi-criteria decision-making framework to evaluate and compare different decommissioning options in order to facilitate the development of sustainable and mutually beneficial business models. Al Hosni et al. (2020) contend that Oman has emphasised a CE due to the need of diversifying its economy beyond the oil and gas sector for sustained prosperity. The researchers aimed to get a deeper understanding of these difficulties within the context of Oman. Results of factor analysis shows that the main problems of CE are governmental restrictions, the lack of the explicit strategy and the supportive regulations. Later on, some technical issues yielded, for instance there is a lack of professionals, especially those with technical skills, and the government did not supply enough funds.

3 Research methodology

The methodology used is qualitative thematic analysis to examine the CE implementation in the oil and gas organisations in the MENA region. To decipher patterns of the identified threats and their impact on the protection concerned entities, thematic analysis was deemed most appropriate for its methodological soundness in extracting, analysing,

and describing patterns in collected data (Braun and Clarke, 2006). This approach is particularly useful when exploring the topic of CE, as it provides the analyst with the ability to capture the variability of the industry and elicit the participants' perceptions towards the concept. Thematic analysis is a way of analysing the data collected in a qualitative research whereby the researcher looks at the data and writes down its patterns in form of themes. While thematic analysis is beneficial in the steps of developing a framework as it propose a way of analysing the data and gives an indication of the useful patterns or relationships that the data depicts.

Accordingly, purposeful intensity sampling was used in order to include only the participants who are well-informed about the practices in the field of the study and are actively involved in those processes. This sampling technique is suitable for this study because it selects respondents with elaborative, descriptive, and useful opinions that are vital for comprehensive and elaborate thematic analysis (Patton, 2014). Due to this method's reliance on a highly involved and knowledgeable audience concerned with the oil and gas sector in many MENA countries, the themes that surface offer substantial validity and credibility, and they stem from energetic, realistic practice environments.

3.1 Sample's demographics and data collection

Purposeful intensity sampling was employed to meticulously select participants who are industry experts with a minimum of ten years of overall experience and at least five years of professional involvement in the MENA region at mid to senior management levels. This sampling technique was particularly chosen to acquire rather detailed and informed views which are vital for good thematic analysis. The participants were selected through recommendation from professionals, and to get a good ratio from some of the most important countries of the MENA region such as Kuwait, Bahrain, UAE, Oman, Qatar, Nigeria, and Saudi Arabia.

Each participant received a detailed briefing about the study's objectives and the confidential nature of the interview process to ensure transparency and secure informed consent. Interviews were conducted using a mix of telephone and face-to-face methods, depending on the geographical and logistical convenience of the participants, with all interactions being meticulously transcribed for subsequent detailed analysis. This approach ensured the collection of diverse, authentic insights directly from individuals steering CE initiatives within the industry.

A few ice-breaking questions were posed to the participants regarding their stay in the MENA region, qualifications, experience, etc. Then, they were asked open-ended questions to determine the extent to which their respective organisations had adopted CE principles. The questions that were asked are as follows:-

1 Could you explain the main behavioural adjustments your company has done to follow CE ideas?

2 Particularly in waste management and resource efficiency, how have these developments affected your daily activities?

3 How has your company included sustainability into its vision and goal?

4 In what ways might the culture of your business encourage the acceptance of CE ideas?

5 How can staff members help your company to shape and enhance its environmental policies?

6 In your company, how does leadership affect the application of ideas of the CE and sustainability?

7 Which particular plans and initiatives have your management carried out to support CE ideas and sustainability inside the company?

8 In particular in waste management and resource optimisation, how does your management structure help the application and monitoring of CE practices?

9 Could you, particularly in waste management, energy efficiency, and environmental protection, explain the new technologies your company has adopted to enhance sustainability in operations?

10 How does your company prioritise and finance fresh sustainability initiatives?

11 In order to forward CE projects, how does your business work with outside consultants and partners?

12 In what ways might government control affect the acceptance of CE concepts by your business?

13 In what way does industry competition affect the way your business approaches implementing CE ideas?

14 How do the CE projects of your business reflect global standards and foreign pressures?

Depending on the degree of knowledge and information participants were ready to provide about their company, the interview took about 45 minutes. English was the language of the interview, and Table 1 summarises the sample's demographics.

Table 1 The sample's demographics

S. no.	*Age*	*Nationality*	*Qualification*	*Country*	*Experience*	*Position*	*Department*
1	36	India	Graduate	Kuwait	15 years	Operation engineer	Operations
2	37	India	Post graduate	Saudi Arabia	12 years	Process engineer	Technical services
3	38	India	Post graduate	Kuwait	15 years	Planning engineer	Operations planning
4	39	India	Graduate	Kuwait	14 years	Engineer	Manufacturing optimisation
5	37	India	Post graduate	Saudi Arabia	14 years	Operations engineer	Operations
6	38	India	Post graduate	Oman	15 years	Team lead	Technical services
7	36	India	Graduate	Oman	14 years	Engineer	Process
8	40	India	Graduate	Nigeria	20 years	DGM	Operations
9	41	India	Post graduate	Nigeria	21 years	AGM	Operations

Table 1 The sample's demographics (continued)

S. no.	*Age*	*Nationality*	*Qualification*	*Country*	*Experience*	*Position*	*Department*
10	39	India	Graduate	UAE	17 years	Sr. process engineer	Technical services
11	36	India	Graduate	UAE	15 years	Specialist	Technical services
12	40	India	Post graduate	Bahrain	18 years	Sr. process engineer	Technical services
13	42	India	Graduate	Qatar	20 years	Operation engineer	Operations
14	45	India	Graduate	Qatar	20 years	Safety engineer	HSE
15	45	India	Graduate	Bahrain	20 years	Engineer	Environment

3.2 The data analysis

Six step process of conducting thematic analysis was used:

Step 1 Becoming familiar with data.

Step 2 Generating initial codes.

Step 3 Searching for subthemes.

Step 4 Reviewing subthemes.

Step 5 Defining themes.

Step 6 The write-up of themes

3.2.1 Theme 1: organisation's inclination

This theme captured the organisation's overall disposition toward CE adoption. In conclusion, adopting CE principles is only possible if an organisation is internally motivated. Organisations can adopt CE principles and achieve sustainability due to internal factors and organisational adaptability. Any organisation's propensity to adopt CE principles will depend on its work culture, internal motivation, and management practices. Consequently, three distinct subthemes were connected to this central theme: one focused on the organisation's behavioural inclination toward CE adoption, another focused on the organisation's work culture inclination toward CE adoption, and the final focused on the organisation's managerial inclination toward CE adoption. The subthemes are described in the section that follows. When applicable, we have also included excerpts from the original interview transcripts.

Table 2 The list of codes and themes

Codes	*Subthemes*	*Frequency*	*Themes*
Trying to gain sustainability; Questioning unsustainability; inclination towards waste management; emphasis on waste management; mission and vision; moving slowly towards sustainability; inclination towards CE; operating in safe, sustainable and reliable manner	Organisation's behavioural inclination to CE adoption	13	Organisation's inclination
Work culture-MENA and home country; things are being followed; employee inclination to CE adoption; policies are communicated hierarchy wise; separate awareness session; encouraged employee participation towards CE; motivation to learn; knowledge about environmental concerns; confidence on management; ownership towards company; corporate broadcast; employee engagement; doing something good for the company; call for papers	Organisation's work culture inclination to CE adoption	14	
Senior management follow up; managing CE principals; reporting of waste; departmental follow up; standard formats; dedicated department; manufacturing optimisation group; check department; dedicated team for decommissioning and site restoration; maintenance procedures; shutdown management; environment division follow up; check on emission and waste; reducing waste and emission; checks, policies and follow ups; circular carbon economy; corporate execution plan; department to take care projects; wastes are treated; waste management hierarchy; dedicated management staff for CE; budget allocation-CE adoption; Policy and procedure for CE adoption	Organisation's managerial inclination to CE adoption	13	
Good technology; recovery system, polishing units; oil catchers, emission monitoring; Sulphur recovery; new units installed, reusing old; treating our waste water; carbon removal technology; recover maximum from fuel, energy transition; waste categorisation	Technical innovations for CE adoption	15	Innovations in CE adoption
Clean fuel project; country level project inclined towards CE; allocated budget; New project for reducing green house gas emission; new projects and CSR	Economical innovations for CE adoption	11	
Consultants assigned for CE adoption; third party for CE adoption; specialists for CE adoption; procedure and third party for CE adoption; scrap management by outside companies	Outsourced innovations for CE adoption	12	

Table 2 The list of codes and themes (continued)

Codes	*Subthemes*	*Frequency*	*Themes*
Checks at government level; surprise visits by ministry; emission monitoring by government; strict environmental laws; separate environment agency; government vision to adopt CE; hefty fines for flaring; prohibition on pollution governed by law; impact on environment is regulated	Government's pressure for CE adoption	15	External pressure push towards CE adoption
Competition is driving force; sense of competition is universally distributed, sister concern company; competitors gives a push	Competitor's pressure for CE adoption	14	
Global positioning of country to achieve CE; Portrayal of organisation at global level; global pressure fo adopting CE	Global pressure for CE adoption	15	

3.2.1.1 Subtheme 1a: organisation's behavioural inclination towards CE adoption

CE implementation necessitates complicated and dynamic adjustments in technical and behavioural factors. Attitudes, values, behaviours, skills, and competencies determine the disposition of an organisation toward CE adoption. Several participant comments addressing the organisation's behavioural inclination led to adopting CE principles. Some hints that ensuring sustainability is the oil and gas industry's primary objective. Indications show that unsustainable activities are being questioned.

> Interviewee 7: "Emphasis on waste management, flaring is questioned, wastage of resources are questioned, reusage is done wherever possible."

> Interviewee 3: "We are trying to reducing energy consumption, water usage and minimising waste. We are trying to reduce the need for new resources and prolonging the life of existing ones. Also, we are trying to reduce flaring thus reducing emissions. We are trying to match the definition of green refinery…though its an oxymoron but still we are trying to reduce the negative impacts of the refinery operations on the environment."

In addition, it was fascinating to observe that organisations are incorporating sustainability and environmental protection into their mission and vision statements, which demonstrates that they take sustainability and CE seriously and are actively working towards the goal.

> Interviewee 1: "In company mission and vision itself there is mention of protecting environment and committing to health and safety is there, there is HSE policy, environmental policy, separate division of environment and reliability."

> Interviewee 2: "You have done research about my company's vision or not, …but our company is to be the world's preeminent integrated energy and chemical company … You know, operating in safe, sustainable and reliable manner."

> Interviewee 3: "The Kuwait National Development Plan 2035 also focuses on ensuring sustainable economic development and increasing energy efficiency."

These responses indicate that oil and gas industry organisations are internally motivated to achieve sustainable operations.

3.2.1.2 Subtheme 1b: organisation's work culture inclination towards CE adoption

Another important subtheme that emerges is that the culture of an organisation can impact the achievement of its objectives. Clear policy communication regarding adoption, encouragement and training provided to employees to participate in CE adoption, motivation and awards given to employees while working towards policy implementation created a pleasant work environment that contributed to adoption of CE principles.

> Interviewee 8: "All the policies are communicated hierarchy wise through standing instructions and internal memos, there are various training programme,…, Whenever there is any oil and gas conference on sustainability, green energy or any other new development and technology, there is call for papers for employee participation, …, Every department announce employee of the quarter and reward them in case they have contributed anyway to company's growth or achieving company's goals."

> Interviewee 11: "My organisation is actively encouraging and rewarding employees for identifying opportunities to improve resource efficiency and reduce waste, such as through recycling, reusing materials, and finding ways to extend the life of equipment. Its all because of this strong work culture that is emphasising us to operate more efficiently, reduce waste, and minimise its environmental impact."

Also, people talk about how they feel about sustainability and make suggestions for how to make it better.

> Interviewee 5: "I will make a comprehensive action plan with representatives of each department, will give them independent power directly reporting to me to achieve CE while taking care of stakeholders and shareholders interests."

> Interviewee 6: "One thing that I will do is I will start following up with each and every department head and will link their performance with their department efficiency. I believe if everyone start doing their designated work, there will not be any need of separate initiatives and I will do collaboration to learn from best practices and share knowledge, expertise, and technology. We would need to explore partnerships with organisations that specialise in recycling, reusing, and refurbishing, in order to improve our own operations."

While others have entire faith in the company's work culture to achieve sustainability.

> Interviewee 8: "OK, seriously speaking, whatever steps taken by our CEO, I would have done the same."

> Interviewee 13: "My organisation has implemented various sustainable initiatives such as 'green refinery' and 'green mobility' which are in alignment with CE principles. Our aim to reduce carbon footprint, which is in line with CE principle. I remember in 2019, we receive a document where our parent organisation announce that they are planning to establish CE principles in their operations. They aim to reduce their greenhouse gas emissions and increase the use of renewable energy, which are also in line with CE principles."

3.2.1.3 Subtheme 1c: organisation's managerial inclination to CE adoption

Several participants made salient points that demonstrate the management's commitment to sustainability and their adoption of CE principles. Based on the data supplied, it is clear that all firms are implementing strict rules and procedures to cut down on waste, with a particular focus on recycling, reusing, and recovering. The conservation and protection of the natural world was a focal point for each and every group. Another major action done by management to implement CE principles was to optimise the use of available resources.

> Interviewee 1: "There is manufacturing optimisation group that deals with resource optimisation and keep a regular check on unit shutdowns, flaring and everything related to environment, resources, optimisation…, this group has its own team with all team leaders, seniors engineers and dedicated group reporting directly to DCEO of the company, it is a very big department."

> Interviewee 14: "We take care of environment by reducing emission and waste, we treat sludges, recover Sulphur and ensure environment is taken care of. For that we have specific department for taking care of environment."

> Interviewee 6: "There is manufacturing optimisation group department that takes care of process optimisation, production optimisation, supply chain optimisation, and energy efficiency. This department have a focus on improving the efficiency and effectiveness of the organisation's manufacturing processes, to optimise resource usage and minimise waste."

According to the feedback, the company's upper management closely monitors CE adoption progress, and the company has developed comprehensive waste management plans, established environmental departments, optimised environmental processes, and allocated sufficient financial resources. As a result, it was clear that the leadership of every company actively pursues sustainability and adopts CE principles.

> Interviewee 2: "In fact, in 2021 there is a corporate execution plan of CE. There is waste Management plan to minimise the environmental impact … Uh, there are separate departments in commercial and Finance department itself that take care of the projects related to environment, resource optimisation, safety … In all, every department as a team representative that communicate with the department. The department itself has a structure and they report directly to the senior management."

3.2.2 Theme 2: innovations in CE adoption

The second theme discusses the novel approaches taken by the oil and gas sector to integrate CE concepts. Green fuel production, waste recycling, and effective effluent treatment are all within reach thanks to technological advancements. To add to this, the oil and gas industry can efficiently adopt CE principles with the assistance of professionals who know the business better than anyone else from the inside out, and by the use of innovative designs of economic projects aimed at attaining sustainability and adopting CE principles.

3.2.2.1 Subtheme 2a: technical innovations for CE adoption

Participants reiterated the notion that the oil and gas industry is embracing new technologies at a fast pace, as new technologies offer improved methods for plant

operation, waste reduction, energy management, and environmental protection. There are flare gas recovery systems, waste recovery units, effluent treatment plants, and water treatment facilities. Similar remarks were made about the treatment facilities given for acid gas recoveries, waste segregation facilities, and the most recent waste treatment technology.

> Interviewee 12: "Wastewater is treated in etf and after treatment water checks were made and finally sent for reuse, we have condensate recovery system, condensate-polishing units. We have Sulphur recovery block, where we are recovering almost all the Sulphur, we have new flare gas recovery system, we have latest furnaces to increase energy efficiency."

It is evident from the comments and information provided by the participants that the oil and gas industry is effectively addressing environmental problems through the use of technology. In some organisations, new novel investigations of carbon recovery and the use of new technology for the same are also being examined. Innovative technologies are being used to develop and integrate into the core of firms' waste management strategies.

> Interviewee 5: "In the case of carbon, we are trying to add the 4th R like removing it from the cycle altogether through carbon capture and storage."

> Interviewee 2: "So basically, waste is categorised into three parts hazardous, non-hazardous and inert management options are ranked by their potential environmental impact and highest priority is given to waste prevention reduction. That is reuse recycle recovery treatment."

3.2.2.2 Subtheme 2b: Economical innovations for CE adoption

Nearly all companies, according to participant responses, are undertaking new efforts to attain sustainability. These projects encompass all elements that facilitate the economical adoption of CE principles by the organisation. These creative new projects aim for cleaner, greener fuels, low waste production, efficient gas recovery, reduced air and water pollution, and smart energy management. The board of directors allots funding for the implementation of such projects in order to fulfil the stated objectives. In addition, via corporate social responsibility initiatives, corporations attempt to promote environmental cleanliness and adopt CE principles.

> Interviewee 7: "OK, so to minimise the environmental impact of our business, we are not working to limit our environment footprint, but like it's our company is creating a legacy of projects that improve both natural habitat and share resources while incorporating CE principles across business."

3.2.2.3 Subtheme 2c: outsourced innovations for CE adoption

Apart from implementing novel economic and technological solutions for CE adoption, it is difficult for every petroleum refinery to do everything in-house, as demonstrated by the findings of this study. There were suggestions of third-party participation, consultants to lead the approach, outsourcing of treatment facilities, and waste segregation and disposal during planned shutdowns to ensure minimal divergence from the company's objective of adopting CE principles. There were instances in which participants suggested cooperative ventures with firms, various forms of training, and seminars to attain the objective.

> Interviewee 2: "And also let me tell you our company is establishing a joint venture with international partners to develop waste management project in the Kingdom. The project is intended to treat all municipal and industrial waste generated in the Kingdom and to be expanding the waste in the Kingdom and the region in the future. So you see, we are taking care of everything."
>
> Interviewee 1: "There are consultants who run special programmes auch as PRIME (Plant reliability integrity and maintenance excellence) where we follow guidance from consultants…sorry, I cannot mention the name of our consultant company…. To ensure efficient production and safe and reliable operation."

Therefore, the novel insight provided by this inquiry is how an established company that has previously invested millions and billions of dollars for production and profit is innovating by adopting CE principles for sustainability.

3.2.3 Theme 3: external pressure push towards CE adoption

This topic relates to the external factors that compel an organisation to adopt the CE principle. To reach the ultimate objective of sustainability, the following subthemes describe the pressure from external forces, whether it be government pressure, pressure from a competitor organisation, or global pressure.

3.2.3.1 Subtheme 3a: government's pressure for CE adoption

Participants reiterated throughout the conversation the government pressure their organisation receives to follow CE principles. Climate change is one of the major issues that any nation must address to ensure that industries, particularly in this case oil and gas industries, do not pollute the environment. Participants made a number of noteworthy remarks regarding government checks; there were mentions of unannounced visits by government agencies and ministers to monitor pollution. Government actively supervises flare stacks, water effluents, and solid waste management, according to participants.

> Interviewee 14: "There are checks at government level…Government is checking at all levels, from air to water to dumps to landfills to people, anywhere there is some waste or pollution there is check by ministry."
>
> "Flaring is monitored by government actively, high emission is reported directly to environment ministry electronoically which we cannot stop."
>
> Interviewee 2: "Also, in our company we have regular visits by ministry people. If you're flaring you know choppers will start circulating around our stacks and there will be a high level committee for the investigation. Hefty fines. And all these things so government is keeping checks for sure."

The countries of the MENA have strict environmental laws and regulations. Environmental protection agencies are government entities that monitor organisations and their operations to ensure strict compliance with environmental laws. Numerous nations have put the accomplishment of sustainability and the adoption of CE in their vision statements as one of their highest priorities.

> Interviewee 5: "OK, Kingdom is actively working to reduce their pollution. We can say any kind of pollution if you see if you happen to see somehow Saudi vision 2030 you will find one of the vision is to reduce air pollution, achieve environment sustainability, creating sustainable economy."

> "For Saudi, the major focus of environmental law is to protect everything like air, water, land, soil. Including natural systems and habitats from pollution, any negative impact on the environment is regulated."

3.2.3.2 Subtheme 3b: competitor's pressure for CE adoption

Competition is something that cannot be avoided at any level. Participants remarked that there are several groups like theirs throughout the country, and everyone strives to meet the objectives set by their parent organisation or government.

> Interviewee 1: "In Kuwait there is only one mother company and with that there are many sister concerns which are in oil and gas business, so basically they have a common CEO, now every sister concern company wants to do better then other company as their DCEO will have chance to become CEO, now this sense of competition is universally distributed, whether it is production or achieving vision statement goals."

> Interviewee 2: "There are many refineries governed by same parent company, you know. And everyone has to prove itself. So as CE is one of the companies and also the Kingdoms goal, so definitely competitors strive and they give us a push."

3.2.3.3 Subtheme 3c: global pressure for CE adoption

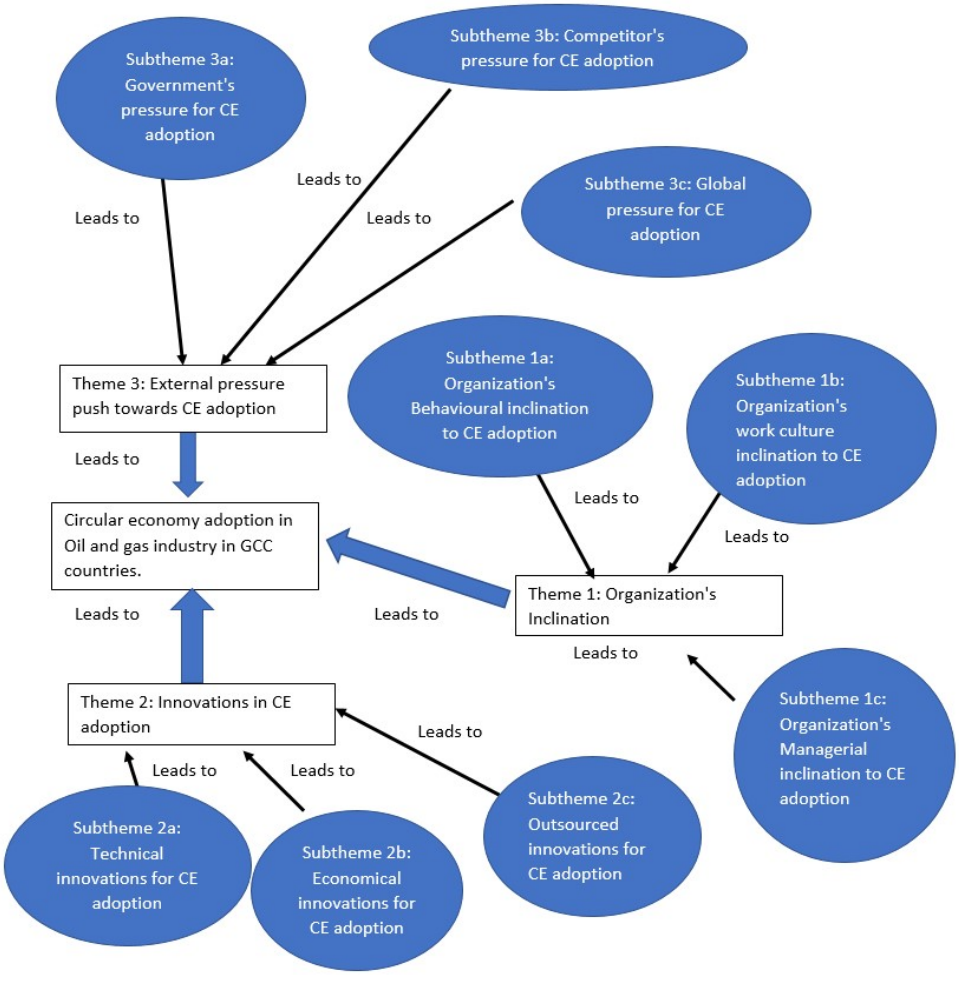
The global transition to a CE entails shifting from linear, highly resource- depleting systems with high emissions, waste generation, and high impacts on ecosystems and natural capital to circular, less wasteful systems that use resources more efficiently and sustainably while providing employment and a high standard of living. The pressure exerted by the United Nations and other nations guarantees that all nations adhere to a sustainable model. The impact on the oil and gas business is identical. Participants noted that as firms become worldwide and export their products, they must guarantee that production is in accordance with global standards. Participants note that the representation and reputation of an organisation at the global level are crucial for the growth of any organisation, and that a false depiction is impossible when confronting the entire globe; therefore, an organisation or country must do something to face the world.

> Interviewee 1: "It makes a huge difference how a country is portrayed at such a global portal, every country is suffering from climate change and every countriy's contribution is mandatory, … as all countries in GCC are trying to contribute in adopting these principals it also press a pressure on Kuwait to do the same."

> Interviewee 4: "If you do not have United Nations, no one will take care of environment, … as it's a global issue, we are suffering misdeeds of developed country, … what they did in past now we cannot undo the past, but we have to ensure that climate is being taken care of …"

> "When a country's representative has to be in front of whole world, he always want to portray good picture of the country now no one can lie in front of the whole world and, to speak truth, you have to do something to tell everyone."

Figure 1 Thematic map (see online version for colours)



In view of the above discourse three main themes can be concluded that influence the shift towards the practice of CE in the oil and industry in the MENA regions.

1 Organisation's inclination: this theme incorporates the cases of drivers observed in organisations towards the implementation of CE principles. Several factors that affect the preparedness of an organisation to switch to a CE model include; work culture, internal motivation, managerial commitment and practices within the organisation. These introduce behavioural changes towards sustainability, incorporation of CE principles into corporation' statements, and stress on the management of waste and resources.

2 Innovation leading to adoption: this theme describes how organisations psychologically and technically implement CE ideas. Some of the innovations contributing to the adoption of CE in the oil and gas sector involves; green fuels, practicable waste disposal, and energy efficiency. Some of the noticeable

technologies, which have remarkably contributed to improving the operations' environmental footprint include flare gas recovery system, waste recovery units and effluent treatment plant.

3 External pressures for CE adoption: this theme gives the external pressures that make organisations adopt CE practices. The major influences include the government regulations, stakeholders' demands, and international sustainability standards. The industry that is comprise of oil and gases is also subjected to checks by the governmental bodies through a surveillance system, integration of specific requirements for emission control and feels pressure from the international organisations such as the United Nations for achieving global standards.

The above themes are the insights drawn from the thematic analysis that outline how and why CE is being implemented in the oil and the gas organisations in the MENA region.

3.3 Thematic map

A crucial aspect of the thematic analysis is diagrammatically summarising the results so that readers can readily examine the findings in a condensed style and comprehend how the data were organised into themes and subthemes. This is accomplished using a thematic map. A thematic map is a schematic illustrating the primary topics and subthemes of the overall study objective. Please refer to Figure 1 for a detailed explanation of the thematic map.

4 Discussion

When compared with previous research, the results of this study on CE acceptance in the MENA oil and gas sector provide original insights. Especially, our study emphasises the important part institutional pressures play in determining CE practices, in line with observations of Bag and Pretorius (2022) stressing the need of eco-innovation and green supply chain management in improving CE capabilities inside small and medium-sized businesses. But our research differs in stressing the particular adaptations required in the context of MENA's regulatory and socioeconomic environment, an element less stressed in other areas as noted by Jain et al. (2020). Our results on the proactive adoption of new technologies for environmental management also reflect the technological emphasis Hees et al. (2019) but offer fresh data on how MENA businesses include these technologies inside current operational systems. By outlining how MENA oil and gas companies use CE for strategic resilience and competitive advantage, this paper also extends the debate by Kirchherr et al. (2017) on the decoupling of economic growth from resource use, so providing a nuanced knowledge of CE's operationalising in a sector known for its heavy resource use. Altogether, this research updates the literature of established earlier by contributing new qualitative research findings concerning the novel implementations of CE in the MENA oil and gas industry.

5 Theoretical and practical implications

Through investigating its implementation in the oil and gas sector in MENA nations, this paper enhances the theoretical framework of CE. Our results imply that conventional CE models need change to properly combine the special socioeconomic and legal environment of the area. This helps to provide a more complex knowledge of CE adoption by including sector-specific and regional traits outside of broad models. Furthermore, the studies support theories of organisational transformation and innovation by proving how outside pressure drives the acceptance of sustainable practices by means of adaptive innovations. Moreover, it relates and expands institutional theory by showing how industry environmental sustainability practices respond to normative, coercive, and mimetic pressures.

Practically, our studies have several ramifications for MENA oil and gas companies as well as legislators. Businesses are advised to include CE ideas into their risk management and strategic planning in order to more fit changes towards sustainability and environmental rules. This covers large expenditures in technologies meant to support resource recycling, energy economy, and waste reduction. By means of focused training programs, improving employee awareness and competencies on CE practices can also help to embed sustainability closer into business cultures.

Policymakers must pay great attention to the creation of unambiguous laws supporting CE practices, including incentives for sustainable resource use and waste reduction. Encouragement of public-private alliances helps to share knowledge, resources, and hazards, so hastening CE acceptance. Government backing for research and development in sustainable technologies and practices could also help to close current technological gaps, so strengthening the CE within the MENA oil and gas sector.

6 Conclusions

This paper conducted a qualitative study of the adoption of CE principles in the oil and gas industry in MENA countries, which is lacking in the existing literature. This is perhaps one of the first few qualitative study to examine the predisposition of the oil and gas business in MENA nations towards CE principles. Only professionals in the oil and gas business with extensive work experience and intercultural exposure can provide in-depth insights into the present setting of an organisation.

Innovations in the framework of the organisational policies and visions of the sector illustrate that the MENA oil and gas sector is in the process of gradually transitioning towards the implementation of CE concepts and enhancing sustainability (Laturkar and Laturkar, 2023). Focusing on a high commitment to the efficient CE implementation, participants have stressed an emerging organisational culture addressing sustainability integration into business practices (Mancini et al., 2021). Adoption of new technologies and strategic projects emphasises this proactive attitude and is essential for developing CE values in the industry.

The change will present different difficulties, though. Adoption of CE seeks to maximise resource efficiency and lower environmental impacts, so improving sustainability and lowering operational costs; but, technological integration and implementation discrepancies create major challenges (Janik et al., 2020). Some companies' capacity to completely adopt new CE-driven systems is further limited by

financial restrictions and current technological systems (Chhimwal et al., 2022). Technology and infrastructure investments are absolutely vital; many companies now concentrate on end-of- life process designs, recycling, and renewable energy. These strategies not only support CE values but also encourage local industrial growth, so giving companies chances to create required technologies (Hartmann et al., 2021). Such projects complement the larger regional objectives of environmental sustainability and economic diversification by motivating nations rich in oil and gas resources to lower their ecological footprints and so support sustainable economic development (Dantas et al., 2021). The subtle development of CE adoption in the MENA oil and gas sector shows important developments and emphasises the difficult issues that must be negotiated. By means of CE principles, the industry's efforts assist in guiding regional economies toward more sustainable development paths, so lowering reliance on fossil fuels and so preserving resources for next generations (Dua, 2024).

It is, therefore, established that the MENA oil and gas firms are integrating CE plans as tactical measures for environmental and internal sustainability strategies (Dua, 2024). This has to involve a shift of structure and processes towards technology applications and managerial dedication (Ruokonen, 2021). This element underlines that modern businesses are adopting innovations that would optimise the consumption of resources and, therefore, decrease negative effects observed in the environment. This change is due to the new regulations and market opportunities that improve environmental performance and productivity.

7 Limitations and future research directions

It is essential to admit that the approach used in this study has some important restrictions that stem from the fact this research is rather potent in its qualitative examination of the CE concepts in the internal environment of the MENA oil and gas sector. Despite the fact that the qualitative nature of the study serves to offer contextual findings, the generalisation of the results over many sectors or even broader geographical locations may be limited. Although the thematic analysis guarantees dependability by methodical coding and consistent theme development, the inherent subjectivity of qualitative data interpretation may influence the apparent validity of the results. Using a mixed-methods approach combining quantitative assessments of CE adoption impacts could improve generalisability in next studies. This would confirm qualitative observations as well as offer a more general assessment of the relevance of the approach across many sectors and nations. Including many industry sectors and geographical areas in the research will help to confirm the validity and applicability of the results, so providing a more complete knowledge of CE concepts all around.

Future studies should investigate the long-term effects of CE acceptance on operational efficiency and sustainability outcomes, so extending the exploration of CE concepts inside the MENA oil and gas sector. Comparative studies could be helpful to find special difficulties and best practices by contrasting CE integration in MENA with other worldwide areas. Furthermore urgently needed is quantitative research measuring the particular economic effects of CE policies so offering a more complex knowledge of cost-benefit dynamics. Examining how newly developed technologies like artificial intelligence and blockchain might improve CE practices will help one understand the next generation of industry innovations. Last but not the least, research focusing on the

human and organisational factors facilitating or inhibiting CE acceptance would provide a richer picture on the required cultural and managerial adjustments for transitioning to circularity. Examples include the research on the level of employees' engagement, the type of leadership and the CE-oriented development of industry-wide instructional projects.

References

Ahmed, M.F., Mokhtar, M.B., Lim, C.K., Hooi, A.W.K. and Lee, K.E. (2021) 'Leadership roles for sustainable development: the case of a Malaysian green hotel', *Sustainability*, Vol. 13, No. 18, p.10260.

Al Hosni, I.S., Amoudi, O. and Callaghan, N. (2020) 'An exploratory study on challenges of circular economy in the built environment in Oman', *Proceedings of the Institution of Civil Engineers-Management, Procurement and Law*, Vol. 173, No. 3, pp.104–113.

Bag, S. and Pretorius, J.H.C. (2022) 'Relationships between Industry 4.0, sustainable manufacturing and circular economy: proposal of a research framework', *International Journal of Organizational Analysis*, Vol. 30, No. 4, pp.864–898.

Barón Dorado, A., Giménez Leal, G. and de Castro Vila, R. (2022) 'Environmental policy and corporate sustainability: the mediating role of environmental management systems in circular economy adoption', *Corporate Social Responsibility and Environmental Management*, Vol. 29, No. 4, pp.830–842.

Basile, V., Capobianco, N. and Vona, R. (2021) 'The usefulness of sustainable business models: analysis from oil and gas industry', *Corporate Social Responsibility and Environmental Management*, Vol. 28, No. 6, pp.1801–1821.

Blomsma, F. and Brennan, G. (2017) 'The emergence of circular economy: a new framing around prolonging resource productivity', *Journal of Industrial Ecology*, Vol. 21, No. 3, pp.603–614.

BP (2015) *BP Energy Outlook 2035*, London, UK.

Braun, V. and Clarke, V. (2006) 'Using thematic analysis in psychology', *Qualitative Research in Psychology*, Vol. 3, No. 2, pp.77–101.

Canlas, I.P. and Karpudewan, M. (2023) 'The continuum of pro-environmental behaviour in the context of the value-belief-norm theory of environmentalism: implications towards sustainable development', *International Journal of Sustainable Development*, Vol. 26, No. 1, pp.22–50.

Cherepovitsyn, A., Metkin, D. and Gladilin, A. (2018) 'An algorithm of management decision-making regarding the feasibility of investing in geological studies of forecasted hydrocarbon resources', *Resources*, Vol. 7, No. 3, p.47.

Chhimwal, M., Agrawal, S. and Kumar, G. (2022) 'Challenges in the implementation of circular economy in manufacturing industry', *Journal of Modelling in Management*, Vol. 17, No. 4, pp.1049–1077.

Cholakov, G.S. (2009) 'Control of pollution in the petroleum industry', *Pollut. Control Technol.*, Vol. 3, pp.86–107.

Dantas, T.E.T., de-Souza, E.D., Destro, I.R., Hammes, G., Rodriguez, C.M.T. and Soares, S.R. (2021) 'How the combination of circular economy and Industry 4.0 can contribute towards achieving the sustainable development goals', *Sustainable Production and Consumption*, Vol. 26, pp.213–227.

De Jesus, A., Antunes, P., Santos, R. and Mendonça, S. (2018) 'Eco-innovation in the transition to a circular economy: an analytical literature review', *Journal of Cleaner Production*, Vol. 172, pp.2999–3018.

De Jesus, A., Antunes, P., Santos, R. and Mendonça, S. (2019) 'Eco-innovation pathways to a circular economy: envisioning priorities through a Delphi approach', *Journal of Cleaner Production*, Vol. 228, pp.1494–1513.

Di, H. and Li, P. (2023) 'Comprehensive evaluation of innovation and entrepreneurship ability in the context of sustainable development', *International Journal of Sustainable Development*, Vol. 26, Nos. 3–4, pp.291–305.

Dua, S. (2024) Circular horizons: pioneering sustainable paths in the oil and gas Industry's journey to net-zero resilience', *International Social Science Journal*.

Dua, S. and Jain, N.K. (2023) 'Circular economy and innovation in oil and gas industry: a systematic literature review and bibliometric analysis', *International Social Science Journal*.

Geissdoerfer, M., Savaget, P., Bocken, N.M. and Hultink, E.J. (2017) 'The circular economy – a new sustainability paradigm?', *Journal of Cleaner Production*, Vol. 143, pp.757–768.

Hartmann, J., Inkpen, A.C. and Ramaswamy, K. (2021) 'Different shades of green: global oil and gas companies and renewable energy', *Journal of International Business Studies*, Vol. 52, pp.879–903.

He, G., Boas, I.J., Mol, A.P. and Lu, Y. (2018) 'What drives public acceptance of chemical industrial park policy and project in China?', *Resources, Conservation and Recycling*, Vol. 138, pp.1–12.

Hees, T., Zhong, F., Stürzel, M. and Mülhaupt, R. (2019) 'Tailoring hydrocarbon polymers and all-hydrocarbon composites for circular economy', *Macromolecular Rapid Communications*, Vol. 40, No. 1, p.1800608.

Heshmati, A. (2017) 'A review of the circular economy and its implementation', *International Journal of Green Economics*, Vol. 11, Nos. 3–4, pp.251–288.

Hu, P. (2023) 'Analysis of industrial transformation strategy of resource-based cities in the era of technological innovation', *International Journal of Sustainable Development*, Vol. 26, Nos. 3–4, pp.243–255.

Ibn-Mohammed, T., Mustapha, K.B., Godsell, J., Adamu, Z., Babatunde, K.A., Akintade, D.D., … and Koh, S.C.L. (2021) 'A critical analysis of the impacts of COVID-19 on the global economy and ecosystems and opportunities for circular economy strategies', *Resources, Conservation and Recycling*, Vol. 164, p.105169.

Jain, N.K., Panda, A. and Choudhary, P. (2020) 'Institutional pressures and circular economy performance: the role of environmental management system and organizational flexibility in oil and gas sector', *Business Strategy and the Environment*, Vol. 29, No. 8, pp.3509–3525.

Janik, A., Ryszko, A. and Szafraniec, M. (2020) 'Greenhouse gases and circular economy issues in sustainability reports from the energy sector in the European Union', *Energies*, Vol. 13, No. 22, p.5993.

Jia, F., Yin, S., Chen, L. and Chen, X. (2020) 'The circular economy in the textile and apparel industry: a systematic literature review', *Journal of Cleaner Production*, Vol. 259, p.120728.

Kadian, A. (2015) *Regulation of Environmental Concerns From Upstream Oil and Gas Activities: An Analysis*.

Katopodis, T. and Sfetsos, A. (2019) 'A review of climate change impacts to oil sector critical services and suggested recommendations for industry uptake', *Infrastructures*, Vol. 4, No. 4, p.74.

Kirchherr, J., Reike, D. and Hekkert, M. (2017) 'Conceptualizing the circular economy: an analysis of 114 definitions', *Resources, Conservation and Recycling*, Vol. 127, pp.221–232.

Kolling, C., de Medeiros, J.F., Ribeiro, J.L.D. and Morea, D. (2022) 'A conceptual model to support sustainable product-service system implementation in the Brazilian agricultural machinery industry', *Journal of Cleaner Production*, Vol. 355, p.131733.

Laturkar, K. and Laturkar, K. (2023) 'Environmental sustainability measures in the oil and gas industry', in *Multidisciplinary Approaches to Sustainable Human Development*, pp.176–205, IGI Global.

Mancini, S.D., de Medeiros, G.A., Paes, M.X., de Oliveira, B.O.S., Antunes, M.L.P., de Souza, R.G. and de Oliveira, J.A.P. (2021) 'Circular economy and solid waste management: challenges and opportunities in Brazil', *Circular Economy and Sustainability*, Vol. 1, No. 1, pp.261–282.

Mandegari, M.A., Farzad, S. and Görgens, J.F. (2017) 'Recent trends on techno-economic assessment (TEA) of sugarcane biorefineries', *Biofuel Research Journal*, Vol. 4, No. 3, pp.704–712.

McKinsey (2020) [online] https://www.mckinsey.com/industries/oil-and-gas/our-insights/the-future-is-now-how-oil-and-gas-companies-can-decarbonize (accessed 20 June 2023).

Mignacca, B., Locatelli, G. and Velenturf, A. (2020) 'Modularisation as enabler of circular economy in energy infrastructure', *Energy Policy*, Vol. 139, p.111371.

Murray, A., Skene, K. and Haynes, K. (2017) 'The circular economy: an interdisciplinary exploration of the concept and application in a global context', *Journal of Business Ethics*, Vol. 140, pp.369–380.

Neves, A., Godina, R., Azevedo, S.G. and Matias, J.C. (2020) 'A comprehensive review of industrial symbiosis', *Journal of Cleaner Production*, Vol. 247, p.119113.

Ngan, S.L., How, B.S., Teng, S.Y., Promentilla, M.A.B., Yatim, P., Er, A.C. and Lam, H.L. (2019) 'Prioritization of sustainability indicators for promoting the circular economy: the case of developing countries', *Renewable and Sustainable Energy Reviews*, Vol. 111, pp.314–331.

Patton, M.Q. (2014) *Qualitative Research & Evaluation Methods: Integrating Theory and Practice*, Sage Publications.

Razzaghi Asl, S. (2022) 'Re-powering the nature-intensive systems: insights from linking nature-based solutions and energy transition', *Frontiers in Sustainable Cities*, Vol. 4, p.860914.

Ruokonen, E. (2021) 'Managerial perspectives on strategies for advancing environmental considerations in the mining industry', *The Extractive Industries and Society*, Vol. 8, No. 1, pp.434–441.

Scarpellini, S., Portillo-Tarragona, P., Aranda-Usón, A. and Llena-Macarulla, F. (2019) 'Definition and measurement of the circular economy's regional impact', *Journal of Environmental Planning and Management*, Vol. 62, No. 13, pp.2211–2237.

Stahel, W.R. (2016) 'The circular economy', *Nature*, Vol. 531, No. 7595, pp.435–438.

Tcvetkov, P. (2022) 'Engagement of resource-based economies in the fight against rising carbon emissions', *Energy Reports*, Vol. 8, pp.874–883.

Tedesco, S. and Stokes, J. (2017) 'Valorisation to biogas of macroalgal waste streams: a circular approach to bioproducts and bioenergy in Ireland', *Chemical Papers*, Vol. 71, pp.721–728.

Thorat, B.N. and Sonwani, R.K. (2022) 'Current technologies and future perspectives for the treatment of complex petroleum refinery wastewater: a review', *Bioresource Technology*, Vol. 355, p.127263.

Tilsted, J.P., Mah, A., Nielsen, T.D., Finkill, G. and Bauer, F. (2022) 'Petrochemical transition narratives: selling fossil fuel solutions in a decarbonizing world', *Energy Research & Social Science*, Vol. 94, p.102880.

Villarín, M.C. and Merel, S. (2020) 'Paradigm shifts and current challenges in wastewater management', *Journal of Hazardous Materials*, Vol. 390, p.122139.

Zaleski, P. and Chawla, Y. (2020) 'Circular economy in Poland: profitability analysis for two methods of waste processing in small municipalities', *Energies*, Vol. 13, No. 19, p.5166.

Zeng, H., Chen, X., Xiao, X. and Zhou, Z. (2017) 'Institutional pressures, sustainable supply chain management, and circular economy capability: empirical evidence from Chinese eco-industrial park firms', *Journal of Cleaner Production*, Vol. 155, pp.54–65.