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Abstract

Although circular economy (CE) has been recognized as a potential enabler of sustainability, it does not clearly outline the methods to reduce carbon emission vis-a-vis fugitive carbon from fossil fuels emitted by the energy sector. Accordingly, this study proposes the implementation of a circular carbon economy (CCE) to reduce carbon emissions from fossil fuels as well as create an economically viable ecosystem. However, there are practical barriers to its operationalization. Our study expects to examine the barriers to the successful implementation of CCE. Following the context of this research, we used Saudi Arabian energy firms for data collection as the country is the largest producer of energy products. The data collection is done through structured interviews with the top managers employed at Saudi Arabian energy firms. The methodological approach of this study is robust and novel as we employ numerous scientific tools for data collection and analysis. The findings of this conceptual study are expected to lay a foundation for the studies examining the methods to reduce carbon emissions from fossil fuels which will allow regional energy producers to stay on track in achieving their sustainable development goals (SDGs).

1. Introduction

Circular economy (CE) is an integrated strategy designed for achieving sustainability and mitigating the effects of climate change (Ellen Macarthur Foundation, 2014). The implications and perspectives of CE are many and firms are expected to operationalize it in a way that they are able to create a business ecosystem essentially covering their environmental, financial, and social goals (Ghisellini et al., 2016). Recently, the circular carbon economy (CCE) was proposed as an extension of the CE to reduce the effects of fugitive carbon on climate ushered by the combustion of fossil fuels (McDonough, 2016; McDonough and Braungart, 2002). Accordingly, CCE conceptualization is based on the distinction between ‘living’, ‘durable’, and ‘fugitive’ carbon and it is fugitive carbon that actually harms the environment by releasing CO₂ during the combustion of fossil fuels.

Practically, CCE was employed by scientists in Germany and the United States by proposing a holistic circular model to use domestic carbon as a feedstock for the chemical industry by extracting it from imported crude oil (Lee et al., 2017). Following its environmental and economic benefits, academicians and policymakers started taking an interest to understand the impact of CCE on sustainability, its ability to fully close the carbon cycle, and the capabilities of energy firms to engage in CCE. This led to establishing a CCE consortium engaging the National Network for a Circular Carbon Economy and the member members from the energy, chemical, and waste management sectors for large-scale implementation of CCE (TU Bergakademie Freiberg, 2018, 2019; Schögl et al., 2020). Further, studies argued that CCE can help firms in identifying the domestic and international choke points by taking a system-wide approach to emissions for achieving desired sustainability and economic goals (Williams, 2020a). Although CCE falls on the weaker side of the sustainability spectrum, it is argued that its rigorous implementation may help in creating a business ecosystem promoting the growth of a CE by decoupling the use of unsustainable resources.

Saudi Arabia being one of the major producers of fossil fuels actively promotes CCE at regional and international fora to seek environmental and social recognition. Also, it is unlikely that global reliance on fossil fuels will reduce in the near future (OPEC, 2020) hence, fossil fuel firms in the country need to consider CCE

operationalization to create a business ecosystem allowing value creation, gaining a competitive advantage, and addressing underlying sustainability issues. Williams (2019, 2020b) was the pioneer of CCE to explore the Saudi context and described it as an exclusive approach to transitioning the country's linear economic system to circular growth by creating a resilient, sustainable, and environment-friendly energy system. His projections contradicted the hierarchical relationship between the 4Rs (reduce, recycle, reuse, and remove) and emphasized the reduction of fugitive carbon instead of controlling the outflow of materials.

The government of Saudi Arabia formally endorsed the CCE concept during the presidency of the G20 summit and issued collaborated with Think-20 Communiqué and G20 Leaders to issue the declaration documents (G20 Saudi Arabia, 2020a, 2020b). To further show its commitment to CCE, the government promoted it at numerous international energy events including the Clean Energy Ministerial (CEM), Mission Innovation meeting, and the International Energy Forum held in Riyadh (Ministry of Energy Saudi Arabia, 2020). Additionally, a series of guidelines and policies were introduced requiring contributions from International Energy Agency (IEA), regional bodies; Organisation for Economic Co-operation and Development (OECD), research institutions, and local firms in the energy sector. However, the Ministry of Energy emphasized the significance of engaging the member firms for the effective operationalizing of CCE and the creation of a sustainability-enabling business ecosystem.

1.2. Research background

Saudi Arabia is the only country among oil-producing nations capable to produce per barrel of oil with the least cost and emissions labeling it the 'last man standing' in global oil markets (Krane, 2019). Initially, it employed conventional approaches to mitigate the effects of global climate change to protect its oil and gas sector and reduce economic reliance on the revenue generated by exporting these resources (Depledge, 2008; Khondaker, et al., 2014; Luomi, 2020; Russell, 2016). The effectiveness of these initiatives was minimal as a large proportion (70%) of Saudi Arabia's gross domestic product (GDP) still relies on the income generated from oil and gas placing the country at risk of a decline in GDP due to the uncertain demand, energy prices, rising trade tensions, and uncertain geopolitical situation (KPMG, 2020). Further, the environmental legitimacies may also remain in the limelight essentializing the need for a business ecosystem covering environmental and economic aspects.

Without disregarding the benefits of CCE, it can be argued that CCE may resolve environmental issues (to some extent) by controlling CO₂ emissions however, its actual adoption in firms remains unclear due to numerous institutional, structural, and infrastructural barriers (Mansouri et al, 2020; Al Saud and Al Shala, 2020). Additionally, CCE being an extension of CE which is yet to even embed in firms' operations may remain neglected and eventually impeded without any action. Following the debates on the risks associated with CCE adoption such as low return over investments and the lack of regulatory support may not motivate firms to prioritize it as a strategic forefront (ESCWA, 2017). Finally, the technical and scientific nature of CCE demand acquiring dynamic capabilities in the form of skilled employees, knowledge advanced technologies, and financial resources to motivate firms to adopt this novel sustainability and value creation approach.

Taking together, the argument presented about the perceived risks of adopting CCE and institutional and structural disparities between firms, it is predicted that its effective implementation may be hampered which requires investigating and understanding these barriers through the following research questions;

1. What are the barriers to implementing CCE in Saudi Arabia?

2. How do these barriers affect the CCE implementation capability of Saudi Arabian firms?

3. What is the relationship between these barriers to derive managerial implications for the effective implementation of CCE in Saudi Arabia?

This conceptual study is expected to make several distinct contributions. First, it will contribute to the growing literature on CF by operationalizing CCE as a key enabler. Second, it will offer a policy guideline to enhance the profitability and stability of the firms in the energy sector by identifying the factors influencing the adoption of CCE. Third, the findings of this research are expected to propose an integrated CCE-based business ecosystem essential for addressing environmental, social, and economic issues for energy firms. Finally, the results of this

study are projected to serve as a toolkit for the consultants of energy firms to suggest business optimization strategies.

The rest of the study proceeds as follows. The literature covering the conceptualization of CCE and some possible barriers are discussed in section 2. Section three outlines the methodological approaches employed to achieve the objectives of this study. The conclusion of this study is presented in section 4.

2. Literature review

2.1 Conceptualizing CCE

The formal operationalization of CCE was proposed by Williams (2019, 2020) defining it as a comprehensive approach employed to transition towards an inclusive, resilient, sustainable, and pollution-free energy system essentially supporting sustainable development goals. CCE differs from the CE concept in terms of its interpretation and views the 4Rs (reduce, recycle, reuse, and remove) as complementary to minimizing fugitive carbon. Additionally, CCE advances implementing approaches to energy products in a way that these inputs minimize carbon flows as compared to CE emphasizing reduction of material outflow.

A few studies viewed CCE as a positive way of redefining the conversation around CO₂ emissions (Mansouri et al., 2020; Al Saud and Al Shalan, 2020). This implies that instead of viewing CO₂ solely as a negative externality, the CCE emphasizes the potential value that can be derived from it. The authors from Saudi Arabia have characterized the CCE as a "framework for climate mitigation that values all options," and argued that it is essential to completely eliminate fossil fuels as it is unlikely that the global energy sector can get rid of fugitive carbon.

A UN study has found that Gulf Cooperation Council (GCC) countries, including Saudi Arabia, still have significant regulatory gaps in carbon capture and storage (CCS), and there is a need for innovative financial incentives to expand CCS implementation beyond enhanced oil recovery (EOR), particularly to industrial facilities through retrofitted integrated CCS. Despite supporting carbon offset mechanisms to monetize CO₂ reductions, including through CCS, Saudi Arabia has made limited progress in implementing such measures domestically. To address this issue, Zakkour and Heidug (2019) have suggested a voluntary CCS-specific technology mechanism that would recognize and trade "carbon storage units" under the Article 6 emission offsetting mechanism of the Paris Agreement.

In comparison to other sustainability concepts, CCE also shares many similarities with the CE, as both aim to promote growth through circularity (Sauvé et al., 2016). The circular economy recognizes the finite boundaries of the planet in terms of resource availability and pollution absorption capacity and seeks to emulate natural cyclical processes by utilizing natural resources more efficiently, and reusing and recycling them (Sauvé et al., 2016). Similarly, the CCE acknowledges the Earth's limits concerning GHG concentration levels and aims to establish a safe balance by limiting fugitive carbon emissions while ensuring circularity in living and durable carbon flows.

2.2. Barriers to implementing CCE

Several recent studies have attempted to identify and categorize the barriers and challenges that organizations face when trying to adopt circular economy (CE) practices. Droege et al. (2021) found that implementing CE in the public sector is hindered by cultural barriers, a lack of awareness to assess CE, and insufficient commitment from top managers. In the European manufacturing industry, Laitala et al. (2021) identified barriers such as consumers' reluctance to purchase recycled products due to perceived lower quality standards, insufficient awareness of products made from recycled materials, and high costs of recycled materials. Salmenpera et al. (2021) conducted a qualitative study and grouped economic, market, technological, communication, organizational, regulatory, and sociocultural factors as major barriers to CE adoption. Feng and Lam (2021) highlighted barriers to CE adoption in China, including cultural factors, weak environmental standards, technological limitations, and financial constraints. Bressanelli et al. (2019) conducted a systemic literature review and identified critical factors affecting

the adoption of CE, such as supply chain management, economic and financial considerations, market competition, product attributes, standards and regulations, technological limitations, and consumer behavior. Other studies have associated factors such as low awareness of CE (De Medici et al., 2018), economic efficiency (Stahel, 2013), policies and regulations (Gottinger et al., 2020), technology and materials availability (Gusmerotti et al., 2019), social acceptance (Madonna, 2020), and collaboration among stakeholders (Buch et al., 2018) with the challenges and obstacles faced by organizations seeking to adopt CE practices.

Considering the fact that the implementation of CE is still in its infancy and CCE's structural similarities with CE, it is predicted that the implementation of CCE at organizational level is likely to face similar barriers as CE. However, it will be interesting to verify through the findings of this study whether these barriers diverge or converge from CE.

3. Research methodology

This research adopts a mixed (qualitative and quantitative) method approach (Khan et al., 2019) using a systematic literature review (SLR) to identify the potential barriers to implementing CCE (qualitative) and interactive structural modeling (ISM) to understand the relationship between these barriers and contextualize them to energy firms (quantitative). ISM is a popular methodological technique used to identify and summarize the nexus among particular items of the problem or issue under investigation. It also offers pathways to group complex items in a certain category which alternatively are used to identify particular relationships and overall structure among the items using a digraph model (Mandal and Deshmukh, 1994). Further, ISM is a venerable method to investigate the effect of one item over the other items (Qureshi et al., 2007). Earlier scholars have vigorously employed the ISM technique to analyze the influence of one factor on other factors, examine the intersection between factors in a similar spectrum, and categorize key elements from the pool of several factors in the studies on environmental, manufacturing, and supply chain disciplines (Kannan et al., 2008; Ravi et al., 2005; Sharma et al., 1995; Singh et al., 2003).

The shortlisted barriers are then validated through structured interviews with an expert panel of 10 professionals employed at managerial positions in Saudi Arabian energy firms. The data collection is done through structured interviews which will offer an inclusive insight into likely barriers to this novel carbon reduction approach and validate the barriers found in the literature. The content of the interview questionnaire will be prepared under the supervision of 4 academics and 4 practitioners who are experts in the thematic areas of CE and CCE. This will also help us in validating the content of the questionnaire before conducting our planned interviews. The interview responses will be recorded and decoded to understand the major themes which will eventually allow us to crosscheck the possible barriers of CCE. Overall, the methodological approach of this study is rigorous and robust.

4. Conclusion

This conceptual study aims to understand the major barriers to the implementation of CCE which is a novel technique to reduce carbon from fossil fuels. We targeted Saudi Arabia's energy firms for our data collection and planned interviews with experts in energy sectors to achieve the objectives of this study. This study is proposed as a developmental study and the authors expect that the results of this study may exhibit various implications for theory and practice during the empirical stage of the study.

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