UNIVERSITI TEKNOLOGI MARA

TECHNO-ECONOMIC ANALYSIS OF CARBON DIOXIDE SEQUESTRATION AND REUTILIZATION IN THE UPSTREAM SECTOR OF THE OIL AND GAS INDUSTRY

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Thesis submitted in fulfilment
of the requirements for the degree of
Doctor of Philosophy
(Business Management)

Faculty of Business and Management

July 2025

ABSTRACT

This thesis investigated the techno-economic analysis of carbon dioxide sequestration and reutilization in the upstream sector of the oil and gas industry. Carbon Capture and Storage (CCS) was a rather new technology with not much research established, especially in the latter part, the CO2 sequestration. Since CO2 sequestration is a new technology, less information is available in the discipline, especially in terms of economics. Apart from a lack of economic studies, CO2 sequestration is often associated with safety concerns regarding the CO2 stored. The amount of research in terms of CO2 sequestration done in Malaysian ground was still bleak. This research aimed to quantify the costs and revenues of CO_2 sequestration, assess its operational safety, conduct a cost–benefit analysis, and perform a sensitivity analysis of key economic. The economic theories governing the thesis work were discounting and intergenerational theory and social cost-benefit, which holistically addressed the economics and the project's safety using technical analysis as the guide. Methods used in the study were Monte Carlo simulation, reservoir simulation, cost-benefit analysis (CBA), and sensitivity studies. Reservoir simulation was utilized to estimate the amount of oil recovery and the CO2 that can be stored. Monte Carlo Simulation was used to categorize the cases into pessimistic, optimistic, and P50, where the optimistic was when the highest oil/carbon price and lowest CAPEX, and vice versa. CBA was done using economic indicators such as Annual Worth (AW), Present Worth (PW), and Future Worth (FW). For the sensitivity analysis, spider plots were used where the economic indicator was Net Present Value (NPV). Since CO2 sequestration resembled upstream oil and gas undertaking much, the PSC system was embedded into the computation and Income Tax Allowance (ITA) too as gazetted in the 2023 National Energy Transformation Roadmap (NETR) blueprint. The results were divided into 2 categories: enhanced oil recovery/secondary recovery and standalone CO2 sequestration. The outcome of the analysis showed that for EOR/secondary, positive outcomes in terms of NPV, internal rate of return (IRR), and payback period were obtained for P50 and the optimistic case, while the pessimistic case registered a loss. The same finding was true for standalone CO2 sequestration, except the P50 case registered a loss as well. In terms of the safety of the operation, the injection process was concluded to be a safe operation because the injection pressure did not exceed the fracture pressure. The sensitivity study revealed that the factors having the highest governance on the profitability varied based on the Monte-Carlo category. For the pessimistic study, the CAPEX had the most prominent effect, while for the optimistic was the oil/carbon price. The implication of the study revealed that to ensure the CO2 sequestration project became monetarily successful, a higher carbon price is needed unless the operation is coupled with EOR (utilization).

ACKNOWLEDGEMENT

Firstly, I wish to thank Allah S.W.T for giving me the opportunity to embark on my PhD and for completing this long and challenging journey successfully. My gratitude and thanks go to my supervisor, Dr. Muhammad Adidinizar Bin Zia Ahmad Kusairee. He was my main support throughout my PhD journey in many ways.

My appreciation goes to Assoc. Prof. Lee Jang Hyun, who provided guidance in my PhD and gave me a career as well. A special thanks to Assoc. Prof. Dr. Khaled Abdalla Elraies, and Assoc. Prof. Ir. Dr. Sivakumar Sivanesan, who gave me a career that indirectly boosted my motivation to complete my PhD. A special thanks to my co-supervisor as well, Assoc. Prof. Ir. Dr. Ismail Mohd Saaid and Assoc. Prof. Dr. Hazliza Haron.

Finally, this thesis is dedicated to the loving memory of my very dear late father, my brother, and my mother for their vision and determination to educate me. This piece of victory is dedicated to three of you. Alhamdulilah.

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