International Journal of Social Science Research and Review

http://ijssrr.com
editor@ijssrr.com
Volume 5, Issue 7
July, 2022
Pages: 253-268

Static and Dynamic Game Theory in Common Oil and Gas Fields: A Literature Review and Bibliometric Analysis

Seyed Pendar Toufighi[1]; Zahra Soltani[2]

[1] Department of Industrial Management, University of Tehran, Tehran, Iran

[2] Department of Energy Economics, University of Kharazmi, Tehran, Iran

Email: toufighi.p@ut.ac.ir

http://dx.doi.org/10.47814/ijssrr.v5i7.356

Abstract

This paper provides a systematic literature review and analysis of game theory to model oil and gas scenarios. We select and review 2514 papers from Scopus, present a complex three-dimensional classification of the selected papers, and analyze the resultant citation network. According to the industry-based classification, the surveyed literature can be classified in common oil and gas supply chain fields. Based on the types of players, the literature can be classified into papers that use government-contractor games, the contractor–contractor games, contractor-subcontractor games, subcontractor–subcontractor games, or games involving other players. Based on the type of games used, papers using normal-form noncooperative games, normal-form cooperative games, extensive-form noncooperative games, or extensive-form cooperative games are present. Also, we show that each of the above classifications plays a role in influencing which papers are likely to cite a particular paper. However, the type-of-game classification exerts the strongest influence. Overall, the citation network in this field is sparse, implying that the authors' awareness of studies by other academics is suboptimal. Our review suggests that game theory is useful for modeling oil and gas scenarios. More work needs to be done on production in this domain and using extensive-form noncooperative games.

Keywords: *Oil and Gas Common Field; Game Theory; Literature Review; Bibliometric Analysis*

1. Introduction

Due to the wide range of possible conflicts, from small disagreements to international military campaigns, there is a great demand for formal methodologies to understand and evaluate real-world conflicts (Madani & Hipel, 2011). (Arsenyan et al., 2015) commented that game theory is a well-known tool to model the potential conflicts among agents, providing insights on negotiating or collaborating under particular conditions and looking for equilibrium solutions. The main goal is to predict the consequences of making potential choices for all players involved to select the best possible action (Kelly, 2003). (Souza & Rêgo, 2013) added that conflicting and cooperative strategic choices could hugely influence agent outcomes in any strategic interaction. The main contributions of game theory approaches are understanding how agents interact strategically under some basic assumption of rationality and considering other agents' expectations in their choices (Osborne & Rubinstein, 1994).

The oil and gas supply chain is characterized as a dynamic business environment dominated by corporate partnerships and joint ventures, as well as tight governmental regulation, where the understanding of all these agents' interests is particularly important to solve potential conflicts (Willigers et al., 2009); (Zhu & Singh, 2016). (Oliveira & Lopes, 2016) mentioned that the oil and gas industry is characterized as a competitive environment with many current challenges, such as price fluctuation, environmental conservation, and partnership among major companies. Huge investment requirements also characterize this industry, generally executed by partnerships and joint ventures for cost and risk sharing (Castillo & Dorao, 2013). (ALCOCK & Johnston, 1994) argued that the main objectives of partnerships and joint ventures among oil and gas companies are to share risks, maximize investment portfolios and optimize short and long-term strategies.

Consequently, allocating capital into the correct portfolio is critical for the oil and gas industry when evaluating possible partnerships (Lopes & Almeida, 2013). Another source of potential conflicts among partnerships is the vertical integration between oil and gas exploration companies and their suppliers, intending to share their particular risks and costs (HAMACHER & MARTINS, 2015). Hence, the presence of multiple (Bratvold & Koch, 2011) argued that potential game theory applications in the oil and gas industry could be grouped into three main categories: (i) competitive bidding, in which companies usually face strong competition among themselves in bids or auctions for oil and gas exploration opportunities; (ii) negotiation between partners, allowing the companies to look at the negotiation from all possible sides, discovering key tradeoffs and accepting terms to create win-win solutions; and (iii) joint ventures and partnerships, in which oil and gas companies need to evaluate cooperation initiatives with their competitors, governments, investors and others, to understand their partners and develop strategies to achieve the best outcome. (Willigers et al., 2009) added two other potential practical applications: (iv) rivalry between service providers, whereby service companies generally compete to be suppliers of oil and gas companies and should decide their strategies based on the relationship between profitability and risks of losing the bid; and (v) employee unions relationship, whereby although oil and gas employees and corporate management might have conflicting objectives, both parties should understand each other and cooperate to maintain business sustainability (Bagheri Nasrabadi et al., 2022; Wagstaff et al., 2021). (Nakhle, 2008) complemented the saying that regional rivalries could be a potential source of many conflicts of interest that affect the oil and gas agents. Each strategy's impact on the outcomes makes the oil and gas industry an interesting field for applying game theory. Industries, such as (i) the UK-Scotland tax rate division conflict; (ii) tribal conflicts in Western Sudan; (iii) division of oil and gas earnings in Russia; (iv) conflicts among some countries in the Caucasus region concerning oil and gas pipelines; and (v) intense regional rivalries in Iraq about the division of its oil and gas resources and revenues (Fedorenko et al., 2021).

In this context, game-theoretic models can aid in the adequate visualization of the strategic interactions faced by the oil and gas industry, with the main goal of a better understanding of the issues or problems, aiming to improve the decision-making processes (Jiang et al., 2022; Roman & Stanculescu, 2021). Applying a game theory approach makes it possible to identify an intrinsic and particular logical structure, where different frameworks for modeling them are exclusively needed. For social and economic interaction and interdependent decision-making processes, the framework of mixed-motive games, with the specific case of 2 x 2 symmetric games, is the most used (Kelly, 2003). (DeCanio & Fremstad, 2013) mentioned that the 2 x 2 symmetrical games were summarized by (Robinson & Goforth, 2005), who proposed to organize and classify these games as a "New Periodic Table" (NPT) in a unified topological framework based on a natural measure of the players' payoff structures. According to (Robinson & Goforth, 2005), Von Neumann and Morgenstern were the pioneers in providing the foundations of game theory methodologies. (Rapoport & Kahan, 1976), and (Brams, 1994) proposed a more organized and structured game theory approach that produced typologies of 2 x 2 games (Keshavarz et al., 2021). Nonetheless, (Robinson & Goforth, 2005) argued that these typologies could be replaced by the topologies presented in the NPT. They provide an easier, more flexible, and better relationship understanding and an improved design for generating testable hypotheses about 2 x 2 strategic games (Golestani et al., 2021; Gupta, 2021). According to the above, the contributions of this research are following:

- A systematic and thorough review based on the citation network analysis.
- Discussion of the theoretical background and main solution concepts.
- The revealed research communities focus on common oil and gas fields and Game Theory applications.
- The applicability of Game Theory in the common oil and gas field becomes recognized.
- We present the bibliometric analysis illustrating time-evolving interests in particular areas, the most published authors, top journals in the field, and most popular keywords.

In Section 2, we illustrate in detail the role of the game theory in common oil and gas fields. Sections 3-4 introduce a systematic review of existing research based on the citation network analysis. Within each of the directions, we discover research highlight and their contributions. We also investigate the bibliometrics of the related literature and discover the most cited authors, top journals in the field, and most popular keywords. Finally, Section 5 concludes the research.

2. *Role of Game Theory in Oil and Gas Fields*

This section first reviews the status of dissertation articles and research papers in oil and gas that were conducted using the game theory approach. All information was drawn from the Scopus website to draw charts. In recent years there has been an upward trend in the number of articles published indicating the importance and necessity of using game theory in the energy field, especially oil and gas. The following is the background of the research in three areas of papers related to applying mathematical Optimization in oil and gas and energy and the application of game theory in oil and gas and energy. Finally, the application of game theory in the common oil and gas fields is described.

(Yue et al., 2014), entitled Biomass and Biofuel Supply Chain Optimization: An overview describes the key issues and challenges in modeling and optimizing biofuel - bioenergy supply chains. This paper examines the main energy pathways from soil and aquatic biomass to bio/biofuel products and power and heat, emphasizing "drop-in liquid hydrocarbon fuels." Then the key components of the bioenergy supply chains are presented along with a comprehensive overview and classification of the existing biofuel/bioenergy supply chain optimization. This paper identifies development paths for future research that focus on multiscale modeling and Optimization, which enables integration between spatial scales from in-unit operations to refinery processes and across time scales from operational level to strategic level. Issues related to sustainability modeling and treatment of uncertainties in supply chain optimization are also discussed. (Garcia & You, 2015) studied an article titled Opportunities and Challenges in Supply Chain Optimization and discussed key opportunities and challenges in supply chain design. However, these research opportunities derive from modeling, algorithms, and computational challenges. There are three major technical challenges in which knowledge gaps can be addressed in supply chain design: multiscale, multi-purpose and sustainability, and multi-player. Provides relevant technicalities and a perspective on how these challenges might be addressed in supply chain design. (Yue & You, 2015) has published an article entitled bi-Level Optimization for Design and Operation of

Biofuels Supply. A nonlinear mixed-integer programming model has been proposed for an optimal investment of biofuels equipment considering noncooperative operation and biofuel customers. The Nash equilibrium hypothesis applied the interactions between supply chain players through Stackelberg Game (one leader - one follower) (Jafarzadeh et al., 2021; Morais et al., 2014).

Applications of the proposed framework have been illustrated through a case study. On the other hand, computational experiments have shown that the proposed solution strategy can improve productivity. (Zhang et al., 2017) conducted a study designing a mixed-integer mathematical model to determine offshore oilfields' optimal resource collection rate. Since the offshore oil collection system is one of the key components of oil extraction, optimizing this system is one of the key processes in reducing the costs of producing oilfields. Minimization of extraction costs was designed and resolved. (Z. Wang et al., 2016) developed a Stackelberg game theory model to optimize product family architecture with supply chain considerations. Planning an optimal product family architecture plays a vital role in defining the product structure for configuring the product type while using diversity. The focus of PFA planning has traditionally been confined to the product design phase; however, given the supply chain issues, supply chain configuration decisions have a profound impact not only on the final cost of realizing the product family but also on how the module architecture is designed within one. It is necessary to optimize the product family and supply chain configuration decisions. A mixed-integer two-level programming model has been developed to counter the leader-follower game decisions between product family architecture and supply chain configuration. The PFA decision is shown as a high-level optimization problem for an optimal base and composite modules selection. There is a lower-level optimization problem with supply chain decisions, in line with high-level product type configuration decisions. In conjunction with the bi-level optimization model, a nested genetic algorithm is developed to derive optimal solutions for PFA and the relevant supply chain network. A case study of supply chain decisions for power transformers has been reported to illustrate the potential for joint Optimization of the Stackelberg game theory and supply chain decision making.

(Jin et al., 2018) conducted a study to develop an integrated model for energy system planning and carbon dioxide reduction under uncertainty among bi-level decision-makers. A Multilevel Planning Approach (BFLP) was developed for Energy Systems Planning (ESP) and carbon. Reducing carbon dioxide in uncertainties can manage incomplete leader-follower information in decision-making processes. It can also examine the balance between different decision-makers with two decision-makers. The planning of the energy system in Beijing has been aimed at a high-level aim to minimize CO2 emissions and a low-level aim to minimize system cost. The model is designed to minimize system costs compared to the single level since the system prefers cleaner energies (i.e., natural gas, LPG, and electricity). The results also showed that a low-carbon policy for power plants (for example, cutting off all firepower plants) could lead to a potential increase in energy imports for Beijing, which would increase the risk of energy shortages. These findings can help decision-makers analyze the interactions between different stakeholders in the ESP and provide useful information for designing policies following UN standards. Table 1 summarizes mathematical modeling research in oil, gas, and energy optimization.

2.1. Game Theory in Common Oil and Gas Fields

(Esmaeili et al., 2015) conducted an article using the game theory approach to select sustainable strategies for Iran's Common oil and gas Fields versus Iraq and Qatar. Since oil and gas resources are unstable and endless and depend on the economies of countries such as Iran, Iraq, and Qatar that share common ground, game theory must approach interests and consequences. This study used a game with incomplete 2 * 2 information. Predictive games such as Prisoner, Chicken, and Hunter games were used to investigate the consequences of the players, which were predicted due to lack of players' information and strategy and incomplete play. According to different scenarios in this study, the best strategy for cooperative players was identified. (Havas, 2015) has completed a master's thesis on the erosion war on the Arctic coast: oil spill technology and high-risk investments in oil and gas extraction. The model developed in this paper examines the oil and gas extraction strategies of the two countries, Norway and Russia, which want to enter the Arctic coast. These strategies are analyzed using the game of attrition in which both countries play a mixed strategy. This model examines the impact of two players' inertia on decision making and the other on specific technologies and the irreversibility of investment.

Both of these factors prevent players from entering the Arctic coast. Also, this model has been developed to investigate the possibility of an oil spill on the Arctic coast and a periodic decline in the expected return on investment. Oil leakage is likely to reduce countries 'tendency to enter the Arctic. At the same time, periodic declines are expected as a result of investment expected to increase countries' willingness to enter the Arctic, as the sooner mining begins, the greater expected return on investment. (Salimian & Shahbazi, 2017) examined Iran's strategies for using common oil and gas fields with a game theory approach. Since 60 percent of the world's oil and 60 percent of its gas resources are in the Persian Gulf, maximizing Iran's interest in using its oil and gas fields will be crucial. The authors identified the best strategy for Iran and other countries in using common oilfields, cooperative and noncooperative gameplay, and static gameplay with complete information and simplified assumptions about the amount of storage and costs and the same strategies. (Toufighi et al., 2020) optimized production in the Forouzan common oil field based on game theory. (Toufighi et al., 2022) studied Modeling of Production Strategies from Common Offshore Gas Field with Game Theory Approach. (Toufighi, 2022) examined assessing the stability of the oil and gas production in common fields in onshore and offshore.

Table 1- Summary of Mathematical Modeling Research in Oil, Gas and Energy Optimization

No.	Year	Researchers	Research Tools			Research Goal	Case Study
			Solution Tools	Modeling Tools	Analytical Tools		
1	2014	(Yue & You, 2014)	Cplex	MILP	Mathematical Optimization	Modeling and optimization of biofuel - bioenergy supply chains	Several biofuel companies in China
2	2015	(Yue & You, 2015)	GAMZ	MILP	Mathematical Optimization	Bi-level Optimization for design and operation of biofuels	Several biofuel companies in China
3	2015	(Garcia & You, 2015)	Qualitative Analyze	Literature Review	Mathematical Optimization	Exploring key opportunities and challenges in supply chain design	Literature Review
4	2016	(D. Wang et al., 2016)	Genetic Algorithm	B- level Optimization	Mathematical Optimization	Optimizing the Family Architecture of Oil and Gas Products with Supply Chain Considerations	Building a Supply Chain for Power Transformers in Japan
5	2017	(Zhang et al., 2017)	GUROBI Optimizer in MATLAB	MILP	Mathematical Optimization	To determine the optimal amount of resource extraction from offshore oilfields	Two hypothetical examples
6	2018	(Jin et al., 2018)	MATLAB	Fuzzy Dual Objective Planning	Mathematical Optimization	Energy systems planning and carbon dioxide reduction under uncertainty	China's energy demand for 2000-2015

Table 2- Summary of the Applications of Game Theory in Common Oil and Gas Fields

No.	Year	Researchers	Research Tools			Research Goal	Case Study	Results
			Solution Tools	Modeling Tools	Analytical Tools			
1	2015	(Esmaeili et al., 2015)	Manual Solution	Game with incomplete information 2 * 2 Prisoner, Chick, and Hunter	Game Theory	Choosing sustainable strategies for Iran's shared oil and gas resources versus Iraq and Qatar	Investigating Iran's Oil and Gas Conflicts with Iraq and Qatar	The best strategy for players was identified as a Cooperative game.
2	2015	(Havas, 2015)	Manual Solution	Mixed Nash Equilibrium	Game Theory	Investigation of oil and gas extraction strategies in Norway and Russia	Russian-Norwegian common oil and gas fields	The sooner a country begins to extract oil, the greater the expected return on investment.
3	2018	(Salimian & Shahbazi, 2017)	Manual Solution	Static game with full information	Game Theory	Investigating Iran's Strategies for Using Common Oil and Gas Fields	Hypothetical data	Simplified assumptions about the amount of storage and the same costs and strategies
4	2020	(Toufighi et al., 2020)	MATLAB, LINGO	Static Game	Game Theory	Optimization of Iran's Production in Forouzan Common Oil Filed Based on Game Theory	Iran's Common Oil Fields in Onshore	The best strategy for players was identified as a Cooperative game.
5	2022	(Toufighi et al., 2022)	MATLAB, LINGO	Static Game	Game Theory	Modeling of Production Strategies from Common Offshore Gas Field with Game Theory Approach	Iran's Common Gas Fields in Offshore	The best strategy for players was identified as a Cooperative game.
6	2022	(Toufighi, 2022)	MATLAB, LINGO	Static Game	Game Theory	Assessing the Stability of the Oil and Gas Production in Common Fields: Application of Game Theory	Iran's Common Oil &Gas Fields in Onshore & Offshore	The best strategy for players was identified as a Cooperative game.

3. Research Methodology

With the mentioned backdrop, we used *"Systematic literature review"* and *"bibliometric analysis"* to understand the relationship of these mentioned approaches and tools. *"Systematic literature review"* is aimed to identify past or existing trends in specific knowledge and evaluate its body or potential research gap (Tranfield et al., 2003). Bibliometric analysis is one of the systematic literature reviews introduced by (Pitchard, 1969) to explicate the communications of scientific texts or written contents of a discipline, which later expanded to the analysis of database websites, etc. (Thelwall, 2009). Indeed, a systematic review has been argued to provide the most efficient and high-quality method for identifying and evaluating extensive literature (Mulrow, 1994). Today, bibliometric analysis is widely used to study quantitative aspects of science and technology literature (Boyack et al., 2005);(Callon et al., 1986);(Hertzel, 2003);(Noyons, 1999). Overwhelming quality management was a motivation to conduct this study using this method. "Systematic literature review "method is classified into different categories, including literature characteristics (Nicholas & Ritchie, 1978) such as authors and co-citation analysis or analysis of producers (institutions, organizations) (Borgman, 1990), geographical region, year or period (Stevens, 1953), artifacts (journal articles, websites) (Stevens, 1953), content analysis such as topic analysis (Griffiths & Steyvers, 2004) and text mining (Wilson & Osareh, 2003).

3.1. Bibliometric analysis on Game Theory

The methodology of Game Theory bibliometric will be a three-level process. The first one is finding and sorting the texts and papers that effectively inform GAME THEORY knowledge. Secondly, the potential structure of knowledge will be extracted from texts and papers, and finally, this structure will be visualized and mapped using bibliometric software VOS VIEWER. We used Web of Science (WOS) in the first step because the database encompasses a wide range of GAME THEORY papers and related scientific texts. The texts will be all the game theory papers that have been published from 1955 up to now. For bibliometric analysis, the title, abstract, and keywords of these papers will be sorted for processing in bibliometric analysis. Firstly, the related papers must be extracted by searching keywords in the WOS database to extract the most related text. Table 3 shows the main words identified in GAME THEORY literature as the most important topics and the main GAME THEORY tools and techniques. The terms will be used for searching the body of knowledge.

Table 3- Keywords of GAME THEORY

Context Keyword
(Common oil field and game theory) or (Oil and Gas) or (Oil and Gas improvement) or (oil and gas common field) or (oil and gas common field production) or (Oil and Gas supply chain) or (Optimization of oil and gas common field) or (a cooperative game in the gas industry) or (a cooperative game in the oil industry) or (game theory in the gas industry) or (game theory in the oil industry) or (game theory in oil supply chain) or (gas supply chain) or (Nash equilibrium in the oil industry) or (Nash equilibrium in the gas industry) or (oil supply chain).

The primary result includes 173,875 articles and books, etc., which were refined according to "document type" and were reduced to 144,467 articles. This paper is aimed to study GAME THEORY in the oil and gas industry. The second step was excluding unrelated articles. The total number of remaining articles is 2514. The next step to obtaining valid evidence for further analysis is selecting journals about game theory to purify irrelevant texts. Table 4 reveals refining articles to Game Theory and Energy journals. We could call these journals the core Journals of game theory or related magazines.

Table 4- Core magazines of Web of Science in game theory

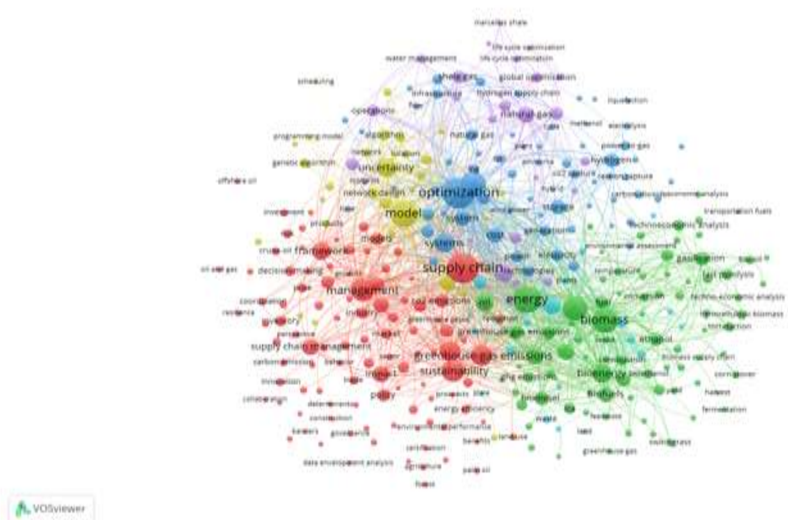
No.	Journal Name	Number of Articles
1	Applied Energy	143
2	Energy	124
3	Renewable And Sustainable Energy Reviews	95
4	Energy Policy (Journal)	93
5	Computer And Chemical Engineering	87
6	Energies (Journal)	82
7	Industrial & Engineering Chemistry Research	68
8	Biomass And Bioenergy	53
9	International Journal of Hydrogen Energy	53
10	International Journal of Production Economics	47
11	ACS Sustainable Chemistry & Engineering	39
12	European Journal of Operation Research	36
13	Biofuels Bioproducts & Biorefining	34
14	Energy Economics	34
15	Aiche Journal	33
16	Renewable Energy	32
17	Energy Conversion and Management	32
18	Journal Of Natural Gas Science and Engineering	27
19	International Journal of Production Research	26
20	fuel	24

In table 5, the number of published articles of the top-fifteen countries. "USA" with 539 articles is the pioneer of publishers of game theory in oil and gas industry papers, and the second and third position belongs to "China and England." According to the table, the number of published articles in the USA greatly differs from other countries.

4. Result

4.1. Results of the reference analysis unit; Keywords

The software entered the keywords of extracted papers, and ten times of occurrence were adopted as the minimum rate of occurrence. VOS Viewer recognizes 9094 verbs. Then, after refining irrelevant and also merging synonyms, 326 items remained, which is visualized according to the following map:



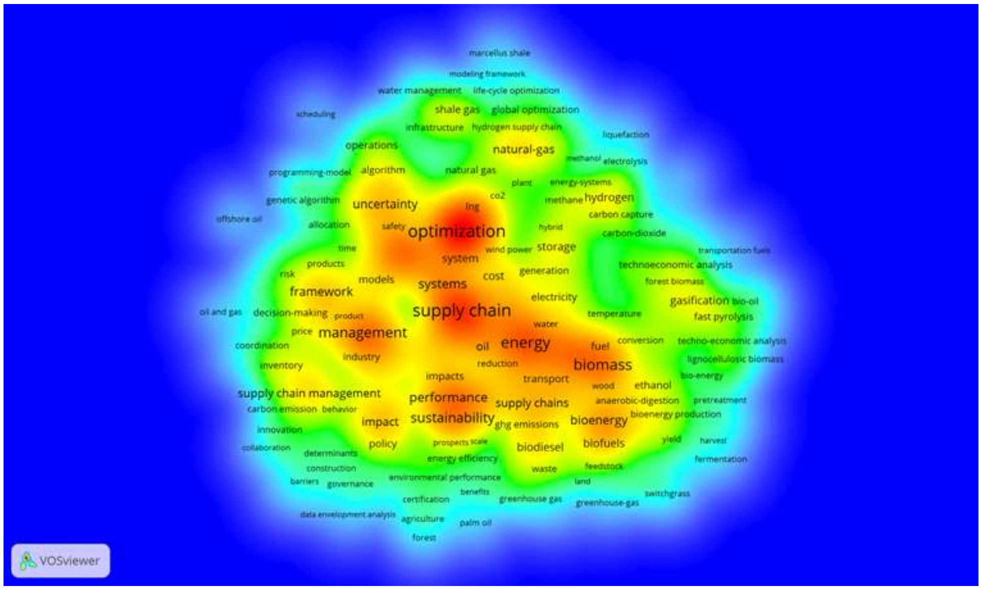
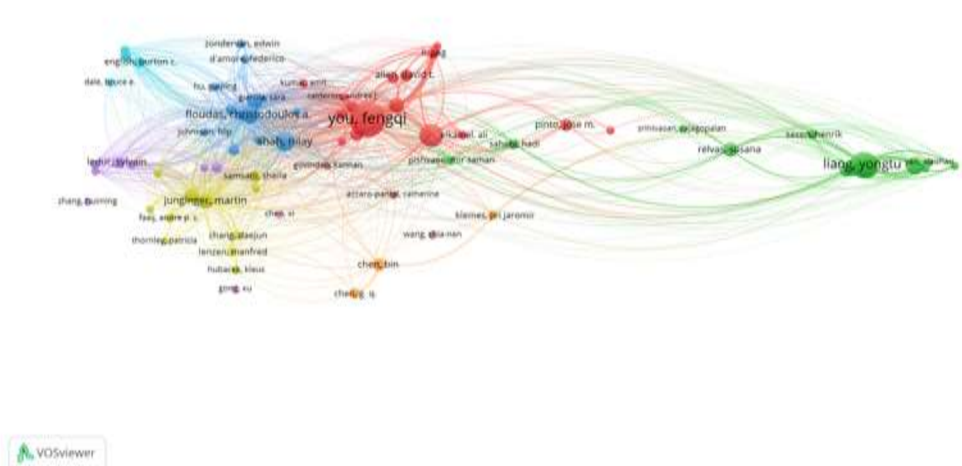


Fig 1- Co-occurrence map of the keywords

VOS Viewer can also find a bibliometric mapping of game theory related to the oil and gas industry. The bibliometric mapping of the keywords used is shown in Figure 1. The bibliometric analysis shows several widely used keywords in the paper that are the research object. The more keywords that appear, the wider the circle indication will be. While the line relationship between keywords shows how much they are related to other keywords.

The most used keywords Optimization, Supply Chain, and Energy were the highest co-occurrence. Based on the closer network visualization in VOS viewer, Optimization was more strongly interlinked with four keywords: Supply chain, Energy, and Model. These could be considered the important topics in Optimization research to game theory.

4.2. Results of the reference analysis unit; Authors



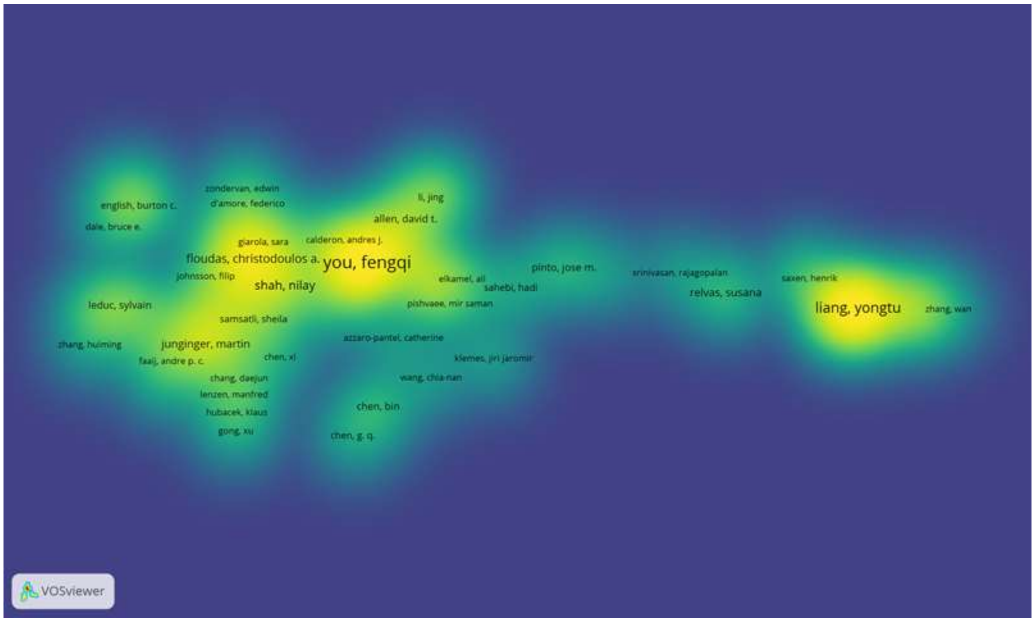
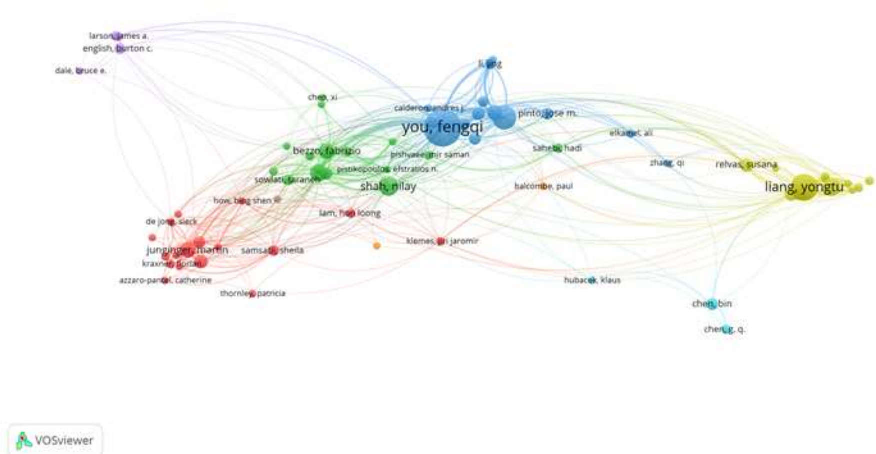


Fig 2- Bibliographic coupling map of the Authors

A total of 6470 authors conducted research in game theory and the oil and gas industry. Figure 2 shows the Bibliographic coupling map of the 75 selected Authors. These authors were distributed into nine clusters.

The bigger shape and the brighter the colour, the author is publishing more and more writings related to Game theory. The appearance of cluster density depends on the level of yellow light brightness. It identifies that the yellow colour on the map depends on the number of items associated with other items. It is possible to interpret the authors who have published the most from the map. Based on these results, the bigger and brighter the author's name, the more papers he published. The author's most published publications related to game theory are based on bibliometric mapping, shown in cluster 1, namely Fengqi You, with 40 documents published in this subject.



International Journal of Social Science Research and Review
Volume 5, Issue 7
July, 2022

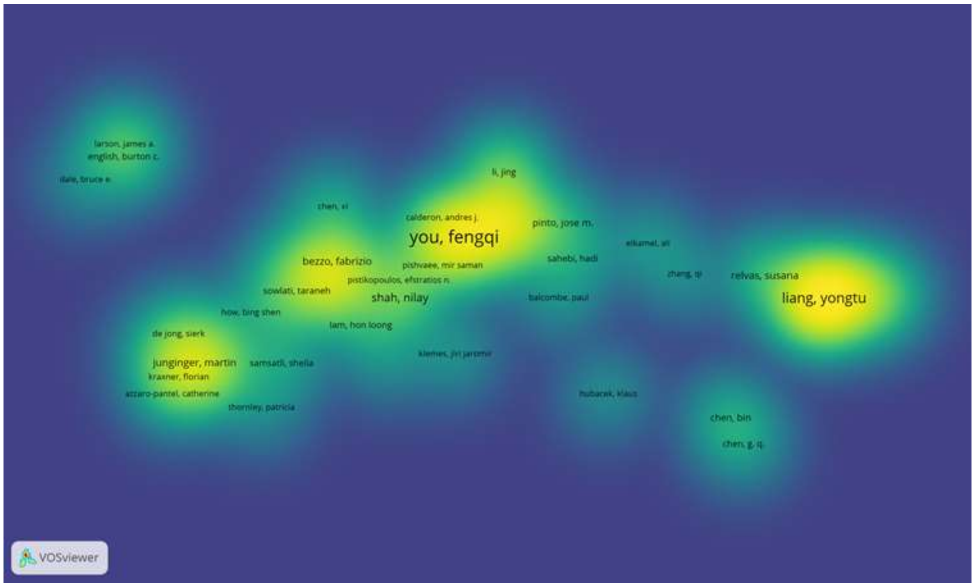
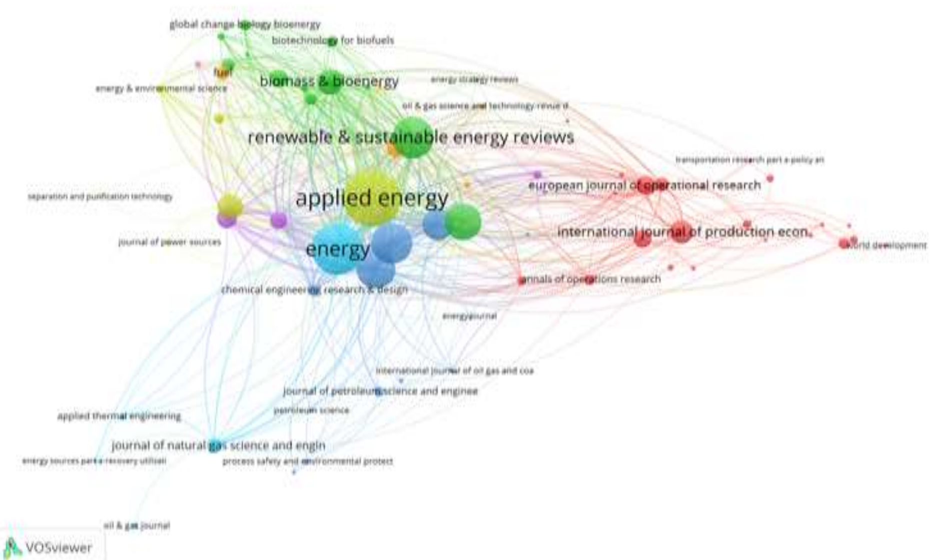


Fig 3- Citation map of the Authors

Based on citation type of analysis which used VOS viewer software to illustrate the visual map produced from bibliographic data, the cited author unit was analysed by the full counting method. The minimum number of documents of an author is 5; from 6470, only 76 authors met the threshold. For each of the 76 authors, the total strength of the citation links with other authors was calculated. Therefore, Figure 3 demonstrates the documents of an author with the greatest total link strength. Therefore, Fengqi You was the most published author with 40 documents and a total link strength of 650.

4.3. Results of the reference analysis unit; Sources



International Journal of Social Science Research and Review

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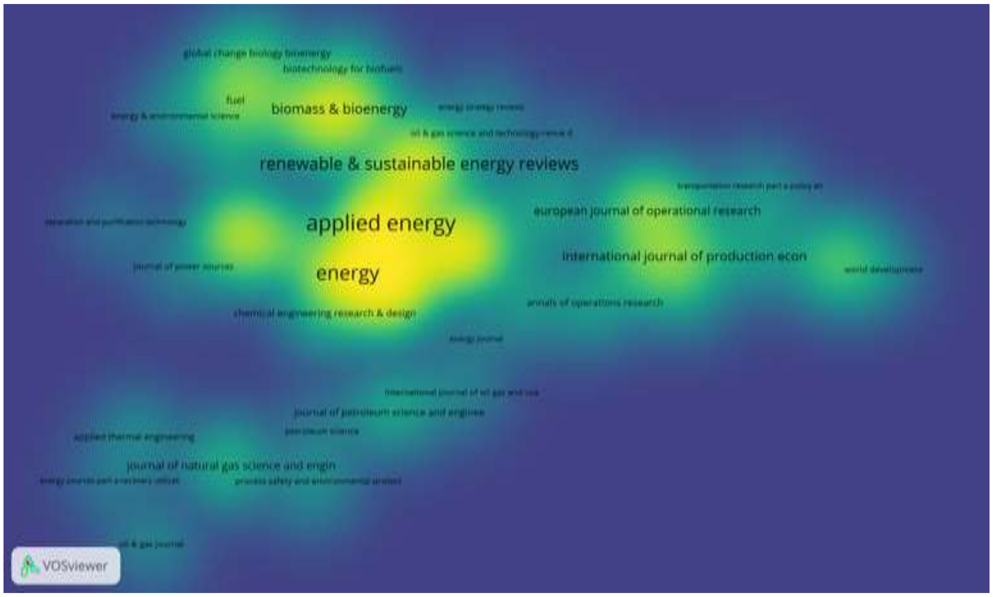

Fig 4- Citation map of the Sources

Based on the VOS viewer software analysis used to illustrate the visual map generated from bibliographic data based on a citation type of analysis, the cited resource unit was analysed by the full counting method. The minimum number of citations of cited references was 5. Of the 319 cited references, 74 met the thresholds. For each of the 74 cited references, the total strength of the authorship links with other cited references was calculated. Figure 9 shows that the cited references with the greatest total link strength were selected. The "applied energy" source had 4289 citations, 143 documents, and a total link strength of 485. The second source refers to "energy," with 4428 citations, 124 documents, and a total link strength of 493. The third source on publication is "renewable & sustainable energy reviews," with 4428 citations, 95 documents, and a total link strength of 380. Finally, the International Journal of Applied Energy had a more significant contribution with a higher score of citations.

Conclusion

Several oil and gas scenarios where decision-making takes place lend themselves to be modelled using game theory. Many studies have applied game-theoretic analysis in this field; however, a concise review of such efforts was lacking. This review paper systematically searched, selected, and reviewed papers that have used game-theoretic analysis in the oil and gas common field. We also proposed a set of classifications that structure and define this niche and demonstrated the importance of such classifications. We analysed the relative importance and impact of the papers reviewed and identified gaps in the literature which represent future research opportunities.

Our analysis showed that papers in this field could be classified based on the domain of application, how the players are modelled, or the type of game utilized. In terms of the domain, papers focusing on the construction domain are the most prominent, though papers also focus on the common field domain. In terms of modelling the players, we showed that five classes of papers exist: papers that model government-private sector games, papers that model contractor–contractor games, papers that model contractor-subcontractor games, papers that model subcontractor–subcontractor games, and papers that model games involving other players. We showed that a complex matrix-based classification exists regarding the type of games used. However, the four basic classes present are papers that use normal-form noncooperative games and those that use normal-form cooperative games. These papers use extensive-form noncooperative games and papers which use extensive-form cooperative games. Based on these

classifications, we showed that papers that focus on common fields and papers that use extensive-form cooperative games are relatively few, representing gaps in the literature.
We also showed that a paper is more likely to cite another paper within the niche if both focus on the same application domain or use the same types of games. In particular, we showed that two large "citation clusters" exist: papers that use noncooperative games mainly in the oil and gas domain and papers that use normal-form cooperative games, which are common field focused and not specific to any application domain. Overall, we made a very strong case for the widespread use of game theory to model and analyse oil and gas-related scenarios by highlighting a range of scenarios where it could be used and the types of games that could be used in each such scenario.

Even though there have been some efforts in the past to summarize efforts made in applying game theory to oil and gas, they have been focused on specific authors, countries, or application domains. On the other hand, this review employed a conscientious and methodical selection process not cantered on any author, country, or application domain. This review also emphasizes structuring, classification, and citation analysis of the covered literature. It also focused explicitly and methodically on citation relationships between the papers it reviewed, highlighting how the works are interrelated and which papers acted as catalysts for further research in the field.

This review highlighted that game theory is a useful tool for analysing oil and gas scenarios, and applying game-theoretic analysis in this field has great potential. Still, at present, this is a developing field. Studies in this niche are often unaware of each other, and the citation density within the niche is relatively low. Therefore, more collaboration must occur among researchers applying game theory in the oil and gas industry, spanning domains and choice of games. This review is expected to catalyse increased interest in applying game theory in oil and gas. It will encourage cross-domain collaboration and sharing of expertise to realize the full potential of game theory in analysing common field oil and gas problems.
The overview illustrated in this research and the citation network analysis performed can help scientists and researchers comprehend the GT solution, discover new applications for common fields, and contribute to the state-of-the-art of this promising multidisciplinary research direction.

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